EXHIBIT A

DONALD W. CHAPMAN, Ph.D.

McCALL, IDAHO — FISHERIES SCIENTIST

EDUCATION:

Ph.D., 1961, Fisheries, Oregon State University

M.S., 1957, Fisheries, Oregon State University

B.S., 1953, Forest Management, Oregon State University

LANGUAGES:

English, Spanish, limited French and Swahili

HONORS AND AWARDS:

Award of Excellence, 1989, Idaho Chapter American Fisheries Society.

Most significant paper of the year award[2], 1965, 1976, and 1988 volumes of Transactions of the American Fisheries Society.

Phi Sigma outstanding graduate student, 1957, Oregon State University.

Sigma Xi

PRESENT ACTIVITIES:

- Anadromous Fish Passage
- Best Management Practices for Land Use
- Catch and Stock Assessment
- Fishery Resource Management

[2] Papers shown with asterisk in publications list.

- Habitat Evaluation
- Population Productivity in Salmon and Steelhead

PROFESSIONAL EXPERIENCE[3]**:**

1978 - Present, Fisheries Scientist, BioAnalysts, Inc., formerly known as Don Chapman Consultants, Inc., Boise, ID.

Big Creek Timber Company:

Advised on effects of riparian logging exclusions.

***Barnum Timber Company*:**

Consultation on productivity of anadromous fish in Redwood Creek.

Idaho Watersheds Project

Consultation on effects of livestock grazing on aquatic ecosystems.

***Chelan County Public Utility District*:**

[3] Currently-active consulting shown with italics.

Estimated potential yield of spring chinook and steelhead smolts in the Lake Chelan basin, upper Columbia River.

Pacific Lumber Company:

Expert witness in lawsuit on effects of land management on ESA-listed coho salmon in northern California.

***Heller Ehrman*:**

Expert witness on effects of mining and other land uses on South Fork Coeur d'Alene River

Grant County Public Utility District:

Prepared pre-listing recovery plan (conservation agreement) draft for summer steelhead in the mid-Columbia region. Advised on fall chinook stranding in Hanford Reach, and optimum yield of ESA-listed spring chinook and steelhead in the upper Columbia River basin.

***Idaho Watersheds Projects and Land and Water Fund*:**

Prepared affidavit in support of reduced cattle grazing on the Owyhee Resource area managed by the Bureau of Land Management. *Currently consulting on effects of irrigation withdrawals and grazing on bull trout, steelhead, and chinook salmon*

Beartrack Mine (Meridian Gold):

Evaluation of fish passage for chinook salmon at Napias Creek falls, Panther Creek drainage, Idaho. Biological assessments for mine enlargement effects on chinook, steelhead, bull trout, and westslope cutthroat trout.

***State of Montana*:**

Expert witness on effects of heavy metals and mining on fisheries in the Clark Fork, Montana.

Seven-Up Pete Joint Venture (majority owner Phelps-Dodge):

Prepared biological evaluation for submittal to Montana Department of Environmental Quality, dealing with ecological effects of McDonald Gold Project on bull trout, westslope cutthroat, brown trout, and other aquatic organisms in the Blackfoot River. Drafted cutthroat and bull trout literature reviews.

ASARCO:

With co-workers, evaluated ecological effects of mining in Rock Creek, lower Clark Fork River, with special reference to bull trout.Contract through Heller-Ehrman to review site data and recommend remediation measures needed in Tacoma Smelter Superfund site in Commencement Bay, Puget Sound.

Snowmass Creek Caucus:

Evaluated instream flow needs for resident trout populations (brown and brook trout) in relation to water withdrawal for snowmaking, Pitkin County, Colorado. Evaluated flow triggers to protect components of Snowmass Creek aquatic community, especially resident brook and brown trout, during water withdrawals.

Committee to Save the Mokelumne:

Assisted on flow needs of chinook salmon in the Mokelumne River. Testified before the California Water Control Board, Sacramento, CA.

Bonneville Power Administration:

Prepared reports on habitat status, fish transportation, effects of marine mammals, and flows and drawdown as they affect Snake River salmon. Currently under contract to evaluate efficacy of flow augmentation for smolt migrations in the Snake River, and to assist with research planning for recovery of ESA-listed salmon.

***Idaho Power Company*:**

Consulted on ecological studies of fall chinook. *Presently analyzing historical effects of dams on fall chinook. Also currently preparing report on potential for reintroduction of salmon and steelhead upstream from Hells Canyon complex.*

Pacific Northwest Generating Council/Public Power Council:

Consulted on conservation of ESA-listed salmon in the Columbia River Basin.

Alaska Pipeline Defense Fund:

Biological witness on proceedings for evaluating civil damage claims arising out of Exxon Valdez oil spill in Prince William Sound, Alaska. Primary emphasis was stock and recruitment effects on salmon.

PacifiCorp:

Evaluated potential of White Salmon River (Columbia River tributary) to produce anadromous fish upstream from Condit Dam.

Battelle Laboratories:

Completed an evaluation of criteria for predicting effects of sediment (fines) on intragravel survival and on rearing and wintering of salmonids.

Los Angeles Department of Water and Power:

Evaluated Fish habitat and ecology in the Mono and Owens basins, California. Instream flow requirements and habitat management for brown and rainbow trout. Testified before California Water Control Board, Sacramento, CA.

State of Idaho:

Consultant in U. S. vs. Oregon case on harvest rates and escapement needs of steelhead trout in mixed stock salmon and steelhead fishery in the Columbia River. Submitted affidavits. Retained as expert rebuttal witness against Southern Refrigerated Transport, Inc., on salmonid kill in the Little Salmon River, caused by Vitavax spill. Testified in U. S. District Court, Boise, ID.

Stone Container Corporation:

Retained to advise on ecological effects of pulp mill effluent on rainbow and brown trout in the Clark Fork River, MT.

Skokomish Indian Tribe:

Consulted on effects of logging on aquatic resources of the Skokomish River.

Bechtel Corporation:

Conducted environmental evaluations of anadromous fish habitat potential in Panther Creek, a Salmon River tributary.

Montgomery Engineers:

Technical advisor on habitat reclamation in Bear Valley Creek, Middle Fork Salmon River.

Montana Power Company:

Retained to advise on mitigation and compensation for resident salmonids affected by Kerr Dam (Flathead River). Participated in settlement discussions.

Chelan, Douglas, and Grant County Public Utility Districts:

Completed status reviews on mid-Columbia summer steelhead, summer/fall chinook, spring chinook and sockeye salmon.

Eugene Water and Electric Board:

Advised utility on ecological studies needed for relicensing McKenzie River hydro projects, and scoped studies for relicensing. Fish species involved included rainbow trout, steelhead, and chinook salmon.

***Native American Rights Fund*:**

Currently advising attorneys on water requirements for fish and wildlife on the Klamath Reservation. Provided advice on sockeye salmon and chinook salmon management problems in Copper River, Alaska.

Envirocon, Ltd.:

Consulted in salmon and steelhead ecology for problems related to ALCAN

developments in the Nechako River, an upper Fraser tributary, and in the Morice River, a Skeena tributary. Subsequently testified for ALCAN in hearings on Nechako River flows and fish needs.

Chelan County Public Utility District:

Conducted a three-year study of microhabitat utilization by chinook salmon and steelhead in the Wenatchee River, Washington. Also conducted a two-year study of genetic makeup of mid-Columbia River salmon and steelhead. Also completed a two-year study on effects of a 3-ft pool raise in Rocky Reach Reservoir on fall chinook spawning

Grant County Public Utility District:

Conducted a 5-year study of effects of peaking flows on fall chinook spawning below Priest Rapids Dam, Columbia River. Completed an analysis of effects of peaking on fish and invertebrates in the Hanford Reach. Testified in FERC hearing re: fish passage facilities at two Grant County Public Utility District dams on the Columbia River.

Douglas County Public Utility District:

Conducted a study of sockeye salmon enhancement opportunities upstream from Wells Dam.

Department of Justice:

Studied the effects of irrigation withdrawals on Lahontan cutthroat trout and cui-ui suckers in the Truckee River.

Chelan County Public Utility District:

Evaluated components of Habitat Conservation Plan for mid-Columbia River chinook salmon, steelhead, and sockeye. Testified in FERC hearings in June/July 1985 as expert witness on river and ocean mortality rates, as well as mitigation and compensation requirements associated with smolts passing Rock

Island Dam.

Several Small-Scale Hydro Entrepreneurs:

Studied instream-flow needs of fish on Billingsley, Cedar Draw, Orofino, Deadhorse, Goose, Mink and Fisher creeks in the Payette River, Patterson Creek, Carmen Creek, and West Fork Hood River. Prepared Exhibit E materials on fish, wildlife and botanical resources for projects at Auger Falls (Snake River), Fisher Creek, Goose Creek, and Elk Creek Falls. A California project, Rock Creek, resulted in a full scale FERC hearing. Species involved were largely resident trouts.

Washington Water Power Company:

Retained as witness in case involving Spokane Indian Tribe claims against the company. Also retained as witness in claims of Nez Perce Tribe for damages associated with Clearwater and South Fork Clearwater dams.

Boise Cascade Corporation:

Reviewed forest management plans of the Payette and Boise National Forests, commenting on issues involving salmon of the South Fork Salmon River.

Muckleshoot Indian Tribe:

Worked for the Native American Rights Fund as witness against Puget Power. Conducted a study of environmental degradation from water diversion and dams on the White River near Seattle, WA.

Thorne Ecological Foundation:

Studies of effects of molybdenum mining in White Cloud Mountains with regard to fish and limnology.

Salmon Unlimited:

Evaluation of potential impoundments for production of coho salmon.

Bureau of Indian Affairs:

Conducted a field study of effects of a dam on Kootenai Falls with regard to trout populations in the Kootenai River, largely rainbow trout. Testified before FERC against Northern Lights, Inc. Studied instream flow and habitat in about 85 reaches in 14 rivers in the Pacific Northwest, to estimate habitat and fishery damages caused by various dams and water diversions. They included the Elwha, Baker, Sultan, Cedar, Green, Puyallup, Nisqually, Skokomish, North Fork Hoquiam, Walla Walla and White Salmon in Washington, Willow Creek and Klamath River in Oregon, Clearwater River in Idaho.

Pacific Northwest Utilities Conference Committee:

Analyzed salmon and steelhead runs in the Columbia River as affected by hydro and other factors, associated with the Power Planning Council's 201 Section. With co-authors, prepared a paper on alternative methods of assessing hydro-caused losses on the Columbia River. Estimated historical run sizes in the Columbia River. With co-authors, completed a study of progress toward the Northwest Power Planning Council's doubling goal. Completed reviews of status of sockeye and chinook salmon in the Snake River basin, and coho salmon in the Lower Columbia River. Reviewed status of Kootenai River sturgeon and bull trout.

Bureau of Land Management:

Prepared an EIS for effects of water withdrawals in the Snake River between Twin Falls and Brownlee pool.

Food and Agriculture Organization of the United Nations:

Periodic missions in South America to provide advice on stock and catch assessment, including 1-2 month consultations in Colombia (1978), Peru (1979 and 1980) and Panama (1984).

U. S. Army Corps of Engineers, Walla Walla District:

Investigated limnological effects of impoundment of North Fork Clearwater River.

Department of Defense:

Critique of Environmental Impact Statement prepared by Bureau of Reclamation on Mountain Home Project.

Hecla Mining Company:

Evaluated habitat alteration by stream diversion in North Fork of Coeur d' Alene River.

1976-1978: Inland Fishery Biologist, Food and Agriculture Organization of the United Nations, Cartagena, Colombia.

Developed catch assessment program and economic evaluations of fishery in Rio Magdelena system. Trained counterpart personnel.

1973-1976: Stock Assessment Specialist, Food and Agriculture Organization of the United Nations, Kigoma, Tanzania.

Assessed population structure, abundance and fish behavior for pelagic species in Lake Tanganyika. Trained counterpart personnel.

1964-1972: Leader, Idaho Cooperative Fishery Unit and Professor, University of Idaho, Moscow, ID.

Taught graduate and undergraduate students in population dynamics and fishery management; conducted personal research; supervised four staff members and up to 18 graduate students. Principal emphasis was salmon and steelhead ecology in fresh water (mostly Salmon and Clearwater rivers).

1963-1964: Director of Research, Oregon Fish Commission, Clackamas, OR.

Supervised research and management work of research division with 65 biologists charged with marine and freshwater food - fish management, with emphasis on Columbia River salmon, steelhead, and other anadromous stocks.

1961-1964: Assistant and Associate Professor, Coordinator of Alsea Watershed Study and Executive Secretary of Water Resources Research Institute, Oregon State University, Corvallis, OR.

Supervised and engaged in research. Taught biometry and ecology.

1959-1961: Assistant Professor, Oregon State University and Coordinator, Alsea Watershed Study, Corvallis, OR.

Coordinated several research activities and engaged in research on effects of timber harvest on stream ecology, especially on coho salmon.

1957-1959: Coordinating Biologist, Governor's Commission on Natural Resources, Salem, OR.

Coordinated several research activities and engaged in research on effects of timber harvest on stream ecology, especially on coho salmon.

1955-1957: Graduate Assistant, Oregon Cooperative Wildlife Research Unit, Corvallis, OR.

Master's research on the life history of steelhead trout.

MILITARY SERVICE:

United States Army - Active duty 1953 to 1955. Honorable discharge as First Lieutenant, Infantry.

PROFESSIONAL ACTIVITIES:

American Fisheries Society.

Associate Editor for American Fisheries Society for salmonids, 1981-1983.

Member of National Marine Fisheries Commission Endangered Species Act Technical Advisory Committee (1990-1992).

Member of National Academy of Science, National Research Council, Committee on Conservation and Management of Northwest Salmon (current). With other committee members, prepared "Upstream," a National Academy of Science book on salmon and

society in the Pacific Northwest.

TEACHING EXPERIENCE:

1984 - 1997: Adjunct Professor, Idaho State University, Pocatello, ID.

Served occasionally on graduate studies committees.

Spring, 1980: Visiting Professor, Montana State University, Bozeman, MT.

Taught fishery management.

1964-1972: Professor, University of Idaho, Moscow, ID.

Taught graduate and undergraduate students in population dynamics and fishery management. Supervised up to 18 graduate students.

Fall, 1972: Visiting Associate Professor of Limnology, University of Wisconsin, Madison, WI.

Taught limnology and population dynamics, advised graduate students on research methods.

1961-1964: Assistant and Associate Professor, Oregon State University, Corvallis, OR.

Taught biometry and ecology.

1959-1961: Assistant Professor, Oregon State University, Corvallis, OR

Taught biometry and ecology.

ADDITIONAL QUALIFICATIONS:

Licensed as SCUBA diver.

Licensed as private pilot, instrument, multi-engine.

PUBLICATIONS[4] AND REPORTS:

Hillman, T., D. Chapman, A. Giorgi, M. Miller, and S. Kreiter. 2000. Potential

[4] * here and later indicates designation by the American Fisheries Society as the most significant paper of the year in the Transactions of the American Fisheries Society.

productivity of anadromous salmonids in the Lake Chelan basin. BioAnalysts, Inc., Report to Chelan County Public Utility District, Wenatchee, WA. 59 p. + tables and figures.

Chapman, D., and T. Hillman. 2000. Potential sockeye smolt yield from Lake Chelan. Addendum to: Potential Productivity of Anadromous Salmonids in the Lake Chelan Basin. Report by BioAnalysts, Inc. to Chelan County Public Utility District, Wenatchee, WA. 16 p.

Chapman, D. and T. Hillman. 1998. Biological assessment of effects of north pit expansion at Beartrack Mine on bull trout. BioAnalysts, Inc., Report to U. S. Forest Service, Salmon, ID.

Chapman, D. and T. Hillman. 1998. Biological assessment of effects of McDonald Gold Project on bull trout. BioAnalysts, Inc., Report to U. S. Army Corps of Engineers, Lincoln, NE.

Chapman, D. and T. Hillman. 1997. Effects of angling on bull trout. BioAnalysts, Inc., Report to Seven-Up Pete Joint Venture, Lincoln, MT. 8 pp.

Chapman, D. and T. Hillman. 1997. Pre-listing plan for recovery of the upper Columbia River ESU of summer steelhead. BioAnalysts, Inc., Report to Grant County Public Utility District, Ephrata, WA. 213 pp.

Hillman, T., M. Miller, and D. Chapman. 1997. Assessment of fish populations and habitat in Napias Creek, Idaho 1997. BioAnalysts, Inc., Report to Meridian Gold Company, Salmon, ID. 22+ pp.

Hillman, T., D. Chapman and M. Miller. 1997. Assessment of fish populations in the Upper Blackfoot River. Basin, 1997. BioAnalysts, Inc., Report to Seven-Up Pete Joint Venture, Lincoln, MT. 131 pp.

Chapman, D., J. Stevenson, M. Miller, C. Carlson, D. Weitkamp, and G. Matthews. 1996. Homing in sockeye and chinook salmon transported

around part of the smolt migration route. N. Am. J. Fish. Management 17:101-113.

Hillman, T. and D. Chapman. 1996. Assessment of fish populations in the upper Blackfoot River basin. BioAnalysts, Inc., Report to Seven-Up Pete Joint Venture, Lincoln, MT. 306 pp.

Hillman, T. and D. Chapman. 1996. Comparison of underwater methods and electrofishing for estimating fish populations in the upper Blackfoot River basin. BioAnalysts, Inc., Report to Seven-Up Pete Joint Venture, Lincoln, MT. 44 pp.

Hillman, T. and D. Chapman. 1996. Winter ecology of trout: implications for Snowmass Creek. Don Chapman Consultants, Inc., Report to Snowmass/Capitol Creek Caucus, Snowmass, CO. 69 pp.

Chapman, D. 1995. Efficacy of structural manipulations of instream habitat in the Columbia River Basin. *Rivers* 5:279-293.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, and F. Utter. 1995. Status of spring chinook salmon in the mid-Columbia region. Don Chapman Consultants, Inc., Report to Chelan, Douglas and Grant County Public Utility Districts, WA. 477 pp.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, F. Utter, M. Hill, J. Stevenson, and M. Miller. 1995. Status of sockeye salmon in the mid-Columbia region. Don Chapman Consultants, Inc., Report to Chelan, Douglas and Grant County Public Utility Districts, WA. 245+ pp.

Hillman, T. and D. Chapman. 1995. Comments on ARCO's reports concerning the State of Montana's injury assessment for the Clark Fork River: evaluation of snorkel methods. Don Chapman Consultants, Inc., Report to

Montana Department of Justice, Natural Resource Damage Litigation Program, Helena, MT. 16 pp.

Hillman, T. and D. Chapman. 1995. Supplement to assessment of injury to fish populations: Clark Fork River NPL sites, Montana, January 1995. Don Chapman Consultants, Inc., Report to Montana Department of Justice, Natural Resource Damage Litigation Program, Helena, MT. 45 pp.

Utter, F., D. Chapman and A. Marshall. 1995. Genetic population structure and history of chinook salmon in the upper Columbia River. pp. 149-165 *In:* J. Nielsen and D. Powers. Evolution and the Aquatic Ecosystem: Defining Unique Units in Population Conservation. American Fisheries Society, Symposium #17. Bethesda, MD.

Chapman, D., and A. Giorgi. 1994. Comments on work of biological and FCRPS alternative work groups. 18 pp. *In:* Joint industry/utility comments on August 1994 proceedings to provider 1994-98 hydropower biological opinion. Don Chapman Consultants, Inc., Submitted to U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and the National Marine Fisheries Service.

Chapman, D., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B. Suzumoto, and R. Klinge. 1994. Status of summer/fall chinook salmon in the mid-Columbia region. Don Chapman Consultants, Inc., Report to Chelan, Douglas, and Grant County Public Utility Districts, WA. 410+ pp.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc., Report to Chelan, Douglas, and Grant County Public Utility Districts, WA. 318+ pp.

Chapman, D., and W. Platts. 1993. Status of the trout habitat and fishery

in Rush Creek, California, from Mono Gate 1 to the Confluence of Parker Creek in the present and before 1941. Section 1 *In:* Direct Testimony: Stream Issues. Los Angeles Department of Water and Power. Los Angeles, CA.

Hillman, T., and D. Chapman. 1993. Assessment of injury to fish populations: Clark Fork River NPL Sites, Montana. Don Chapman Consultants, Inc., Report to RCG/Hagler, Bailly, Inc., Boulder, CO. 132 pp.

Hillman, T., D. Chapman, and J. Griffith. 1992. Seasonal habitat utilization and behavioral interaction of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. I: Daytime habitat selection. Submitted to Can. J. Fish. Aquat. Sci.

Hillman, T., and D. Chapman. 1992. Seasonal abundance, growth, and movement of chinook salmon and steelhead trout in the Wenatchee River, Washington. Manuscript pending with Can. J. Zoology.

Hillman, T., D. Chapman, and J. Griffith. 1992. Seasonal habitat utilization and behavioral interaction of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Manuscript pending with Can. J. Fish. Aquat. Sci.

Platts, W., and D. Chapman. 1992. Status of chinook salmon spawning and rearing habitat in the Salmon River drainage. Don Chapman Consultants, Inc., Boise, ID. 18 pp.

Chapman, D., A. Giorgi, M. Hill, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Pratt, J. Seeb, L. Seeb, and F. Utter. 1991. Status of Snake River chinook salmon. Don Chapman Consultants, Inc., Report to Pacific Northwest Utilities Conference Committee, Portland, OR. 251+ pp.

Hill, M., W. Platts, D. Chapman, S. Jensen, R. Salter, G. Ahlborn, T. Holland, J. Crockett, K. Pratt, K. Gebhardt, T. Frest, C. Myers, C.

Yarborough, and T. Hardin. 1991. Ecology of the Middle Snake River and cumulative impact assessment of three proposed hydroelectric projects. Don Chapman Consultants, Inc., Report to L.B. Industries, Inc., Boise, ID. 45+ pp.

Pratt, K., D. Chapman, and M. Hill. 1991. Potential to enhance sockeye salmon upstream from Wells Dam, Columbia River. Don Chapman Consultants, Inc., Report to Douglas County Public Utility District, East Wenatchee, WA. 87 pp.

Chapman, D., W. Platts, D. Park, and M. Hill. 1990. Status of Snake River sockeye salmon. Don Chapman Consultants, Inc., Report to Pacific Northwest Utilities Conference Committee, Portland, OR. 90 pp.

Chapman, D., W. Platts, and M. Hill. 1990. Evaluation of anadromous salmonids upstream from Condit Dam in the Big White Salmon River, Washington. Don Chapman Consultants, Inc., Report to Pacific Power and Light, Portland, OR. 101+ pp.

Carlson, C., G. Matthews, D. Weitkamp, R. Whitman, R. Raleigh, and D. Chapman. 1989. Fish transportation studies Priest Rapids Dam, 1988. Grant County Public Utility District, National Marine Fisheries Service, Parametrix, Inc. and Don Chapman Consultants, Inc. Ephrata, WA. 67+ pp.

Chapman, D., W. Platts, and M. Hill. 1989. Evaluation of the potential effects of Elk Creek Dam on fisheries in the Rogue River and Elk Creek. Don Chapman Consultants, Inc., Report to U.S. Army Corps of Engineers, Portland, OR.

Chapman, D. 1989. "Visiting hours only", or, catch and release revisited. pp. 197-204 *In:* F. Richardson and R. Hamre, Editors, Wild Trout IV., Yellowstone National Park, WY.

Hillman, T., D. Chapman, and J. Griffith. 1989. Seasonal habitat use and

behavioral interaction of juvenile chinook salmon and steelhead, I: daytime habitat selection. pp. 42-82 *In:* Don Chapman Consultants, Inc., Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Don Chapman Consultants, Inc., Report to Chelan County Public Utility District, Wenatchee, WA.

Hillman, T., D. Chapman, and J. Griffith. 1989. Seasonal habitat use and behavioral interaction of juvenile chinook salmon and steelhead, II: Nighttime habitat selection. pp. 83-108 *In:* Don Chapman Consultants, Inc., Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Don Chapman Consultants, Inc., Report to Chelan County Public Utility District, Wenatchee, WA.

Pratt, K., and D. Chapman, 1989. Progress toward the doubling goal of the Northwest Power Planning Council. Don Chapman Consultants, Inc. Report to the Pacific Northwest Utilities Conference Committee, Portland, OR. 77 pp.

Carlson, C., S. Achord, G. Matthews, D. Weitkamp, R. Whitman, R. Raleigh, and D. Chapman. 1988. Fish transportation studies, Priest Rapids Dam, 1987. Joint report of Grant County Public Utility District, National Marine Fisheries Service (CZES), Parametrix, Inc., and Don Chapman Consultants, Inc. 67+ pp.

*Chapman, D. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Trans. Amer. Fish. Soc. 117:1-21.

Hillman, T., D. Chapman, J. Spaulding, and J. Griffith. 1988. Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Don Chapman Consultants, Inc., Report to Chelan County Public Utility District, Wenatchee, WA.
379 pp.

Chapman, D. and K. McLeod. 1987. Development of criteria for sediment in the Northern Rockies Ecoregion. Final Report to Battelle Columbus Laboratories - Work Assignment 2-73. EPA Contract No. 68-01-6986. 279 pp.

Chapman, D. 1985. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Amer. Fish. Soc. 115:662-670.

Chapman, D., D. Weitkamp, T. Welsh, T. Schadt, and M. Dell. 1985. Effects of river flow on the distribution of fall chinook salmon redds. Trans. Amer. Fish. Soc. 115:537-547.

Chapman, D., and B. May. 1984. Downstream movement of rainbow trout (Salmo gairdneri) past Kootenai Falls, Montana. N. Am. J. Fish. Manage. 6:47-51.

Chapman, D. W., D. E. Weitkamp, T. L. Welsh, and T. Schadt. 1983. Effects of minimum flow regimes on fall chinook spawning at Vernita Bar 1978-82. Don Chapman Consultants, Inc. and Parametrix, Inc., Report to Grant County Public Utility District, Ephrata, WA. 123 pp.

McKenzie, D., D. Weitkamp, T. Schadt, D. Carlile, and D. Chapman. 1983. 1982 systems mortality study. Battelle Pacific Northwest Laboratories, Report to Chelan, Douglas, and Grant County Public Utility Districts, WA.

Chapman, D., J. Van Hyning, and D. McKenzie. 1982. Alternative approaches to base run and compensation goals for Columbia River salmon and steelhead resources. Battelle Pacific Northwest Laboratories, Contribution #2311204080.

Chapman, D. 1980. Evaluacion de capturas en el Lago Titicaca y en el Rio Amazonas en Peru. pp. 49-108 *In:* Informe No. 81, Instituto del Mar del Peru, Food and Agriculture Organization of the United Nations, Proyecto

PNUD/FAO-PER/76/011, Callao, Peru. 303 pp.

Chapman, D. 1980. Practical fisheries assessment in a tropical floodplain. Fisheries 6:2-6.

Chapman, D., and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Trans. Amer. Fish Soc. 109:357-363.

Chapman, D. 1977. Methods for assessment of fish production. pp. 199-214, *In:* T. Bagenal, Editor, Methods for assessment of fish production in fresh waters. Blackwell Scientific Publications, IBP Handbook No. 3, Oxford, England. 348 pp.

Chapman, D. 1977. Production. pp. 5-25, *In:* S. D. Gerking, Editor, Ecology of fresh water fish production, Blackwell Scientific Publications, Oxford, England. 520 pp.

Chapman, D. W., J. Escobar, P. Arias, M. Zarate, M. Valderrama, and Y. C. Lara. 1977. La pescaria, captura y ingreso le los pescadores en el Rio Magdalena y el plano inundable. Food and Agriculture Organization of the United Nations, Technical Report.

Chapman, D., and P. Van Well. 1977. Observations on the biology of Luciolates stappersii in Lake Tanganyika. Trans. Amer. Fish. Soc. 107:567-573.

Chapman, D., and P. Van Well. 1977. Growth and mortality of Stolothrissa tanganicae. Trans. Amer. Fish. Soc. 107: 26-35.

Chapman, D. 1976. Assessing the skipper factor - fishing sense for ring-net skippers on Lake Tanganyika. World Fishing, Sept. 76:65-67.

*Chapman, D. 1976. Acoustic estimates of pelagic ichthyomass in Lake Tanganyika with an inexpensive echo sounder. Trans. Amer. Fish. Soc.

105:581-587.

Gordon, D., D. Chapman, and T. Bjornn. 1973. Economic evaluations of sport fisheries - what do they mean? Trans. Amer. Fish. Soc. 102:293-311.

Everest, F., and D. Chapman. 1972. Habitat selection and spatial interaction of juvenile chinook salmon and steelhead trout in two Idaho streams. J. Fish. Res. Bd. Can. 29:91-100.

Chapman, D., and H. Gibson. 1972. Effects of Zectran insecticide on aquatic organisms in Bear Valley Creek, Idaho. Trans. Amer. Fish. Soc. 101:330-344.

Chapman, D. 1971. Scientific communications via meetings. Trans. Amer. Fish. Soc. 100:400-402.

Chapman, D., C. Falter, and F. Rabe. 1971. Water quality implications of clearing Dworshak pool below 1440 elevation. *In:* Design Memo. #19, Reservoir Clearing, Supplement #1, Dworshak Project, North Fork, Clearwater River, Idaho. U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, WA.

Chapman, D., W. Miller, R. Dudley, and R. Scully. 1971. Ecology of fishes in the Kafue River. pp. 1-66 *In:* Food and Agriculture Organization of the United Nations, Technical Report #2, Rome, Italy.

Raleigh, R., and D. Chapman. 1971. Genetic control in lakeward migrations of cutthroat trout fry. Trans. Amer. Fish. Soc. 71:33-40.

Chapman, D., and T. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. pp. 153-176 *In:* T. G. Northcote, Editor, Symposium on salmon and trout in streams. University of British Columbia, H. R. MacMillan Lectures in Fisheries, Vancouver, BC, Canada.

Chapman, D. 1968. Production. *In:* W. E. Ricker, Editor. Methods for assessment of fish production in fresh waters. Blackwell Scientific Publications, IBP Handbook #3. Oxford, England.

Edmundson, E., F. Everest, and D. Chapman. 1968. Permanence of station in juvenile chinook salmon and steelhead trout. J. Fish. Res. Bd. Can. 25:1453-1464.

Chapman, D. 1967. Production. *In*: S. D. Gerking, Editor, Biological basis of freshwater fish production. Blackwell Scientific Publications, Oxford, England.

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EXHIBIT B

Mr. Thomas M. Herman
2103 Myrtle Avenue
Eureka, CA 95501

September 21, 2000

Dear Mr. Herman:

In this letter I offer opinions on the present condition of Redwood Creek. I visited the watershed on 1-2 August at the invitation of Barnum Timber Company, and with guidance of Mr. Steve Horner. I toured the watershed by helicopter from headwaters to the estuary, inspected the location and operation of a downstream trap that operated this spring in Redwood Creek, and visited the watershed of Minor Creek on August 1. We visited the estuary of Redwood Creek on the ground on August 2. I also examined materials from various published and file reports, photos of the entire stream system obtained recently, photos of single points from various time periods, and the preliminary data from the downstream trap.

Condition of uplands and riparian zone

Although my experience and graduate degrees dealt with fisheries and stream habitat, I was trained first in forest management. Hence I venture to offer a few observations on conditions extant in uplands in Redwood Creek.

The uplands are well-vegetated. Hardwoods, especially red alder, are a major component of the canopy in many areas. Recent timber harvest areas appear stable, with no evidence of mass soil movements associated with the harvesting. Conifer plantings in cutover areas mostly appear to be prospering. The basin contains some unstable areas, some of which consist of slumpy prairie

lands. I was pleased to learn that few humboldt crossings remain in the basin, for they usually are sources of ongoing recruitment of fines to the stream. We did see one crossing in the Redwood Creek drainage in process of removal and rehabilitation.

I asked Mr. Horner to show me examples of the worst erosion problem areas on lands owned by Barnum Timber Company. He took me to areas of past erosion associated with the road up Minor Creek. Those sites are priority ones in storm periods for inspection to assure that culverts remain operative. The use of outsloped roads with minimal cut and fill, and protected with frequent waterbars appear to be important management tools currently being utilized that minimize movement of sediments.

Mr. Horner explained that in the conversion of widespread hardwoods that captured much of the area after the first harvests in Redwood Creek to coniferous stands, clearcutting is the tool of choice. Once the downed hardwoods and the few conifers are removed, the areas are being planted with conifers. Use of this silvicultural system is producing well stocked even-aged conifer stands. Thinning and selective cutting will be useful interim treatments, but clearcutting may be the best subsequent harvest system in many cases. Certainly it is the tool of choice as hardwoods are removed. As an aquatic ecologist, I have no objection to carefully planned and executed clearcuts that meet extant rules for forest practices on areas with low risk of mass wasting. Studies in the Caspar Creek watershed demonstrate that planning and execution of road construction and logging in the North Fork of Caspar Creek in 1985-1991 with roads high on ridges and cable yarding produced no more landslides than occurred in unlogged areas (Cafferata and Spittler 1998). On the other hand, road construction and extensive tractor logging that took place in the South Fork of Caspar Creek in the 1960s and early 1970s, before implementation of the California Forest Practice Rules, caused extensive landslides. Risk depends upon slope, underlying bedrock, vegetation, and land use (Harden et al. 1995). Risk is site-specific, and I do not believe it can be determined on the basis of slope alone. Careful watershed analysis helps to determine areas of high risk, and an experts may be needed to delineate high-risk zones where

harvesting operations should incorporate special measures to avoid accelerated erosion.

The large range of streamflows in Redwood Creek (high discharges 4,500 to 7,300 times summer low flows), leads to presence of streambars that lack permanent vegetation. Photo sequences show that hardwoods may encroach on some streambars after periods of low winter discharge, but that floods subsequently remove them. Old photo sequences show that the stream moves about, particularly in Redwood Valley. In more-incised areas the stream has less opportunity to move across the floodplain. It appears that thalweg shifts have occurred for as long as photo records have been available. They are part of the range of conditions that define dynamic equilibrium in the stream and riparian system.

Large woody debris is limited in much of the main stem of Redwood Creek, I believe largely because high flows remove it. Where large conifers have fallen into and remained in the stream, especially in lower Redwood Creek within the park, the trees tend to lie along the stream axis, attesting to the forces present at high winter flows. Woody debris is more likely to hold in incised tributary streams, where it stores sediment and create habitat diversity in tributary streams (Pitlick 1995).

Overall, I was impressed with the degree to which the watershed and riparian zone have stabilized since the high-flow year of 1964. My reading of reports and publications leads me to believe that roads and past logging operations, many dating from the 1950s and 1960s, exacerbated sediment movement into Redwood Creek during that event. Photo points and stream profile changes at transects show that aggradation of the streambed occurred (Madej 1995), with materials deposited to a depth of several feet in some areas. That influx of materials moved rapidly through tributaries (Pitlick 1995) and has passed through most of the mainstem of Redwood Creek. Most aggraded areas in the upper two-thirds of the watershed have returned to pre-1964 grade, although several inches of aggraded material apparently remain in lower portions of the stream within the park. I would expect much of that material to move seaward in the next major storm.

I would also expect that the next major storm event would recruit less sediment to stream channels than did the 1964 event due to improved contemporary forest practices.

The 1964 flood, while it contributed large amounts of sediment to Redwood Creek, appears not to have been unusual in historic times. The available literature indicates that major storms led to severe flooding several times in the century preceding the mid-1900s.

Fish abundance

The climatic pattern of northern California and the high rate of uplift in the area (Cashman et al. 1995; Madej 1995) lead me to conclude that stream biota in Redwood Creek and other nearby drainages had to adapt to great instability. Salmon and steelhead that use the area are no exception. Anadromous salmonids that use the northern coastal streams of California have had to contend with rather extreme environmental dynamics, not limited to variable times of sandbar closure and periodic severe flooding.

Redwood Creek has been termed "impaired." I believe that fish yields in Redwood Creek offer a very important indication of whether that term is appropriately applied to the stream. Fish abundance integratively indexes conditions for reproduction, rearing, and current status of the stream, riparian area, and watershed. Trap catches in the screw trap in Redwood Creek during the 2000 season provide a tool for assessing salmonid yields. The trap lay below about 65,000 acres of the upper basin, thus sampled juvenile yields from about 36% of the 180,000 ac. watershed. Catches[5] totaled 123,633 age 0 (subyearling) chinook salmon, 12,263 age 1+ rainbow/steelhead, and 736 age 2+ steelhead. When adjusted for trap efficiency, assessed from release of marked juveniles upstream and recovery at the screw trap (necessary because the trap

[5] Data and population estimates obtained from M. Sparkman, consultant to Barnum Timber Company. My review of the trap, its operation, and the resulting data indicates to me that trapping and data analysis was appropriate and undertaken with widely-accepted scientific techniques.

could not cover the entire stream)[6], the total numbers of fish that passed the screw trap can be estimated at over 436,060 age 0 chinook salmon (95% confidence limits (CL) = 389,636 and 482,484), 68,328 1+ rainbow/steelhead[7] (95% CL = 59,055 and 77,601), and 4,739 age 2+ steelhead (95% CL = 3,669 and 5,808). Inasmuch as (1) the trap caught juvenile fish on the first night of operations on April 5, (2) some fish escaped from the trap live box in periods of high flow with accompanying debris, and (3) some juvenile steelhead move downstream in fall and early winter, the estimated numbers of fish that passed the trap constitute a minimum estimate of the yield of juveniles from the area upstream from the trap.

The numbers of salmon and steelhead that passed the screw trap between early April and late July can be allocated to about 37 miles (59 km) of upstream habitat (from Brown 1988). Thus, the yields of age 0 chinook and age >1 steelhead can be estimated at about 11,785/mi (7,071/km) and 1,974/mi (1,185/km), respectively. Examining the literature on salmon and steelhead yields, I find that the production rate per unit distance for chinook salmon juveniles in Redwood Creek lies at the top end of the range for yields for other streams along the Pacific Coast. The production rate

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[6] Efficiencies by week ranged from 5.7% to 56% over the 17-week trapping period from April 5 to the end of July, depending strongly on the fraction of streamflow intercepted by the screw trap. Thus, efficiencies increased as flows dropped.

[7] Efficiencies by week tended to decrease, which suggests some trap avoidance as flows declined. No evidence is available to determine whether marked steelhead evaded the trap more or less then unmarked fish.

for steelhead also lies in the upper part of the range of yields.

Not all juvenile chinook salmon and steelhead can be considered smolts, ready for sea entry. Many fish that pass the screw-trap site will continue to rear in the lower portions of Redwood Creek, and some will rear in the estuary (Anderson 1999). Research on the growth and behavior of juveniles in lower Redwood Creek is scant, but information from other coastal rivers indicates that most steelhead remain in natal rivers until they have spent two winters, and go to sea at lengths in excess of 150-160 mm. Many juvenile chinook salmon remain in the estuary for some time before they move to sea. The size of age 0 chinook at ocean entry appears to range from about 80 mm upward, with 100 mm common in streams studied along the southern Oregon coast (Nicholas and Hankin 1988). Most work on chinook residence in estuaries has been done in those that lack sandbar closure. However, even where chinook have egress to the sea at any time, they often choose to rear in the estuary, even to October. Anderson (1999) found that chinook salmon juveniles in the estuary of Redwood Creek had mean lengths of 80 mm in mid-June (range 53-99 mm), 83 mm in mid-July (range 67-102 mm), and 107 mm in mid-September (range 93-102 mm). The sandbar at the mouth had closed by the September sample dates.

I found no data for Redwood Creek to indicate that the yield of salmon and steelhead from the portions of the stream downstream from the screw-trap site would be less than the yield of areas upstream from the trap site. If the lower Redwood Creek watershed (exclusive of Prairie Creek) produces juveniles at the same rate as the upper portion, the total output of the stream could be well over twice as great as the output estimated at the trap site.

I estimate that a yield of about 436,000 age 0 chinook from the watershed upstream from the screw-trap site represents an egg deposition of roughly 4.36 million.[8] If I assume a fecundity of

[8] I assumed survival of 10% from deposited eggs to downstream migrants. Wales and Coots (1955) estimated a survival of 14.5% in Fall Creek, California. Lister and Walker (1966) reported survival of 8.4% in the Big Qualicum River, B.C.

about 4,200 for the average female, 4.36 million eggs represents roughly 1,014 females. If I further assume that each female represents about 2.5 to 3.1 fish in the escapement, I can estimate that over 2,595 to 3,120 chinook salmon (males and females combined) escaped to the area upstream from the screw-trap site. A downstream migration of about 73,000 age >1 steelhead would represent an egg deposition of roughly 3.65 to 4.9 million eggs.[9] If I assume fecundity of 4,500-5,000, this converts (using midpoints of ranges) to about 891 females and about 1,693 escaping steelhead[10] upstream from the trap site.

USFWS (1960) estimated a fall chinook run of 5,000 fish in Redwood Creek. That estimate, which preceded the 1964 flood, would comport with the 2,595-3,120 chinook salmon that I estimated for the upper third of the Redwood Creek watershed in the 1999 brood year. It seems reasonable to conclude that the remaining two-thirds could contribute sufficient fish to equal or exceed a run of 5,000 fish in the 1999 brood year.

USFWS (1960) estimated a winter steelhead run of about 10,000 fish. I doubt that the Redwood Creek basin outside the 65,000 ac. watershed upstream from the screw-trap site produced sufficient returning steelhead in the parent broods that produced the 2000 downstream migration to make up a total run of 10,000 fish. However, I also question whether Redwood Creek ever had runs as large as 10,000 steelhead.

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[9] Assumes survival of 1.5-2.0% from egg deposition to downstream migration.

[10] The ratio of adult males to females equaled about 48:52 in Waddell Creek 1933-1942 (Shapovalov and Taft 1954).

Waddell Creek, with about 11 km of usable habitat, had average annual runs of 431 adults 1933-1941 (Shapovalov and Taft 1954), when the watershed was in good condition. Brown (1988) estimated total usable habitat in the Redwood Creek basin as 177 km, including Prairie Creek. If habitat in Redwood Creek produced steelhead at the same rate as Waddell Creek, it could have runs of about 6,750 steelhead. The 59 km upstream from the screw-trap site could, on the same calculation basis, produce runs of 2,250, not greatly different from the estimate in an earlier paragraph for the 1999-2000 steelhead run.

The U.S. Commission of Fish and Fisheries (1892-1899) shows that about 17-375 adult steelhead females were captured annually at Redwood Creek Egg Collecting Station. The station was located at the confluence of Minor and Redwood creeks, shortly upstream from the site of the screw trap in 2000. Chinook salmon collections ranged from 49-563 females from 1892 through 1898. Trapping usually included December and January, sometimes extending into March.

The following table lists yields per kilometer from various stream habitats along the Pacific Coast:

Stream/(years of data)	Km usable	Chinook juveniles yield/km	Rainbow/ steelhead yield/km	Source
Redwood Creek (1)	59 >trap site	7576	1158 age 1+ 83 age 2	Screw-trap data spring 2000; Brown (1988)
Blue Creek (Klamath River basin) (4)	20.3 >trap site	5016 (max. of 4 yrs)	836 age 1+ 121 age 2 (max. of 4 yrs)	Longenbaugh and Chan (1994)
Sproul Creek	22.4	---	1231	Vaughn (2000); S. Horner, pers. comm.
Little River	49.6	4220	---	Shaw and Jackson (1994); S. Horner, pers. comm.
Prairie Creek	17.6	2556	---	Klatte and Roelofs (1997); S. Horner, pers. comm.
Cowichan River, B.C. (2)	41.6	5500 (max. of 2 yrs)	---	Marshall et al. (1980)
Big Qualicum R. (12) (4 before flow control)	10.4	12600 max. w/ flow control, 3212 max. w/o	---	Lister and Walker (1966); Marshall et al. (1980)
Snow Creek, WA. (3)	13.4	---	82	Marshall et al. (1980)
Keogh River, B.C. (7)	30.2	---	227 max.	Ward (2000)
Waddell Creek (9)	11.3	---	545-763 age 2+[11]	Shapovalov and Taft (1954)

[11] Estimated from average run of 431 adults and an assumed smolt return of 5% to 7%.

I found no quantitative data on yields of juvenile salmon and steelhead in Redwood Creek in the first half of the 1900s. Brown (1988) censused age 1+ steelhead in 9 tributaries (exclusive of Prairie Creek) and in one site in Redwood Creek. He used electrofishing with removal-depletion in 50 m with block nets at each end of the section. From his Table 5, p. 65, I calculated that he found an average of six 1+ steelhead in each of the 9 tributary sites and 20 in the single mainstem site. The sample size and length of sites (50 m) was small. However, the numbers convert to an average of 120 steelhead/km in several tributaries and 400/km in the single mainstem site in 1981.

Stream conditions

Woods (1995) reported percentages of fines <0.83 mm as 18.6%, 17%, and 21.9% in riffles at Redwood Creek river miles 5.3, 24.5, and 44.5, respectively, in summer of 1974. Woods (1995) was unable to explain difference in water exchange in Redwood Creek among the three sample sites by the amounts of sediment finer than 0.83 mm. The percentages of fines present historically at these and other sites in Redwood Creek are unknown. However, Burns (1970) reported fine sediment of diameter <0.8 mm in an unlogged tributary to Prairie Creek as ranging from 13.2% to 21.3%.

No satisfactory assessment technique permits one to determine accurately the degree to which fine sediment in undisturbed gravels (not modified by spawning salmonids) may affect subsequent success of salmon reproduction (Chapman 1988). One reason is that spawning females select spawning sites and create conditions favorable for survival of embryos and alevins in egg pockets in the redd. Wood (1995) examined substrate sediments in the lower third of the main stem of Redwood Creek. He reported conditions that appeared favorable for salmonid spawning.

Aggradation of the streambed was extensive in and after the 1964 flood (Madej 1995). Examination of images taken over time from photo points, and cross-sectional profiles, show that

the aggraded material subsequently moved seaward (Madej 1995). Erosion of the aggraded material contributed strongly to bedload movement. A few inches of aggradation attributable to the 1964 flood and associated mass soil movements remain in lower Redwood Creek. Extensive aggradation and its reverse, degradation (refers in this sense to channel lowering), occurred in Redwood Creek before timber harvest began, as a result of extensive uplift and downcutting (Cashman et al. 1995).

Aggradation should not always be considered as damaging to salmonid reproduction. Adult chinook salmon will spawn on aggraded material. However, one can visualize aggradations that succeed spawning as being sufficiently severe to prevent emergence of fry. One can also visualize gravel downcutting in floods that occur over aggraded gravels after fish spawn, sufficient to scour fertilized eggs and embryos from the redds.

Brown (1988) described the streambed of Redwood Creek and tributaries in 1980 and 1981 as "... extensive sedimentation exacerbated the reduced quality of rearing habitat for juvenile salmonids during summer low-flow conditions. Pool depth and cover at all sample sites were rated low in quality. Sediment accumulations at tributary mouths limited emigration and trapped fish in drying streams." He thought sediment aggradation in tributaries responsible for reduced habitat diversity. However, total biomasses of rainbow/steelhead of all ages in Redwood Creek did not differ significantly[12] from biomasses in several other streams in northern California, whether steelhead lived either allopatrically (without other species) or sympatrically with other salmonid species. He did find significantly fewer age 1+ rainbow/steelhead in 9 Redwood Creek tributary sites than sites in 49 other streams outside the Redwood Creek basin where the steelhead lived allopatrically. The utility of this finding is unclear. Brown (1988) speculated that the difference in

[12] Figures 31 and 32 in Brown (1988) show means plus or minus one standard error rather than confidence limits, the extent of which would roughly double the ranges shown in the figures.

allopatric steelhead densities in 1981 was due to habitat degradation in the Redwood Creek[13] sites. However, the comparative biomass data for streams outside the Redwood Creek basin were obtained from July (Godwood Creek) through October (several streams) with varyied data collection methods. Brown (1988) found that stream order strongly affects fish densities, but his analyses and comparisons combined sites in four different stream orders (stream orders 3 through 6) in the basin of Redwood Creek. He did not specify stream order in streams outside the basin.

Timber harvest contributed to increased suspended-sediment transport and streamflows in Redwood Creek (Nolan and Janda 1995), and mass soil movements (Harden et al. 1995). Rice (1999) discussed how improved forest practices have greatly reduced road-related erosion in middle reaches of Redwood Creek. He attributed reductions in erosion to better sizing and placement of culverts, less reliance on culverts, and reduced tractor yarding.

Channelization (Ricks 1995) and conversion of wetlands and backwaters to agricultural use in the estuary of Redwood Creek greatly reduced quality and quantity of estuarine habitat. This very likely reduced the capacity of the system to support fall chinook in the period before juveniles enter the open sea. The reduced estuary probably also decreased carrying capacity for steelhead and overwintering coho.

Even in absence of anthropogenic effects, conditions in Redwood Creek probably fluctuated widely from year to year and decade to decade. Variable ocean productivity contributed to the dynamism. Tectonic uplift, extreme variation in flows and floods, and downcutting must also have strongly affected conditions for anadromous fish.

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[13] Brown (1988) did not census fish in the middle and lower mainstem of Redwood Creek.

Conclusion

The flood of 1964 temporarily reduced quality of stream habitat in Redwood Creek. However, the literature that I examined, estimates of yields of juvenile anadromous salmonids in spring of the current year, and my observations of Redwood Creek would not support a contention that the stream/riparian system of Redwood Creek currently remains in poor condition. In evaluating habitat quality, I consider fish abundance a useful integrative index of condition of the substrate, stream morphology, riparian zone, and biota. Yields of juvenile chinook salmon and steelhead in Redwood Creek in spring, 2000, fall at the high end and middle, respectively, of the range of yields in other streams along the Pacific Coast. Anadromous fish productivity fluctuates from year to year, varying with ocean productivity, escapements, and winter and summer stream discharges, hence I cannot determine where the juvenile yield of this year falls in the range of yields from Redwood Creek. The stream system appears to have provided productive habitat for anadromous juveniles that moved downstream in 2000. Objective review of the available information does not support a conclusion that fine sediments currently impair the aquatic habitat of Redwood Creek.

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