EVALUATING EFFECTS OF FINE SEDIMENT ON SALMONID EGG SURVIVAL, PRAIRIE CREEK, NORTHWESTERN CALIFORNIA

A Proposal To

The U.S. Man and the Biosphere Program

Submitted by:

Randy D. Klein
Mary Ann Madej
Redwood National Park
1125 16th Street
Arcata, California 95521

(707) 822-7611

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Project Title: Evaluating Effects of Fine Sediment on Salmonid Egg Survival, Prairie Creek, Northwestern California

Principal Investigators:

Randy Klein, Geologist, Redwood National Park
Mary Ann Madej, Geologist, Redwood National Park
Thomas Lisle, Hydrologist, U.S. Forest Service Pacific Southwest Forest and Range Experiment Station
G. Mathias Kondolf, Asst. Professor of Environmental Planning, U.C. Berkely
Roger Barnhart, Professor of Fishery Science, Humboldt State University

Background:

Prairie Creek, located within Prairie Creek Redwoods State Park, is one of the few remaining examples of a pristine redwood ecosystem. The main channel of Prairie Creek, as well as the lower reaches of several tributaries, are important areas for anadromous fish habitat (chinook and coho salmon and steelhead trout). Each winter, several runs of anadromous fish migrate up Prairie Creek from the Pacific Ocean to spawn in the high quality gravels which compose the streambed.

Several years ago, a large highway construction project was begun which crossed the headwaters of several tributaries to Prairie Creek. A failure to implement erosion control measures on the construction site prior to the onset of winter rains in October, 1989, caused a large amount of fine sediment to enter the stream system as a single pulse. Ongoing monitoring has shown that a large proportion of this sediment remains in temporary storage in the gravels of the tributary streambeds. Future high streamflows are expected to transport this sediment downstream through important fish spawning reaches over the next several years. As this material moves downstream, it is likely to have a significant effect on salmonid egg survival.

When anadromous fish dig nests (called redds) in which eggs will be laid, they cleanse the streambed gravel of fine sediments in the process. When the eggs are buried after fertilization, the cleansed gravel allows relatively unimpeded water flow through the redd, supplying sufficient dissolved oxygen and removing the waste products from around the developing eggs. When excessive amounts of fine sediment infiltrate into the egg-bearing zones (pockets) within the redd, the flow of intragravel water can be slowed to a point resulting in diminished egg vitality or, in severe cases, egg mortality.

Studies aimed at quantifying the effects of fine sediment on salmonid spawning have been conducted since the 1920's by researchers from both the physical and biological sciences, owing to the interdisciplinary nature of the problem. In spite of the vast effort, however, progress toward defining reliable variables to predict effects of fine sediment on salmonid reproduction success has been slow. Practical difficulties associated with measuring the physical attributes of a streambed are coupled with difficulties in measuring salmonid egg health and survival in the stream environment. In addition, past studies have not focused on measurement of conditions specifically in the egg pocket, which have been shown to differ from those in other locations within the redd. Finally, lack of standardization of measurement techniques and methods of data expression have hampered comparison of studies and pooling of data sets.

Approach:

Recent work on the effects of fine sediment on salmonid egg survival has recommended specific data collection and expression methods to be standardized in future studies. Also, measurement of conditions within the egg pocket has been advocated as the best method of determining effects at the crucial locality. The study proposed here takes these recommendations to heart. We propose to utilize methods of assessing physical conditions which have been shown in past studies to correlate well with salmonid egg survival. These proven methods will be integrated in a unique manner which will likely reduce some of the variability which has hampered interpretation of results of past studies.

Objectives:

Two objectives are identified for this study. The first is to quantitatively assess the impacts to salmonid spawning success of the sediment derived from the highway construction project. The second is to help identify the most appropriate predictors of effects of fine sediment on salmonid egg survival.

Study Site:

The Prairie Creek watershed lies within the boundaries of both Prairie Creek Redwoods State Park and Redwood National Park in northwestern California. The entire watershed, as well as much of the adjacent land, is designated as a biosphere reserve. Located near the Pacific Coast, the area has a mild, temperate climate. Prior to the influence of the highway construction project, nearly all of the watershed was composed of pristine, old-growth redwood forest.

In much of the Pacific Northwest, degradation of spawning habitat due to land use has been a major contributor to the decline of native runs of anadromous fish. Undisturbed watersheds are extremely rare, and those which remain are valuable as examples of ideal conditions for guiding restoration efforts in disturbed areas. Although Prairie Creek has been impacted by sediment inputs from highway construction, we are hopeful that natural recovery of the stream will occur within a relatively short time frame (5-10 years). The present situation does, however, present a unique opportunity to examine the process of recovery. The proposed study would address an important element of the recovery process, and would complement an existing study presently underway in Prairie Creek to quantify sediment transport and deposition in the stream system.

Methods:

Artificial redds will be constructed in Prairie Creek, with several sampling sites mimicking egg pockets in each redd. Each sample site will contain equipment for measuring physical variables and will also contain fertilized salmonid eggs. Percent survival of the eggs will be correlated with the physical variables to determine which variable or combination of variables is the best predictor of effects of fine sediment on salmonid egg survival. By consolidating physical measurements to the same locations as the eggs, the problem of high spatial variability of physical conditions within the streambed will be diminished.

The physical variables to be measured include: 1) gravel permeability, 2) seepage rate of intragravel water, 3) dissolved oxygen content of intragravel water, and 4) several properties related to the size distribution of the gravel composing the egg pocket and the change in fine sediment content during the egg incubation period. To obtain all these measurements in close

proximity to the incubating eggs will require some modification of existing equipment and purchasing some additional equipment.

Physical variables will be measured upon initial placement of the sampling sites in the streambed. Several of the variables will also be measured periodically during the incubation period to ascribe observed changes to specific hydrologic events. Just prior to the expected time of emergence of fry from the streambed, the sites will be capped with netting to catch the fry for determination of percent of eggs which survived to emergence. The egg pocket gravels will then be removed from the streambed and taken to the laboratory for particle size analysis.

Management implications:

Results of this study are likely to provide insights helpful to several issues pertaining to resource management, ecological restoration, impacts assessment, and policies affecting resource protection from land use activities. Presently, efforts are underway to artificially sustain pre-impact levels of salmonid reproduction in Prairie Creek as mitigation for the effects of highway construction. The question of how long this effort is necessary will depend on the persistence of any impacts to natural reproduction which occur. The proposed study will help resolve this. This study will also help to refine the use of salmonid spawning success as an indicator of offsite effects from resource management activities such as logging and road building. Use of a reliable indicator of such effects will assist in developing intelligent strategies for resource protection and will serve as a measure of success for ecological restoration projects.

Preliminary Budget:

A preliminary budget for the project follows:

Field personnel	$22,000
Supervisory personnel	$10,000
Advisory personnel	$6,000
Equipment	$8,000
Services	$1,500
Total	$45,500

RANDY D. KLEIN
HYDROLOGIST
Watershed Hydrology and Fluvial Geomorphology

EDUCATION

M.S. Degree in Watershed Management 1987
Thesis title: Channel Adjustments Following Logging Road Removal in Redwood National Park. Humboldt State University, Arcata, CA. Course work included wildland hydrology, watershed management, erosion and sedimentation, river morphology, and soils.

B.S. Degree in Resources Management 1974
University of Wisconsin, Stevens Point, WI. Course work included resources management, forestry, soils, limnology, and environmental studies.

EXPERIENCE

Hydrologist 1988 - Present
Thomas R. Payne & Associates Fisheries Consultants, Arcata, CA
Perform hydrologic analyses of watershed yield to evaluate alterations in flow regimes for hydroelectric projects. Design and supervise installation of instream structures for creation of anadromous fish spawning and rearing habitat. Analyze gravel deposition patterns on tributary deltas as a result of watershed alterations and recommend corrective actions.

Geologist (hydrology) 1981 - Present
U.S. Department of the Interior, Redwood National Park, Orick, CA
Design, carry out, analyze and publish results of scientific studies of hillslope and instream hydrologic and geomorphic processes. Formulate and implement management recommendations from study results for incorporation into large scale watershed restoration program involving logged hillslopes and impacted stream channels. Provide expertise on site-specific erosion and sedimentation problems on other federal lands including national parks and forests. Provide hydrologic expertise on aquatic studies and projects (estuarine hydraulics and circulation modeling, salmon spawning ground restoration, watershed rehabilitation, design of stream crossings, and culvert sizing).

Director of Personnel and Safety 1977-1979
Crystal Silica Company, Oceanside, CA
Instituted occupational health and safety program for surface (open pit) mining and processing facility. Developed and taught a series of safety training courses. Assured company compliance with provisions of the Mine Safety and Health Act of 1978. Conducted regular inspections of plant safety conditions and made recommendations for improvement. Conducted employment interviews and hiring. Performed miscellaneous engineering duties including plant effluent sampling and testing, drafting of mining and reclamation plans, supervision of quality control department, and environmental monitoring for air and noise pollution.

Quality Control Technician 1975-1977
Crystal Silica Company, Oceanside, CA
Sampled and analyzed raw material and finished product (high-grade silica sand) for chemical purity (percent aluminum and iron oxides) and particle size distribution (bulk sieve and hydrometer analyses). Recommended corrective measures in processing of ore when quality problems were encountered. Investigated customer complaints to determine validity and initiate corrective action when necessary.

PROFESSIONAL ORGANIZATIONS

International Association of Hydrological Sciences
American Geophysical Union (Hydrology Section)
American Fisheries Society
Soil and Water Conservation Society of America
California Watershed Management Council
California Forest Soils Council

TECHNICAL TRAINING

Effective Slide Presentations
BASIC Programming
Fishery Habitat Enhancement Evaluation
Watershed Instrumentation
Surveying Techniques Using Theodolite and Electronic Distance Meter

ACCOMPLISHMENTS

Special Achievement Award, U.S. Department of the Interior
Developed and co-taught hydrology course offered by the American Fisheries Society
Certified Erosion and Sediment Specialist, Soil and Water Conservation Society of America

LIST OF PUBLICATIONS

Sole Author:

Klein, R.D. 1984. Channel adjustments following logging road removal in small steepland drainages. In C.L. O'Loughlin and A.J. Pearce (eds.) Proceedings of Symposium on Effects of Forest Land Use on Erosion and Slope Stability. Sponsored by the International Union of Forestry Research Organizations, Honolulu, Hawaii. May 7-11, 1984. pp. 139-145.

Klein, R.D. 1985. The role of organic debris in channel erosion and armor development in disturbed headwater streams. In H.M. Kelsey, T.E. Lisle, and M.E. Savina (eds.) American Geomorphological Field Group Guidebook, Redwood Country. Arcata, Calif. 195 p.

Klein, R.D. 1987. Stream channel adjustments following logging road removal in Redwood National Park. Redwood National Park Watershed Rehabilitation Technical Report No. 23. 45 p.

Primary Author:

Klein, R.D., R.A. Sonnevil, and D.A. Short. 1987. Effects of woody debris removal on sediment storage in a northwest California stream. In R.L. Beschta, T. Blinn, G.E. Grant, F.J. Swanson, and G.G. Ice (eds.) Erosion and Sedimentation in the Pacific Rim, International Association of Hydrological Sciences Pub. No. 165. Corvallis, Oregon. pp. 403-404.

Klein, R.D., and W.E. Weaver. 1989. Hydrologic restoration of the Redwood Creek Estuary. In Proceedings of the 1988 Conference of the Society for Ecological Restoration. Oakland, California.

Co-author:

Sonnevil, R.A., R.D. Klein, D.A. Short, and W.E. Weaver. 1987. Forested blockslides in the lower Redwood Creek basin, northwest California. In R.L. Beschta, T. Blinn, G.E. Grant, F.J. Swanson, and G.G. Ice (eds.) Erosion and Sedimentation in the Pacific Rim, International Association of Hydrological Sciences Pub. No. 165. Corvallis, Oregon. pp. 145-146.

Weaver, W.E., R.A. Sonnevil, and R.D. Klein. 1987. Field methods used for monitoring erosion and sedimentation processes in steeplands of northwestern California, USA. In R.L. Beschta, T. Blinn, G.E. Grant, F.J. Swanson, and G.G. Ice (eds.) Erosion and Sedimentation in the Pacific Rim, International Association of Hydrological Sciences Pub. No. 165. Corvallis, Oregon. pp. 509-510.

Babcock, E.M., R.G. LaHusen, R.D. Klein, and D.K. Hagans. 1982 Status of the Emerald Creek landslide, Redwood National Park. In C. van Riper III, L.D. Whittig, and M.L. Murphy (eds.) Proceedings of the First Biennial Conference of Research in California's National Parks. Davis, California. pp. 15-30.

REFERENCES

Available on request.

CURRICULUM VITAE

Mary Ann Madej
Geologist
Redwood National Park
Arcata, California 95521

Education: Knox College, Galesburg, Illinois, 1971-73, 1974-74, B.A. magna cum laude, geology
University of Besancon, France, 1973-74, geology
University of Washington, Settle, Washington, 1975-78, M.S. geology

Work Experience:

1987-Present: Redwood National Park. I design and conduct a basic and applied geological research program to acquire information necessary to develop a fundamental resource information base regarding interrelationships among land use, ground and surface waters, rivers, lagoons, wetlands and the ocean. I am responsible for coordinating and integrating independent studies on various aspects of Redwood National Park's physical resources, including groundwater-surface water interaction, landslide mechanics, bedload sediment transport and stream channel stability. I am part of an interdisciplinary team that includes aquatic biologists, soil scientists, botanists and forest ecologists. I serve as principal advisor for park staff on geologic and hydrologic concerns, and I make recommendations for the effective management of Park's rivers, estuaries, lagoons and coastline, for the restoration of hillslopes damaged by past logging activities, and for formulating land use guidelines for adjacent landowners to reduce the potential for further damage to park resources. I occasionally consult for other western park units on geologic and hydrologic problems.

1980-1987: Redwood National Park. I directed a team of geologists and hydrologists to construct a sediment budget in the Redwood Creek basin, that is, to quantify and understand the mechanics of sediment sources, evaluate effects of sediment loading on streams, measure sediment storage, and assess sediment transport trends in various river basins. This study included analyzing a wide range of hydrologic data collected by the U.S. Geological Survey, evaluating effects of erosion control techniques on sediment yield in highly erosive terrain, and assess the relative importance of erosional and sedimenation processes. Based on this information I made recommendations to mitigate adverse impacts, improve fisheries habitat and protect riparian communities, especially old-growth redwood forests.

1978-1980: As an erosion control geologist, I assessed and ranked erosional problems for priority in rehabilitation work. I directed heavy equipment on rehabilitation sites on logged areas, which included excavating and reshaping stream channels and removing erosive logging roads. I supervised labor intensive work crews in constructing erosion control projects and in designing bio-geologic erosion control techniques. I monitored effects of rehabilitation efforts and designed modifications for future projects.

1975-1978: University of Washington. I worked as both a teaching and research assistant in the Department of Geology and the Department of

Environmental Studies. I received a grant for my research on the effects of land use disturbances on stream channel dynamics and fish habitat.

1977: U.S. Environmental Protection Agency: Under contract with the USEPA, I reviewed the current literature on water monitoring techniques, with specific emphasis on sedimentation. The purpose of the review was to make recommendations on revising criteria used in water quality monitoring.

Research interests:

Fluvial and hillslope geomorphology, watershed management, sediment transport dynamics, coastal processes.

Professional Affiliations:

Adjunct Professor, Humboldt State University
American Geophysical Union
American Geomorphological Field Group
British Geomorphological Research Group

LIST OF RELEVANT PUBLICATIONS

Hagans, D.K., W.E. Weaver and M.A. Madej. 1986. Long-term on-site and off-site effects of logging and erosion in the Redwood Creek basin, northern California, National Council of the Paper Industry for Air and Stream Improvement Technical Bulletin, No. 490. p. 38-65.

Iwamoto, R.E., E. Salo, M.A. Madej, and R.L. McComas. 1978. Sediment and water quality: A review of the literature including a suggested approach for water quality criteria. U.S. Environmental Protection Agency Pub. 910/9-78-048. U.S. EPA Region X, Seattle, WA. 151 pp.

Kelsey, H., M.A. Madej, J. Pitlick, P. Stroud and M. Coghlan. 1981. Major sediment sources and limits to the effectiveness of erosion control techniques in the highly erosive watershed of north coastal California. International Association of Hydrologic Sciences Publication No. 132. pp. 493-509.

Kelsey, H.M., and M.A. Madej. 1986. Modelling the transport of stored sediment in a gravel-bed river, northwestern California, International Association of Hydrologic Sciences Publication 159. p. 367-392.

Kelsey, H.M., R. Lamberson and M.A. Madej. 1987. Stochastic model for the long-term transport of stored sediment in a river channel. Water Resources Research. Vol. 23. No. 9. p. 1738-1750.

Lisle, T.E. and M.A. Madej. (In review) Spatial variation in armouring in a channel with high sediment supply. Proceedings of the Third International Workshop on Gravel Bed Rivers.

Madej, M.A. 1978. Response of a stream channel to an increase in sediment load. Unpublished thesis. University of Washington. 110 pp.

Madej, M.A. 1981. Management of steeplands for erosion control: A review. Journal of Hydrology (NZ), V. 20:1. p. 108-11.

Madej, M.A. and H. Kelsey. 1981. Sediment routing in stream channels: its implications for watershed rehabilitation. Proceedings of a symposium on watershed rehabilitation in Redwood National Park and other Pacific coastal areas. R.N. Coats, ed., John Muir Institute of California. p. 17-25.

Madej, M.A. 1982. Sediment transport and channel in an aggrading stream in the Puget Lowland, Washington, in "Sediment budgets and routing in forested drainage basins". U.S. Forest Service General Technical Report PNW 141. p. 97-108.

Madej, M.A. 1985. The quantity and rate of movement of sediment stored in Redwood Creek, North Coastal California. Abstract of paper presented at First International Conference on Geomorphology, Manchester, England. September 15-20, 1985.

Madej, M.A. 1987. Residence times of channel-stored sediment in Redwood Creek, northwestern California, International Association of Hydrologic Sciences Publication 165. pp. 429-438.

Madej, M.A. 1990. Determining replenishment rates for aggregate mining. Proc. of the 8th Annual California Salmon, Steelhead & Trout Restoration Conference. Feb. 23-25, 1990. Eureka, Ca. p. 71-74.

Madej, M.A., R. Klein, C. Meyer, 1990. Persistence and impacts of fine-grained sediment on an anadromous fish, gravel-bed stream, northwestern California. Transactions, American Geophysical Union. Vol. 71 No. 43

Madej, M.A. In press. Recent changes in channel stored sediment, Redwood Creek, California. U.S. Geological Survey Professional Paper 1454.

Weaver, W.E. and M.A. Madej. 1981. Erosion control techniques used in Redwood National Park, northern California, 1978-1979. International Association of Hydrologic Sciences Publication No. 132. pp. 640-654.

Weaver, W.E., D.K. Hagans, and M.A. Madej. 1987. Managing forest roads to control cumulative erosion and sedimentation effects. In: Proceedings of the California Watershed Management Conference. November 18-20, 1986. West Sacramento, California. Report 11. Wildland Resources Center, University of California. Berkeley, California. 6 pp.

Weaver, W.E., M.A. Madej, D.K. Hagans. 1990. Recent channel changes in the Merced River, Yosemite National Park. in Abstract in Proceedings of Yosemite National Park Centennial Celebration "Natural areas and Yosemite: Prospects for the future."

RESUME

Thomas E. Lisle
USDA Forest Service Pacific Southwest Experiment Station
Redwood Sciences Laboratory
1700 Bayview Drive
Arcata, CA 95521

Birthdate: 10/28/47
Married; two children

Present position: Research Hydrologist (GS-13)

Previous employment: Forest Hydrologist, National Park Service, Redwood National Park, Crescent City, CA

Education:
B.A. (Geology) - Cornell College, Mt. Vernon, IA (1970)
M.S. (Geology) - University of Montana, Missoula (1972)
Ph.D. (Geology) - University of California, Berkeley (1976)

Professional interests: Fluvial geomorphology, sediment transport and stream mechanics, fish habitat, watershed management

Publications:

Deenihan, P., and T.E. Lisle. in press. DEBRIS: A versatile program for analyzing channel cross sections using the Data General System: PSW Research Note.

Lehre, A.K., Lisle, T.E., and P. Dunwiddie, 1982. Shoreline erosion induced by small dams. In L.B. Leopold, ed., American Geomorphological Field Group Field Trip Guidebook, 1982 Conference, Pinedale, WY, p. 121-129.

Lisle, T.E., 1979, The Caspar Creek Experimental Watershed. In Guidebook for a Field Trip to Observe Natural and Management-related Erosion in Franciscan Terrane of Northern California, Cordilleran Section of the Geological Society of America. p. XIV-(1-8).

Lisle, T. E. 1979. A sorting mechanism for a riffle-pool sequence. Geological Society of America Bulletin, Part II, v.90, p.1142-1157.

Lisle, T. E. 1981. The recovery of aggraded stream channels at gauging stations in northern California and southern Oregon. in T. R. H. Davies and A. J. Pearce, Eds., Erosion and Sediment Transport in Pacific Rim Steeplands, IAHS-AISH Publication No. 132, pp. 188-211.

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Lisle, T. E. 1982. Effects of aggradation and degradation on riffle-pool

morphology in natural gravel channels, Northwestern California. Water Resources Research, v. 18(6) p. 1643-1651.

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Lisle, T. E. 1983. The role of structure in the physical habitat of anadromous salmonids. In C. Toole, B. Wyatt, S. Sommarstrom, and K. Hashagen, Eds., Report of the 1st California Salmon and Steelhead Restoration Conference, Bodega Bay, CA, January 22-23, 1983, pp. 43-51.

Lisle, T. E. 1984. Occurrence of high sediment concentrations with abundant in-channel supply of sediment. In D. L. Schreiber, Ed. Water for Resources Development, Couer d' Alene, ID, August 14-17, 1984. American Society of Civil Engineers, pp. 1-5.

Lisle, T.E. 1985. Jacoby Creek: Influence of non-alluvial boundaries on channel form and process. In M.E. Savina, ed., Redwood Country: American Geomorphological Field Group Field Trip Guidebook, 1985 Conference, Northwestern California, p. 95-103.

Lisle, T. E., Lehre, A.K., Martinson, H.A., Meyer, D.K., Nolan, K.M., and R.D. Smith, 1982. Stream channel adjustments after the 1980 Mount St. Helens eruptions. In Proc. of a Symposium on Erosion Control in Volcanic Areas, Seattle and Vancouver, WA, July 6-9, 1982, Tech. Memo. PWRI 1908, pp. 31-72.

Lisle, T.E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, Alaska: North American Journal of Fisheries Management 6:538-550.

Lisle, T.E. 1986. Stabilization of a gravel channel by large streamside obstructions and bedrock bends, Jacoby Creek, northwestern California: Geological Society of America Bulletin 97:999-1011.

Lisle, T.E. 1987. Discussion of 'Sediment transport in step-pool streams' by J.G. Whittaker. in Thorne, C.R., Bathurst, J.C., and R.D. Hey, ed., Sediment Transport in Gravel-Bed Rivers, Proc. Pingree Park Workshop, Aug. 12-17, 1985, J. Wiley and Sons, Chichester, UK.

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Lisle, T.E. in press. The Eel River, northwestern California: High sediment yields from a dynamic landscape: in M.G. Wolman, ed., Riverscapes, Book 3 of Decade of North American Geology, Geological Society of America.

Nolan, K.M., Lisle, T.E., and H.M Kelsey. 1987. Bankfull discharge and sediment transport in northwestern California: in Beschta, R., Swanson, F., and G. Grant, ed., Erosion and Sedimentation in the Pacific Rim. International Association of Hydrological Sciences Pub. No. 165, p. 439-450

Sullivan, K., Lisle, T.E., Dolloff, C.A., Grant, G.E., and L.M. Reid. 1987. Stream channels--the link between forests and fish. Chapter 3 in Salo, E.O., and T. Cundy, ed., Streamside Management: Forestry and Fishery Interactions Symposium, February 12-14, 1986, University of Washington, Seattle, p. 39-97.

Abstracts:

Lisle, T.E. 1976. Components of flow resistance, East Fork River, Wyoming. Geological Society of America Annual Meeting, Denver, 1976.

Lisle, T.E. 1977. A sorting mechanism for a riffle-pool sequence. American Geophysical Union Fall Meeting, San Francisco, 1977.

Lisle, T.E. 1980. Episodes of aggradation observed at nine gaging stations in northern California and southern Oregon. Geological Society of America, Cordilleran Section, Corvallis, 3/18/80.

Lisle, T.E. 1980. Sediment transport and channel adjustments observed during a stormflow event, North Fork Caspar Creek, north coastal California. American Water Resources Association Annual Meeting, Minneapolis, 10/16/80.

Lisle, T.E. 1981. Effects of aggradation and degradation on bar structure in natural gravel channels, northern California and southern Oregon. American Geophysical Union Annual Meeting, San Francisco, 19/9/81.

Lisle, T.E. 1985. Sedimentation of gravel beds by fine material in three streams, north coastal California. Transactions, American Geophysical Union, 66(46):912.

Lisle, T.E. and H.M. Kelsey. 1982. Effects of large roughness elements on thalweg course and pool spacing, Jacoby Creek, Northwestern California. American Geomorphological Field Group 1982 Conference, Pinedale, WY, 9/5/82.

Lisle, T.E. 1983. Thalweg attachment to large roughness elements, Jacoby Creek northwestern California. Geological Society of America Annual Meeting, Indianapolis, 11/1/83.

Lisle, T.E. 1984. Effects of woody debris and its removal on the physical habitat of anadromous salmonids, Prince of Wales Island, Southeast Alaska. American Fisheries Society Western Division Annual Meeting, Victoria 7/18/94.

Lisle, T.E. 1985. Stabilization of a gravel channel by large streamside obstructions, Jacoby Creek, northwestern California: in T.Spencer, ed., First International Conference on Geomorphology, Manchester, England, September, 1985, p. 366.

Lisle, T.E. 1985. Sedimentation of gravel beds by fine material in three streams, north coastal Calfornia. American Geophysical Union Fall Meeting, San Francisco, 12/85.

Florsheim, F. and T.E. Lisle. 1985. Channel geometries limiting gravel bar formation, northwestern California: Transactions, American Geophysical Union, 66(46):912.

G. MATTHIAS KONDOLF
2241 Ward Street
Berkeley CA 94705
(415) 644-8381
FAX (415) 486-1210

EDUCATION

THE JOHNS HOPKINS UNIVERSITY PhD in Geography and Environmental Engineering awarded May 1988.
Thesis topic: Size distributions of salmonid spawning gravels.

UNIVERSITY OF CALIFORNIA AT SANTA CRUZ MS in Earth Sciences awarded 1982.
Thesis topic: Channel instability along the Carmel River, California.

PRINCETON UNIVERSITY AB cum laude in Geology awarded 1978.

PROFESSIONAL EXPERIENCE

ASSISTANT PROFESSOR OF ENVIRONMENTAL PLANNING, University of California, Berkeley. July 1988 to present.
Courses: Environmental Geology for Planners, Hydrology for Planners, Ecological Analysis, Current Literature in Environmental Research and Planning. Courses co-taught: The Process of Planning, Environmental Planning Studio.

Funded Research Projects:
1988-present. "Evaluation of Potential Impacts of a Licensed Hydro-Electric Project on the Riparian Vegetation, Sand Bar Location and Formation, and Recreational Suitability of the North Fork Stanislaus River in Calaveras-Big Trees State Park." (study funded by the California Department of Parks and Recreation)

1988-present. "Assessment of Geomorphic and Sediment-Related Issues in Jamison Creek, Plumas-Eureka State Park. (study funded by the California Department of Parks and Recreation)

1989-present. "Management of Coarse Sediment in Regulated Rivers." (study funded by University of California Water Resources Center)

1989-present. "Development of Debris Management Plan for General Creek, Sugar Pine Point State Park." (study funded by the California Department of Parks and Recreation)

1989-present. Evaluation of geomorphic and hydrologic influences on Lower Blackwood Creek, the Upper Truckee River, and other sites in the Lake Tahoe Basin; development of recommendations to enhance channel stability and aqautic habitat. (study funded by the California Tahoe Conservancy.)

RESEARCH SCIENTIST, University of California White Mountain Research Station, Bishop. (33% appointment, 1989-present.) Research on channel adjustments to altered flow regime, Upper Owens River and effects of gravel enhancement in North Fork Cottonwood Creek, White Mountains.

PUBLICATIONS

Papers Published in Refereed Journals

Kondolf, G.M., and W.V.G. Matthews. 1986. Transport of tracer gravels on a coastal California river. Journal of Hydrology. v.85: 265-280.

Kondolf, G.M., and R.R. Curry. 1986. Channel erosion along the Carmel River, Monterey County, California. Earth Surface Processes and Landforms. v.11:307-319.

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Curry, R.R. and G.M. Kondolf. 1981. Strategy for restoration of channel stability, Carmel River, Monterey County, CA. in Watershed Rehabilitation in Redwood National Park and Other Pacific Coastal Areas. Proceedings of a Symposium, August 24-28, 1981. Arcata, CA. pp. 191-208.

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Kondolf, G.M., and M.J. Sale. 1985. Application of historical channel stability analysis (HCSA) to instream flow studies. Proceedings of the Symposium on Small Hydropower and Fisheries. American Fisheries Society, Bio-Engineering Section and Western Division, May 1-3, 1985, Denver, CO. pp. 184-194.

Kondolf, G.M., P. Vorster, and J.G. Williams. Hydrologic and channel stability considerations in stream habitat restoration. Proceedings of the Restoring the Earth Conference, Berkeley, California, January 13-16, 1988. (in press)

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PROFESSIONAL AFFILIATIONS

American Geomorphological Field Group
American Geophysical Union
American Water Resources Association
Arizona-Nevada Academy of Science
Geological Society of America, and Quaternary and Geomorphology Division of G.S.A.
International Association for Scientific Hydrology

RESUME

ROGER A. BARNHART, Leader
California Cooperative Fishery Research Unit
Humboldt State University
Arcata, California 95521

Office Phone: (707)826-3268 Home Phone: (707)822-6089

EDUCATION

Ph.D.: Colorado State University, 1964. Major: Fishery Science Dissertation: Hematological Parameters of Rainbow Trout.

M.S.: Colorado State University, 1957. Major: Fishery Science. Thesis: Chemical Factors Affecting the Survival of Gamefish in a Western Colorado Reservoir.

B.S.: Colorado State University, 1955. Major: Fishery Science.

SKILLS

ADMINISTRATIVE AND SUPERVISORY SKILLS

As Unit Leader have administered Federal and State budgeted funds and research grant funds according to Federal,State and other fiscal regulations. Supervised the preparation of administrative and operational records and reports and the management and clerical operations of the Unit. Have supervised three Assistant Leaders and numerous graduate students. Have worked effectively with university, state fish and game and federal personnel and the public, maintaining good relations.

PLANNING, DESIGNING AND MANAGING RESEARCH SKILLS

As Leader of Fishery Research Unit for over 20 years have developed ability to analyze and evaluate resource problems, to evaluate the feasibility of obtaining solutions taking into account time, manpower and resource constraints, to plan the investigative procedures and supervise the collection and analyses of data and the reporting of results.

ORAL AND WRITTEN COMMUNICATION SKILLS

As a university adjunct faculty member have taught and guest lectured each year; have presented a number of papers at scientific meetings, symposia and workshops and have spoken to sportsmen groups and for television programs. Have continued to write scientific papers for publication, to serve as a referee for professional journals and to edit and guide the preparation of student research theses and reports.

PROFESSIONAL EXPERIENCE

LEADER, CALIFORNIA COOPERATIVE FISHERY RESEARCH UNIT, Humboldt State University, Arcata, California. Direct the program of the California Unit as part of the nationwide Cooperative Unit Program of the U.S. Fish and Wildlife Service in cooperation with universities and state fish and game agencies. Jan. 1967 - present.

FISHERY BIOLOGIST, TEMPORARY, Colorado State University Research Foundation, Colorado State University, Fort Collins, Colorado. Conducted research on "Hepatoma in Rainbow Trout" - morphological and physiological comparisons of diseased and healthy trout. Resulted in Ph.D. dissertation and publication. July 1961 - Nov. 1964.

SENIOR FISHERY BIOLOGIST, Colorado Game and Fish Department, Denver, Colorado. Directed research on two different trout reservoirs including managing a complete creel census. Assisted in high lake fishery research. July 1957 - July 1961.

PROFESSIONAL AFFILIATION

Present or past member of:

American Fisheries Society, Pacific Fisheries Biologists, American Institute of Fishery Research Biologists, Pacific Estuarine Research Society, Humboldt Bay Ecological Society, Georgia Academy of Science.

Honoraries: Sigma Xi, Beta Beta Beta, Xi Sigma Pi

APPROPRIATE PUBLICATIONS

Barnhart, R.A. 1990. Comparison of steelhead caught and lost by anglers using flies with barbed or barbless hooks in the Klamath River, California. Calif. Fish Game 76(1):43-45.

Barnhart, R.A. 1989. Symposium review: Catch-and-release fishing, a decade of experience. N. Am. J. Fish. Mgmt. 9:74-80.

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Rabin, D.J., and R.A. Barnhart. 1986. Population characteristics of Pacific herring, Clupea harengus pallasi, in Humboldt Bay, California. Calif. Fish Game 72(1):4-16.

Barnhart, R.A. 1983. Towards an overall strategy in designing wetlands restoration; panel presentation in: M. Josselyn, editor. Wetland restoration and enhancement in California, workshop proceedings. Sea Grant Publication Number T-C36P-007. 110 pp.

Barnhart, R.A. 1982. Humboldt Bay fisheries and aquaculture; present status and potential development, Pages 106-116 In C. Toole and C. Diebel, editors. Proceedings, Humboldt Bay Symposium. Center for Community Development. Humboldt State University, Arcata, California. 116 pp.

Peterson, G.D., and R.A. Barnhart. 1982. Artificial seeding of fertilized eggs in salmonid streams: past, present, future. Part One -- Historical perspective. Federation of Flyfishers Magazine. The Flyfisher Volume 15, Number 1, pages 14-17.

Gotshall, D.W., G.H. Allen, and R.A. Barnhart. 1980. An annotated checklist of fishes from Humboldt Bay, California. Calif. Fish Game 66(4):220-232.

Barnhart, R.A. 1979. Current status of the Whitlock-Vibert egg incubation box. Pages 10-14 In Proceedings, Wild Trout II Symposium. Trout Unlimited and Federation of Fly Fishers.

Rabin, D.J. and R.A. Barnhart. 1977. Fecundity of Pacific herring, Clupea harengus pallasi, in Humboldt Bay. Calif. Fish Game 63(3):193-196.

Barnhart, R.A. 1975. Pacific slope steelhead management. pages 7-11, In Wild Trout Management, Symposium Proceedings, Trout Unlimited.

Kesner, W.D., and R.A. Barnhart. 1972. Characteristics of the fall-run steelhead of the Klamath River system with emphasis on the half-pounder. Calif. Fish Game 58(3):204-220.

Barnhart, R.A. 1969. Effects of certain variables on hematological characteristics of rainbow trout. Trans. Am. Fish. Soc. 98(3):411-418.

Federal Form 171 - Personal Qualifications Statement available upon request. Lists all significant work experience, all publications and references.

United States Department of the Interior

NATIONAL PARK SERVICE
REDWOOD NATIONAL PARK
ARCATA OFFICE
1125 16th STREET
ARCATA, CALIFORNIA 95521

IN REPLY REFER TO:

N2219

November 1, 1990

U.S. MAB Secretariat
OES/BGC/MAB
Room 833, SA-5
U.S. Department of State
Washington D.C. 20522-0508

Dear Sir or Madam:

Enclosed is a prospectus describing a proposed study of the effects fine-grained sediment on the survival of eggs of anadromous salmonid fish. The study will be conducted in Prairie Creek, a biosphere reserve located in coastal northwestern California. It will serve as an important research project of interest to scientists and land managers alike, and will also be integrated into an ongoing monitoring project which is separately funded in the study area. Of particular interest to land owners and agencies regulating land use in areas of multiple ownership, the use of salmonid spawning success as one indicator of cumulative watershed effects (CWE's) shows promise. Recent revisions to the rules governing timber harvest practices require consideration of CWE's, however methods of assessing these effects are in the developing stages. The proposed study may yield a suitable method for this purpose.

The proposed study is interdisciplinary in that biological effects will be linked to physical stream processes. As indicated by the list of principal investigators, the project will require expertise from several disciplines. Individuals from several agencies and educational institutions are gathered together to assemble a qualified team of researchers for this project. Biographical information on the principal investigators is also enclosed.

We believe this proposal meets the requisite criteria for projects in the area of temperate ecosystems as outlined in the mission statement. We will be happy to submit a more detailed proposal, if requested.

Thank you for your consideration of this prospectus.

Sincerely,

Randy D. Klein

Randy D. Klein
Geologist

Enclosures