6/12/07 Workshop
Suction Dredge
Deadline: 6/22/07 Noon

Song Her
State Water Resources Control Board
Sacramento, California

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June 22, 2007

SUBJECT: Comment Letter – Suction Dredge Mining

Dear Song Her and the State Water Resources Control Board (SWRCB):

Please consider my comments as you review water quality impacts of suction dredging:

In relation to suction dredging and water quality, I have the following background. For the last 13 years I have been employed full time as a Fishery Biologist by a Federal agency to monitor fish populations and assess fish habitat and water quality along 90 miles of the mid-Klamath River including tributary streams from Beaver Creek to the Salmon River. From 1989 until 1994 I was employed by a Federal research agency as technical and field coordinator for research on the effects of land use on aquatic habitats and fish populations. I have observed suction dredges being operated many times during field work in the last 18 years, as well as observed the effects of suction dredging on water quality and the stream channel after dredging. I am still currently employed by the Federal government as a Fisheries Biologist working along the mid-Klamath River but the comments I am submitting in this letter are my own opinions. I am writing this letter on my own time as a concerned private citizen and my comments do not represent the position of the Federal agency that employs me.

From my 18 years of observation of suction dredging effects I do believe that suction dredging degrades water quality and can adversely affect beneficial uses including fish habitat, and domestic, municipal, and recreational uses of water. Impacts of suction dredging are often greater than what is assumed in the California Department Fish and Game (CDFG) regulations and supporting environmental analyses. For instance, the turbidity plume from suction dredging usually exceeds the 300 feet that is assumed by CDFG – often by hundreds of feet, in some cases by miles. Spills and leaks of gas and oil from suction dredges are not un-common. In Northern California (and other places), suction dredging is particularly impacting in small streams and rivers because dredging is often permitted and can only be accomplished safely during seasons when stream flows are low and there is not enough water to easily dilute the turbidity/pollutants generated by suction dredging. Also, fish and other aquatic organisms are not adapted to the uncharacteristic chronic turbidity during the low-flow seasons. Increased turbidity and other pollutants can adversely affect fish and other aquatic organisms, particularly when these impacts occur synergistically with other environmental stressors occurring during the low-flow season, such as high water temperature.

The SWRCB should restrict or prohibit suction dredging where the beneficial uses of water can be adversely affected. These areas include domestic and municipal sources, of course, but also should include water quality necessary to support aquatic species. Critical areas for at-risk salmon and steelhead stocks should be protected from adverse water quality associated with suction dredging. Maintenance of salmon and steelhead (and other aquatic fauna) is the primary beneficial use of water in many California streams. From my 18 years of observation of suction dredging effects, I have to agree with Harvey and Lisle (1998) who conclude that suction dredging should be assumed to harm declining species unless it can be proven otherwise. From what I know of the Klamath River and tributaries, and of Klamath River fish populations, I have to agree with the Expert Report of Peter B Moyle (one of the Nation's most prominent and respected fishery scientists) that **"suction dredging should be banned in tributaries to the Klamath River, 500 meters above and below cool-water refuge areas (stream mouths) on the mainstem Klamath River, the Klamath River from the Trinity River confluence to Green Riffle, Canyon Creek and all other Scott River tributaries, and the Salmon River including the north and south forks and all tributaries"** until further analyses prove that suction dredging would not contribute to the decline of aquatic resources.

Please let me share with you a few papers and documents that may aid your review of water quality impacts of suction dredge mining (my apologies if you have already seen these). There are relatively few studies on the effects of suction dredging mining, and really only three good reviews of the subject. Harvey and Lisle (1998) provide the best comprehensive review of suction dredging. Good reviews are also provided by the Washington Department of Fish and Wildlife (2006), and by the Siskiyou National Forest (2001). Both Harvey and Lisle (1998) and Washington Department of Fish and Wildlife (2006) conclude with warnings of potential adverse effects to fish habitat and populations form suction dredging. The Siskiyou National Forest document reviews a study that demonstrates that turbidity can travel downstream much further than is assumed by the CDFG.

Here are those references:

Harvey, B. C., and T. E. Lisle. 1998. Effects of suction dredging on streams: a review and an evaluation strategy. Fisheries 23(8):8-17

USDA (Siskiyou National Forest), 2001. Draft Environmental Impact Statement - Suction Dredging Activities.

Washington Department of Fish and Wildlife. 2006. Small-Scale Mineral Prospecting White Paper. Prepared by R2 Resource Consultants; Redmond, Washington.

Attachment: Peter Moyle Expert Report

Thank you for considering my concerns.

Sincerely,

/s/ Jon B. Grunbaum

Jon B. Grunbaum – Fisheries Biologist

EXPERT REPORT OF PROFESSOR PETER B. MOYLE, PH.D.

I have been asked to provide my expert opinion on the potential effects of suction dredging on fishes of the Klamath River and tributaries, on behalf of the plaintiffs in Karuk Tribe vs California Department of Fish and Game (Superior Court of California, Alameda County, RG0521197).

I. QUALIFICATIONS AND EXPERIENCE

I have been researching freshwater and anadromous fish in California since 1969. I was appointed Professor of Fisheries Biology at the University of California at Davis in 1972, and held the chair of the University's Department of Wildlife, Fish and Conservation Biology from 1982 to 1987. I have served as Associate Director of the Center for Integrated Watershed Science and Management since 2002. My *curriculum vitae* is attached as Exhibit A.

The principal area of my research and expertise is the ecology and conservation of freshwater and anadromous fishes, particularly in California. A significant portion of my research has focused on regulated streams and the impacts of dams, diversions, and other factors on fish populations in California, including the Central Valley. I have authored or co-authored more than 160 publications, most of which concern freshwater and anadromous fishes. Among my publications is *Inland Fishes of California* (Moyle 2002), the standard reference work on California fishes, as well as four other books and monographs on fishes. A list of my publications is attached as Exhibit B.

In 1993, I was named a Fellow of the California Academy of Sciences. I serve on the editorial boards of several peer-reviewed journals, including *Environmental Biology of Fishes*, *Biological Conservation*, and *Biological Invasions*. I am a member of the American Fisheries Society, American Society of Ichthyologists and Herpetologists, Ecological Society of America, Society for Conservation Biology, American Association for the Advancement of Science, and American Institute of Biological Sciences. I also have received an Award of Excellence from the Western Division of the American Fisheries Society (1991); recognition as a Distinguished

Fellow of the Gilbert Ichthyological Society (1993); the Outstanding Educator Award from the American Fisheries Society (1995, with J. J. Cech); and recognition as Distinguished Ecologist by Colorado State University (2001). I currently co-hold the President's Chair in Undergraduate Education at UC Davis.

In 2003, I was one of the co-authors of the National Research Council's final report on the causes of the decline and strategies for recovery of coho salmon and other fishes in the Klamath River Basin (National Research Council 2003). I also was a member of the Science Board of the CALFED Ecosystem Restoration Program and its predecessor (1998-2005), led the USFWS Delta Native Fishes Recovery Team (1993-1995), and served as a member of the USFS Sierra Nevada Ecosystem Project Team (1994-1996). I currently serve as a member of interagency Fish Screen Evaluation Committee.

I have previously served as an expert witness or consultant on salmon and other fishes in California in a number of venues. I was retained as a consultant by the City and County of San Francisco in a re-licensing proceeding before the Federal Energy Regulatory Commission (FERC), and served as an expert witness for the Putah Creek Council, in the *Putah Creek Water Cases*, Judicial Council Coordination Proceeding Number 2565 (Sacramento Superior Court). I also have testified before the State Water Resources Control Board and a congressional committee. In 2000 I was deposed as an expert witness on coho salmon in the case *Environmental Protection & Information Center. Andrea Tuttle*, Case No. 00-0713-SC (N.D. Cal). In March, 2004, I was deposed as an expert witness on the 2002 Klamath River salmon kill in the case *Pacific Coast Federation of Fisherman's Associations, Yurok Tribe, Hoopa Valley Tribe v. Bureau of Reclamation, Klamath Water Users, No.C 02-020006 SBA* (N.D.California). I am currently serving as an expert witness for the Natural Resources Defense Council on NRDC vs Rodgers (E.D. Cal. No. Civ. 88-1658 LKK) on restoring flows to the San Joaquin River.

I have also been called on to provide expertise on salmon and native fish restoration in many other venues and proceedings. For example, I recently presented expert testimony regarding Section 5937 in proceedings before the California State Water Resources Control Board involving the Santa Ynez River (*in re Santa Ynez River Public Trust Proceedings on U.S. Bureau of Reclamation Water Rights Permits, Applications 11331 and 11332*, 2003).

In relation to the suction dredging and fishes of the Klamath River, I have the following background. I have been keeping track of the status of Klamath River fishes ever since I began writing the standard reference work on California fishes, *Inland Fishes of California,* first published in 1976. In the revised edition, published in 2002, I extensively reviewed the biology and status of fishes of the Klamath Basin. I was responsible for the analyses that led to various species being listed as Species of Special Concern by the California Department of Fish and Game (Moyle et al. 1994) and with two postdoctoral scholars in my laboratory, produced the first major peer-reviewed review of the status of coho salmon in California (Brown et al.1994). As the result of my expertise, I was appointed a member of the National Research Council's committee to review the causes of fish declines in the Klamath Basin (NRC 2003). In the summer of 2002, Dr. Jeffrey Mount and I brought a team of advanced undergraduates and graduate students into the Scott River basin to conduct field investigations on the status of coho salmon in Scott River tributaries. I am aware of the impacts of suction dredging primarily through the work of Dr. Bret Harvey, who conducted his first studies under me while a graduate student in my laboratory. Subsequently, I reviewed several drafts of the best (really *only*) review paper on suction dredging impacts in California written by Dr. Harvey (Harvey and Lisle 1998). I have also observed suctions dredges at work numerous times while conducting field work.

II. PREVIOUS TESTIMONY

See qualifications section (last three paragraphs).

III. COMPENSATION

I am not being paid and have not been paid for my work as an expert witness for this legal proceeding or for other similar matters relating to the Klamath River.

IV. SCOPE OF ASSIGNMENT

I was asked by the Plaintiffs to investigate and provide expert opinion, as a fisheries biologist, on the following questions:

(1) What are the likely effects of suction dredging on anadromous fishes, especially coho salmon, in the Klamath River and its tributaries?
(2) What tributaries and thermal refugia contain fish that would be particularly at risk from suction dredging?

V. MATERIALS CONSIDERED IN FORMULATING THIS EXPERT REPORT

In formulating the opinions stated in this expert report, I have relied on information I accumulated working on salmon and other California fishes since 1969. Much of this material is summarized in my 2002 book, *Inland Fishes of California* (University of California Press, 502 pp) and in my 160+ peer-reviewed publications. More specifically, I considered each of the publications cited in this report and materials cited in my publications on the Klamath River. Particularly important was the research I conducted on the status of Klamath River fishes on behalf of the NRC. Thus the opinions that I express in this report are based on my 35 years of experience and publications and on periodicals, texts, research, and historical and other materials that other experts in my field would consider reliable.

VI. SUMMARY OF EXPERT OPINIONS

Opinion 1: *All* anadromous fishes in the Klamath basin should be considered to be in decline and ultimately threatened with extirpation as wild populations because of the long history of decline and the multiple threats to river system. Suction dredging through a combination of disturbance of resident fish, alteration of substrates, and indirect effects of heavy human use of small areas, especially thermal refugia, will further contribute to the decline of the fishes. I agree with thrust of Harvey and Lisle (1998), that it should be assumed that dredging is harming declining species unless it can be proven otherwise.

Opinion 2. Suction dredging should be banned from following areas, unless it can be proven using peer-reviewed scientific studies that the dredging has no short term or cumulative effects: All tributaries to the Klamath River, 500 m above and below cool-water refuge areas (stream mouths) on the mainstem Klamath River, Klamath River from Trinity River confluence

to Green Riffle, Canyon Creek and all other Scott River tributaries, and Salmon River including the north and south forks and all tributaries.

VII. WHAT ARE THE LIKELY EFFECTS OF SUCTION DREDGING ON ANADROMOUS FISHES, ESPECIALLY COHO SALMON, IN THE KLAMATH RIVER AND ITS TRIBUTARIES?

The general effects of suction dredging on fish are well described in Harvey (1986) and Harvey and Lisle (1998) and so will be described only briefly here. The effects vary according to a variety of factors including size of stream, fish species present, season of dredging, and frequency and intensity of dredging. The key is that suction dredging represents a chronic unnatural disturbance of natural habitats that are already likely to be stressed by other factors and can therefore have a negative impact on fishes that use the reach being dredged. Direct effects include entrainment of invertebrates and small fish in the dredges, altering of the habitat that supports the food supply of fishes, and changing channel structure in ways that make it less favorable for fish (usually by making it less stable and complex). An area of particular concern in the Klamath River and its tributaries is the creation of piles of dredge tailings that are attractive for the spawning of salmonids but that are so unstable they are likely to scour under high flows, greatly reducing survival of the embryos placed within the gravel.

A more immediate effect is the impact of chronic disturbance of the fishes, which can change their behavior and cause them to move to less favorable conditions. I am particularly concerned in this regard with dredging in or near thermal refugia of juvenile salmonids. As discussed in the NRC (2003) report and references therein, the Klamath River and some of its tributaries can reach temperatures in excess of 65-70ºF during the day in late summer. Such temperatures are very stressful or even lethal for many salmonids, so the fish seek out cooler areas, where small tributaries flow into the river or there is upwelling of ground water. Juvenile coho salmon, Chinook salmon, and steelhead will often be packed into these areas during the day. This past August, I spent a day with Dr. Michael Deas, who was documenting the nature of a thermal refuge created by the inflow of single creek into the Klamath River. When I swam through the refuge area with a mask and snorkel I was impressed with the concentrations of fish

in the area (and the lack of them in the main river) and how much even a minor disturbance of the habitat would reduce the ability of the area to support fish.

Adult salmon and steelhead can also be disturbed by the intense dredging activities. I am particularly concerned with spring-run Chinook salmon, a species with which I have worked closely in the Sacramento River drainage. Adult spring-run Chinook spend the summer in pools in rivers, especially the Salmon River (and its forks) and Wooley Creek. They have to survive the summer without feeding, using reserves of fats and oils they bring up from the ocean. Chronic disturbance of the type created by dredging and dredgers can increase stress on these fish and has the potential to reduce their over-summer survival. An often overlooked impact of dredging is that the people involved often live on or close to the stream in remote areas for weeks at a time, where they not only dredge, but swim, bathe, and fish (sometimes illegally). Such activity can cause spring-run Chinook to use up precious energy reserves if they have to move to less favorable areas or swim about avoiding people.

It is important to note that the Klamath River and its tributaries support the highest diversity of anadromous fishes of any river in California including: coho salmon, chum salmon, multiple runs of Chinook salmon, coastal cutthroat trout, multiple runs of steelhead, eulachon, green sturgeon, white sturgeon, Pacific lamprey, and river lamprey. This is the reason, of course, why the river also supported a rich and diverse fishery by the native peoples who live along the river. Today virtually all the species are in decline or threatened with declines from multiple factors (see NRC 2003). Therefore, in my professional opinion, suction dredging should only be allowed in areas where it can be demonstrated there will no immediate or cumulative impact on the anadromous fishes. It should be assumed there is harm, unless it can be proven otherwise.

One reason for my taking this conservative position, is that we simply do not know the effects of dredging on many species, especially when the intensity of dredging is increasing. For example, the larvae (ammocoetes) of Pacific and river lamprey live in soft materials along the stream edge or in slow-moving sections of stream. Dredging of areas where ammocoetes are abundant will push them into the water column where they can be readily consumed by predators, contributing further to the likely declines of the species. Even for salmonids, our information, with the exception of a few studies such as that of Harvey (1989), is largely

anecdotal or in non-peer reviewed reports (see, for example, the bibliography of DFG 1994).. Studies are also largely confined to looking at immediate effects of single dredges and they do not examine the cumulative or long-term effects of multiple dredges and activities associated with the dredges. Indeed little has changed since DFG (1994, p. 71) listed the need for additional studies on practically every important aspect of the environmental impacts of dredging. Harvey and Lisle (1998) present a strategy for acquiring much of the needed information.

VII. WHAT TRIBUTARIES AND THERMAL REFUGIA CONTAIN FISH THAT WOULD BE PARTICULARLY AT RISK FROM SUCTION DREDGING?

The NRC (2003) report emphasized two important considerations for the recovery of Klamath basin fishes that are especially relevant here: (1) cold water refuges are key to the persistence of many species, especially coho salmon and (2) the entire array of anadromous fishes (i.e., the Tribal Trust Species) need large scale and pro-active measures to assure recovery. Suction dredging is one more insult to these fishes that is likely to hurt their chances for recovery. In particular, coho salmon, spring-run Chinook salmon, and summer (spring) steelhead are particularly vulnerable to the immediate effects of dredging and have been reduced to low numbers in the Klamath Basin so need special protection.

In my professional opinion, the following waters should be Class A (no dredging permitted) waters beyond what is already classified as such:

1. All Klamath River cold-water tributaries, including the Shasta (already class A) River. This is to protect coho salmon in particular.
2. The Klamath River below Iron Gate at the mouths of all tributaries for a minimum of 500 meters (1500 ft) upstream of the mouths and 500 meters downstream of detectable coldwater influence. Most of the smaller tributaries of the Klamath River are substantially colder than the main river and the short sections along the edges that are influenced by the creeks are important summer refuges for juvenile Chinook and coho salmon, as well as steelhead. For example in 2001, USFWS (unpublished data) found juvenile salmonids using refuge areas at the mouths of the following creeks: Aikins, Beaver, Blue, Bluff, Bogus, Boise, Cade, Camp, Cappell, China, Clear, Coon, Dillon, Elk, Elliott, Fort Goff, Grider, Halverson, Hopkins, Horse, Independence,

Indian, Irving, Little Grider, McGarvey, Miners, Oak Flat, Pearch, Pecwan, Perch, Pine, Portuguese, Red Cap, Roach, Rock, Rogers, Roseland, Sandy Bar, Seiad, Slate, Stanshaw, Swillup, Thompson, Ti, Tinkman, Tully, Uksnom, Ullthorne, Ukanom, Upsanddown, and Walker. The mouths of the Scott, Shasta, and Salmon rivers should also be protected.

3. Klamath River from Trinity River confluence to Green Riffle, to reduce potential impacts on green sturgeon spawning and rearing.

4. Canyon Creek and all other Scott River tributaries. These streams contain cold water habitats essential for the rearing of juvenile coho salmon.

5. Salmon River including the north and south forks and all tributaries. This designation is to protect the entire suite of Klamath Basin anadromous fishes, especially coho salmon in the tributaries, spring-run Chinook and summer steelhead in the two forks of the Salmon River, and green sturgeon and lamprey in the mainstem salmon.

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National Research Council 2003. *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery*. Committee on Endangered and Threatened Fishes in the Klamath River Basin. Board on Environmental Studies and Toxicology.. National Academy Press.

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Peter B. Moyle Date

EXHIBIT A: CURRICULUM VITAE

PETER BRIGGS MOYLE

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And

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EDUCATION

1964	University of Minnesota	**B.A. -**	**Zoology**
1966	Cornell University	**M.S. -**	**Conservation**
1969	University of Minnesota	**Ph.D. -**	**Zoology**

UNIVERSITY POSITIONS

1969 - 1972	Assistant Professor, Biology, California State University, Fresno, CA
1972 – present	Assistant to Full Professor, University of California, Davis, California
1982 - 1987	Chair, Department of Wildlife & Fisheries Biology, University of California, Davis, California
2002-present	Associate Director, Center for Integrated Watershed Science and Management UCD

PROFESSIONAL SOCIETIES/ORGANIZATIONS

American Fisheries Society (national & local chapters); American Society of Ichthyologists and Herpetologists; Ecological Society of America; Desert Fishes Council; Society for Conservation Biology; AAAS; AIBS

AWARDS

Award of Excellence, Western Division, American Fisheries Society (1991); Haig-Brown Award, California Trout (1993); Distinguished Fellow, Gilbert Ichthyological Society (1993); Fellow, California Academy of Sciences (1993); Bay Education Award, Bay Institute (1994); Public Service Award, UCD (1995); Outstanding Educator Award, American Fisheries Society (1995, with J. J. Cech); Streamkeeper Award, Putah Creek Council (1997); Distinguished Ecologist, Colorado State University (2001); Outstanding Mentor Award, UCD (2003); President's Chair in Undergraduate Education, UCD (2003-2005, with J. Mount).

OTHER

Editorial Boards, *Environmental Biology of Fishes*, *Biological Conservation*, and *Biological Invasions*. Expert testimony: Bay/Delta Hearings, State Water Resources Control Board; Congressional hearings, Re-authorization of Endangered Species Act, etc. Head, Delta Native Fishes Recovery Team (1993-1995); Member, Sierra Nevada Ecosystem Project Team (1994-1996); Member, Independent Science Board, CALFED Ecosystem Restoration Program; Vice President, The Natural Heritage Institute; Fisheries Consultant, City and County of San Francisco. Member, National Research Council Committee on Endangered Fishes in the Klamath Basin (2002-2003).

TEACHING

Teach basic courses in fish biology, wildlife conservation, fisheries, watershed ecology, and nature/culture. Co-authored (with J. Cech) widely used ichthyology text (5th edition, 2003) and co-edited (with C. Schreck) handbook on techniques for working with fish. Active in Graduate Group in Ecology (currently on Executive Committee). Steering Committee, Nature and Culture Program.

PUBLICATIONS

Author or co-author of over 150 peer-reviewed publications, including five books/monographs.

EXIBIT B

PEER-REVIEWED PUBLICATIONS

Peter Briggs Moyle

(Does not include ca. 100 non-peer-reviewed publications)

1. Moyle P.B. and J. A. Israel. 2005 Untested assumptions: effectiveness of screening diversions for conservation of fish populations, Fisheries 30 (5):20-28.
2. Kimmerer, W., S. R. Avent, S. M. Bollens, F. Feyrer, L. F. Grimaldo, P. B Moyle, M. Nobriga, and T. Visintainer. 2005. Variability in length-weight relationships used to estimate biomass of estuarine fish from survey data. Transactions, American Fisheries Society 134:481-495.
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4. Brown, L. and P. B. Moyle 2004. Native Fishes of the Sacramento-San Joaquin Drainage, California: a History of Decline" Pages xxx-xxx *in Historical Changes in Fish Assemblages of Large North American Rivers.* American Fisheries Society, Bethesda.
5. Ribeiro, F., P. K. Crain, and P. B. Moyle. 2004. Variation in condition factor and growth in young-of-year fishes in floodplain and riverine habitats of the Cosumnes River, California. Hydrobiologia 527:77-84.
6. Marchetti, M. P., T. Light, P. B. Moyle, and J. H. Viers. 2004. Fish invasions in California watersheds: testing hypotheses using landscape patterns. Ecological Applications 14:1507-1525.
7. Marchetti, M. P., P. B. Moyle, and R. Levine. 2004. Invasive species profiling: exploring the characteristics of exotic fishes across invasion stages in California. Freshwater Biology 49:646-661..
8. Moyle, P.B., R. D. Baxter, T. Sommer, T. C. Foin, and S. A. Matern. 2004. Biology and population dynamics of Sacramento Splittail (*Pogonichthys macrolepidotus)* in the San Francisco Estuary: a review. San Francisco Estuary and Watershed Science [online serial] 2(2):1-47.
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10. Marchetti, M. P. , P. B. Moyle, and R. Levine. 2004. Alien fishes in California watersheds: characteristics of successful and failed invaders. Ecological Applications 14:587-596.
11. Lewis, W. A., R. M. Adams, E.B. Cowling, E. S. Helfman, C.D.D.Howard, R. J, Huggett, N. E. Langston, J. F. Mount, P. B. Moyle, T. J. Newcomb, M. L. Pace, and J. B. Ruhl. 2004. Endangered and threatened fishes of the Klamath River Basin: Causes of decline and strategies for recovery. National Academies Press. 334 pp.
12. Crain, P.K., K. Whitener, P.B. Moyle. 2004. Use of a restored central California floodplain by larvae of native and alien fishes. Pages 125-140 in F. Feyrer, L.R. Brown, R.L. Brown, and J.J. Orsi, editors. *Early life history of fishes in the San Francisco Estuary and watershed*. American Fisheries Society Symposum 39, Bethesda, Maryland.
13. Moyle, P. B., P. K. Crain, K. Whitener, and J. F. Mount. 2003. Alien fishes in natural streams: fish distribution, assemblage structure, and conservation in the Cosumnes River, California, USA. Environmental Biology of Fishes 67:277-288.

14. Feyrer, F., B. Herbold, S.A. Matern, and P.B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: consequences of a bivalve invasion in the San Francisco Estuary. Environmental Biology of Fishes 67:277-288.

15. Matern, S. A., P. B. Moyle, and L. C. Pierce. 2002. Native and alien fishes in a California estuarine marsh: twenty-one years of changing assemblages. Transactions of the American Fisheries Society 131:797-816.

16. Moyle, P. B. 2002. *Inland Fishes of California. Revised and expanded*. Berkeley: University of California Press. 502 pp.

17. Chasnoff, B. and P. B. Moyle. 2001. Ethics, ecology, and economics in river management: the benefits of working together. Pages 157-176 *in* C. K, Davis and R. E. McGinn, editors. *Navigating rough waters: ethical issues in the water industry*. Denver, Colorado, American Waterworks Association.

18. Sweetnam, D. S., R. D. Baxter, and P. B. Moyle. 2001. True smelts. Pages 472-479 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, eds. *California's living marine resources: a status report*. Sacramento: California Department of Fish and Game.

19. Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and present distribution of chinook salmon in the Central Valley. Pages 71-176 *in* R. Brown, ed. *Contributions to the biology of Central Valley salmonids*. CDFG Fish Bulletin 179.

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21. Sommer, T. R., W. C. Harrell, M. Nobriga, R. Brown, P. B. Moyle, W. J. Kimmerer and L. Schemel. 2001. California's Yolo Bypass: evidence that flood control can be compatible with fish, wetlands, wildlife and agriculture. Fisheries 58(2):325-333.

22. Moyle, P. B., and L. H. Davis. 2001. A list of freshwater, anadromous, and euryhaline fishes of California. California Fish and Game 86:244-258.

23. Marchetti, M. P., T. Light, J. Feliciano, T. Armstrong, Z. Hogan, and P. B. Moyle. 2001. Homogenization of California's fish fauna through abiotic change. Pages 269-288 *in* J.L. Lockwood and M.L. McKinney, editors. *Biotic Homogenization*. Kluwer/Academic Press, New York.

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25. Marchetti, M. P., and P. B. Moyle. 2000. Spatial and temporal ecology of native and introduced fish larvae in lower Putah Creek, California. Environmental Biology of Fishes 58:75-87.

26. Moyle, P. B. 2000. Restoring aquatic ecosystems is a matter of values. California Agriculture 54(2):16-25.

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