

California Cooperative Fish & Wildlife Research Unit

2010 Coordinating Meeting

May 13, 2010

Humboldt Bay Aquatic Center
921 Waterfront Drive, Eureka, CA



Thomas B. Dunklin

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AGENDA

Introductions and Welcome (Chair, Neil Manji)	9:00
Additions to the Agenda	
Approval of 2009 Meeting Minutes	
Cooperator Reports and Research Needs	9:15
Each Cooperator is given the opportunity to speak about current issues and research needs within their organization as they relate to the mission and operation of the Cooperative Research Unit.	
Unit Research Summary	
Completed Projects Review (Duffy & Wilzbach)	11:15
Lunch at Hurricane Kate's	11:45
Unit Research Summary (continued)	
Research Presentation (Brian Hodge)	1:15
Research Presentation (Matt Metheny)	1:35
Current Research Projects Review (Duffy & Wilzbach)	2:00
New Research Projects (Duffy & Wilzbach)	2:15
Unit Program Review	2:45
University Service and Technical Assistance	
Cooperative Agreement and Program Direction	
Accomplishments	
Facilities and Equipment	
Financial Status	
Adjorn	3:15

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**California Cooperative Fish & Wildlife Research Unit
2009 Coordinating Committee Meeting Minutes
Tuesday, June 9, 2009**

The annual coordinating meeting was held at the Humboldt Bay Aquatic Center, 921 Waterfront Drive, Eureka, California. It began at 9:10 am and concluded at 3:15 pm.

In attendance:

Bernard Shanks, Supervisor, USGS/BRD/Cooperative Research Units
Walter Duffy, Leader, CA Cooperative Research Unit
Peggy Wilzbach, Asst. Leader, CA Cooperative Research Unit
Neil Manji, California Dept. of Fish & Game
Russell Bellmer, Cooperator Representative, California Dept. of Fish & Game
Phil Bairrington, California Dept. of Fish & Game, Arcata
James Howard, Dean, CNRS, Humboldt State University
David Hankin, Chair, Department of Fisheries Biology, HSU
Randy Brown, U.S. Fish and Wildlife Service, Arcata
Charlie Chamberlain, U.S. Fish and Wildlife Service, Arcata
Mary Ann Madej, USGS Western Ecological Research Center
Pete Adams, NOAA Fisheries Service, Santa Cruz Lab
Ken Cummins, CA Cooperative Research Unit
Rosemary Records, CA Cooperative Research Unit (presenter)
Seth Naman, USFWS/CA Cooperative Research Unit (presenter)
Kay Brisby, Administrative Coordinator, CA Cooperative Research Unit

Bernard Shanks opened the meeting. He gave a brief description of the unit program and purpose of the annual coordinating meeting. The agenda was reviewed and no changes were requested. Minutes of the 2008 meeting were reviewed and approved (James Howard motioned, Ken Cummins seconded).

COOPERATOR REPORTS

Report from Humboldt State University - James Howard, CNRS Dean

- There is a call for 15% reduction in staffing at the CSU due to anticipated 15-20% deficit in the state General Fund. Actual cuts will not be known until budget passes. Despite tuition hikes, California State University tuition is still very competitive with other states.
- There is some possibility of replacing Terry Roelof's position in Fisheries Biology.
- Enrollment is at its highest ever and is greater in sciences and natural resources. There is a long waiting list for campus housing.
- Program prioritization process resulted in identification of some programs as in need of restructuring, reorganization, or elimination. However, most of CNRS was evaluated positively.

Report from U.S. Fish and Wildlife Service - Randy Brown, Arcata Field Office

- Brown is currently the acting Arcata field office director. USFWS is awaiting a national director. This region has recently become its own Region within USFWS—Region 8, which covers California, Nevada and some of the Klamath Basin to Oregon. They also have a new regional director in Sacramento. There is an interest in downsizing field

office size but increasing the number of offices—including a Bay-Delta office to address Delta smelt, and offices in Carlsbad, Riverside, and other locations. Decrease in state bond money has impacted some USFWS offices but funding is currently being covered by USFWS.

- The Strategic Habitat Conservation Program currently being established in Arcata Office will serve entire Klamath Basin, in cooperation with Klamath Falls, Yreka, and Klamath Refuge Complex.
- Except for Fisheries Program, they are still awaiting a budget for this year. Fisheries Program has the greatest number of on-the-ground studies in the Arcata Field Office.

Report from U.S. Fish and Wildlife Service - Charlie Chamberlain, Arcata Field Office

- About 90% of funding for local fisheries program is Klamath and Trinity Basin work. Klamath work focuses on the restoration agreement for dam removal.

Report from Humboldt State University - David Hankin, Dept. of Fisheries Biology Chair

- Andrew Kinziger of Fisheries Biology was recently tenured.
- Hankin has been serving as interim Associate Dean of Marine Sciences, and was able to obtain an appropriations request from Mike Thompson for a salmon and marine sciences center that would be located on Humboldt Bay.
- The Fisheries Program has struggled with the lack of a freshwater fish ecologist since the retirement of Terry Roelofs. Hankin was able to get assurance from local and regional NOAA offices to support half of a freshwater fish ecologist position and there is a tentative go-ahead to fill position.
- It is becoming extremely difficult for students to obtain necessary classes; Hankin supports a letter-writing campaign to address these problems.

Report from California Dept. of Fish and Game - Neil Manji

- Don Koch was confirmed as director about a month prior to this meeting.
- CDFG is also affected by state funds: the governor is considering taking upwards of \$30M from CDFG's non-dedicated reserve and CDFG may or may not be repaid.
- Suction dredging has become a big issue, and a new bill would require CDFG to stop issuing permits till EIR/EIS is completed. This arose because the Department was sued over their old Environmental Document. Manji met with the Karuk Tribe plaintiffs recently and reached a compromise, and a consulting firm is beginning EIR. However, the judge may wait on ruling until it is known if bill will pass.
- CDFG is still involved in stocking lawsuit, brought by Center for Biological Diversity. EIS/EIR should be done around January 2010, and plaintiffs will create a stock/no stock list with CDFG.
- Restoration Grants Program is Department's main effort for salmonid restoration in coastal streams, for which they received almost 200 proposals this year. They have applied for \$25M for Pacific Coastal Salmonid Recovery, which required correspondence with the President and a letter-writing campaign to governors of Western states. They will need to match one third of these dollars with General Fund and Proposition 84 money.
- Other work: Hatchery Genetics Management Plan. NOAA Fisheries, CDFG, and U.S. Fish and Wildlife Service have agreed to address together drought-related issues of fish rescue on a case-by-case basis. A letter is circulating with an agreement for 25%

constant fractional marking and supporting a NOAA Fisheries paper on impacts associated with mass marking, and expressing the need for a panel on mass marking.

- In response to a question from Peggy Wilzbach, Manji replied that he sees no significant educational areas needing change in Humboldt State Fisheries program, based on his experiences with recent graduates who now work for the Department.

Report from California Dept. of Fish and Game - Russell Bellmer

- Directors of U.S. Fish and Wildlife Service and CDFG are very supportive of the new Memorandum of Understanding.
- CDFG has increased its contribution to the Coop. Wilzbach expressed the Coop's thanks.

Report from California Dept. of Fish and Game - Phil Bairrington, Arcata Field Office

- Anticipating the passage of Salmon Conservation Act for the Smith River. If Act is successful, it will result in about \$13M divided among five states; California's share would adequately cover Smith River salmonid monitoring.
- There is ongoing monitoring on Klamath-Trinity, Redwood Creek, Mad River, and for Hatchery Genetics Management Plan. Humboldt Bay Estuary Slough work is continuing with monitoring of Coho juveniles and of tributaries to Humboldt Bay. Sacramento Pikeminnow monitoring in Humboldt Bay tributaries has not yet found the species.
- They are also managing New Zealand Mud Snail (found in Big Lagoon) and are trying to expedite scientific collection permitting process.

Report from U.S. Geological Survey - Bernard Shanks

- Omnibus Bill added about \$1M to their budget. Operating support for the Coop Units shrunk from about \$30,000 per average Unit to \$2,000, but some of the funds were restored this year.
- Stimulus package money has been received for 70 fuel-efficient vehicles. 2010 budget (not yet passed) is proposed to provide \$2.5M new money, which would allow Coop Units to fill most vacancies.
- Funding for this year and next year's budget is in climate change and wildlife (\$10M in this year's USGS budget), and next year both the USFWS and USGS funding is proposed to double. USGS received \$140M in Stimulus money for certain research programs.
- Hawaii and California Coop Units have been working to expand to include wildlife.

Report from CA Cooperative Fish & Wildlife Research Unit - Walt Duffy, Unit Leader

- Recently attended meeting on Coop Unit Programs. Ken Williams, Director, emphasized structured decision-making, adaptive management and collaboration among units.
- They drafted a concept for short proposal to obtain funding for a USGS-sponsored post-doctoral scientist. This position would examine range changes in aquatic species in the Western U.S. The Coop Units would assist with identifying suitable data.
- Duffy thanked Bellmer for his continued support.

Report from USGS Western Ecological Research Center - Mary Ann Madej

- Her report also represents interests and needs of National Park Service.
- Their watershed restoration on the North Coast has continued over the past 15-20 years. They would like to evaluate effectiveness of this restoration.
- NPS is beginning to evaluate marine resources, including estuaries and levees.
- New money has come in for several projects: USGS and NPS are working on a joint project called Vital Signs Monitoring, which examines long-term flow records in coastal rivers to evaluate effects of climate change. The USGS River Ecosystem Model Science Project on the Klamath River involves Madej, Wilzbach, and Duffy. Carbon sequestration studies have begun on forest management and large wood loading in streams. USGS has stationed a Forest Ecologist from Sequoia National Park to assess second-growth management plans.

Report from NOAA Fisheries Service - Pete Adams, Santa Cruz Lab

- NOAA has a new director. They have received increased funding—this money has been in the budget but only became available this year.
- Re-energizing ocean ecology department, beginning a habitat restoration position and modeling. Klamath involvement has increased dramatically due to secretarial decision about Iron Gate dam. They are modeling habitat of potential relocation of salmonids above Iron Gate if the dam were to be removed. They are also doing a larger economic study of the impacts of Iron Gate removal and several other Klamath-based projects: disease, temperature, and population-level impacts modeling. The loss of Anadromous Fish Act funds may impact Klamath modeling and monitoring work.
- The Coastal Monitoring Plan has been internally peer reviewed and should be done near the end of the month for external review. They are monitoring abundance, productivity, spatial structure, and diversity.

(Break for lunch at 11:30. Meeting reconvened at 1:15)

Walt Duffy and Peggy Wilzbach reviewed the nine projects that were completed since the last meeting, as well as the status of the seven current projects (see narratives in meeting notes).

UNIT RESEARCH SUMMARY

Seth Naman, a California Coop Unit graduate student, gave a presentation on “Predation impact of hatchery practices on juvenile steelhead,” a thesis project supported by the Yurok Tribe and the Coop Unit. Rosie Records, research technician, presented an update on the project “Assessing the effects of USDA conservation practices on wetland ecosystem services in California’s Central Valley.”

Walt Duffy and Peggy Wilzbach introduced the four new research projects to be approved. None are continuing projects from previous years.

1. Klamath REMS, Fisheries.
2. Quantifying the influence of climate change on Rocky Mountain ungulate populations, migration and feedground use, and herbivory impacts on vegetation.
3. Corixids - a keystone taxon for freshwater invertebrates of Copper River Delta ecosystems.
4. Lower Redwood Creek juvenile salmonid abundance 09-10.

James Howard moved to approve the projects as described, with Russ Bellmer seconding the motion. All approved.

UNIT PROGRAM DIRECTION

Neil Manji noted the importance of advance information to direct research into areas of CDFG’s real need. Cooperators discussed how to ensure that CDFG is getting the results they want for their funds. The importance of publishing results was emphasized.

CLOSING

The meeting was adjourned at 3:15 pm

CALIFORNIA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

Annual Report of Activities to the Coordinating Committee May 13, 2010

REVIEW OF PROJECTS COMPLETED IN 2009

POPULATION STRUCTURE OF STEELHEAD IN THE KLAMATH RIVER BASIN, AND CONSEQUENCES OF THE HALF-POUNDER LIFE HISTORY.

Investigators: Dr. Walter Duffy, CACFWRU
Dr. Peggy Wilzbach, CACFWRU
Brian Hodge, MS Student

Completed: December 2009

Funding: California Department
of Fish and Game/AFRAMP (\$52,972)

The Klamath River is the most productive steelhead fishery in the state of California, and one of only several rivers in the world in which steelhead exhibit the unique half-pounder life history. Half-pounders return to overwinter in freshwater less than a year after initial ocean entry, despite that fact that few fish have attained sexual maturity. Although existence of the half-pounder life history is well documented, the ecological conditions promoting this life history are poorly understood.



Objectives of this study were to: 1) describe patterns of age, growth, and reproductive history of wild *Oncorhynchus mykiss* from the Lower Klamath River Basin; 2) determine if expression of a half-pounder life history varied among sub-basins of natal origin; and 3) evaluate the growth and fecundity consequences of differing life history patterns.

From August 2007 through April 2009, otoliths, scales, and biological data were collected from fish that were captured with hook and line and at weir trapping facilities. Scales were analyzed to determine the age, growth, and life history of fish. Otolith strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) were analyzed to determine migratory history and the anadromous or nonanadromous origin of maternal parents. Half-pounders were examined to determine gender and incidence of maturity, and biological data were collected from adult, female steelhead to quantify the relationship between length and fecundity.

Analyses indicated that wild Klamath River steelhead exhibited a multitude of age categories at maturity. Klamath steelhead may spend up to four years in freshwater before initial ocean entry. Most steelhead from the middle and upper Klamath River Basin exhibit the half-pounder trait, while most Trinity River Basin fish remain in the ocean for a year or more before returning to freshwater. Anadromous and nonanadromous forms of *O. mykiss* occur sympatrically in the lower Klamath River Basin, and steelhead and rainbow trout may each give rise to the alternative life history form. Among sub-basins, incidence of resident rainbow trout ranged from 1 to 57%, and incidence of the half-pounder life history ranged from 11 to 100%. Approximately 8% of half-pounders, including both males and females, attained full maturity after spending less than one year at sea. Adult steelhead that exhibited the half-pounder phenotype were smaller and less fecund than fish that exhibited the normal ocean phenotype. Existence of the half-pounder trait suggests that survival during the first ocean winter is greater for half-pounders than for their cohorts at sea. Findings regarding the ability of rainbow trout to give rise to steelhead have important management implications in the Klamath River Basin, where the scheduled removal of four dams is expected to restore connectivity between the ocean and the upper basin. Because resident rainbow trout in the upper basin may be able to contribute towards recovery of steelhead following dam removal, anadromous and nonanadromous forms of *O. mykiss* should be managed under a joint conservation strategy.

Brian Hodge, the graduate student working on this project, has submitted a thesis draft and the final project report is in preparation.

QUANTIFYING THE INFLUENCE OF CLIMATE CHANGE ON ROCKY MOUNTAIN UNGULATE POPULATIONS, MIGRATION AND FEEDGROUND USE, AND HERBIVORY IMPACTS ON VEGETATION. (RWO 81)

Investigators: Dr. Erik S. Jules, HSU, Biology
Duration: September 2008 to December 2009
Funding: U. S. Geological Survey (\$21,391)

The purpose of the research was to reconstruct past climate in Yellowstone National Park (YNP) using tree-ring data. Tree-ring increment cores from over 250 aspen trees in YNP were collected previously. The trees date back to the early 1800s, and the widths of the rings produced each year are a good reflection of climate (e.g., moisture stress). The ring widths will be used to create the first climate reconstruction for YNP. The project is part of a larger, collaborative effort with investigators at several other institutions; the other investigators will use our reconstruction to understand the relationship of climate with ungulate populations and their migratory patterns.

Because the aspen increment cores have already been measured for the earlier project, the work conducted under this grant was limited to data analysis and preparation of a manuscript.

Final Report Abstract: Quaking aspen is a widespread tree that is in decline across wide areas of western North America, and is predicted to experience a large range shift if future climate predictions are realized. The purpose of our study was to determine what climate factors have influenced aspen growth in Yellowstone National Park, USA, and to determine whether these climatic influences vary across a heterogeneous landscape. We extracted increment cores from 10-12 aspen in each of 16 stands spread across a 1,526 km² area. Using ring widths, we created a 182-year standardized chronology from 1821 to 2003 A.D. composed of 151 series. We then assessed correlations of growth using instrumental records of temperature, precipitation, and the Palmer Drought Severity Index (PDSI) from 1932 to 2002, and records of maximum snow depth from 1949 to 2002. We found positive relationships between growth and springtime maximum snow depth, and negative relationships between growth and temperature and moisture stress (PDSI).

Aspen were impacted by these factors from the previous growing season, suggesting a lag effect of climate. Variation in sensitivity to temperature and PDSI among our stands could not be explained by landscape variables, but sensitivity to the prior March maximum snow depth was greater at high elevations and on shallower slopes. High snow depth probably produces a long lived water source at the beginning of the growing season. Our study demonstrated that aspen respond to variation in moisture related factors, and that changes in aspen growth due to future climate shifts will vary across small scales.

The final report is available at:

www.humboldt.edu/~cuca/documents/reports/CA-RWO81FinalReport-1.pdf

REDWOOD CREEK JUVENILE SALMONID ABUNDANCE PROJECTS.

Investigators: Dr. Walter Duffy, CACFRU
Michael Sparkman, CDFG
Completed: June 2009
Upper RC Funding: California Department of Fish and Game (\$38,654)
Lower RC Funding: California Department of Fish and Game (\$43,976)

Upper Redwood Creek Final Report Abstract: Juvenile anadromous salmonid trapping was conducted for the tenth consecutive year in upper Redwood Creek, Humboldt County, California during the spring/summer emigration period (March - August) in YR 2009. The purpose of the study is to describe juvenile salmonid out-migration and estimate smolt population abundances for wild 0+ Chinook salmon, 1+ coho salmon, 1+ steelhead trout, and 2+ steelhead trout using mark/recapture methods. The long term goal is to monitor the status and trends of out-migrating juvenile salmonid smolts in upper Redwood Creek in relation to watershed conditions and restoration activities in the basin. These data are also utilized for Viable Salmonid Population (VSP) Analysis.

A rotary screw trap and fyke net trap collectively operated 131 day/nights out of 133 possible, and captured 50,055 0+ Chinook salmon, 15 1+ Chinook salmon, 32,585 0+ steelhead trout, 8,082 1+ steelhead trout, 462 2+ steelhead trout, and 5 cutthroat trout to total 91,204 individuals. Juvenile coho salmon and pink salmon were not captured in YR 2009. Catches in YR 2009 were 10% less than catches in YR 2008, and 47% less than the previous nine year average catch. Average weekly trapping efficiency was 33% for 0+ Chinook salmon, 58% for 1+ Chinook salmon, 22% for 1+ steelhead trout, and 22% for 2+ steelhead trout. Trapping efficiency of 0+ Chinook salmon was inversely related to stream discharge and stream gage height. The total 0+ Chinook salmon population estimate with 95% confidence intervals in YR 2009 equaled 144,490 (136,215 - 152,764), and was 1.3 times greater than emigration in YR 2008 and 38% less than emigration for the previous nine year average. The large decrease in YR 2009 most likely reflected a large decrease in the number of adult spawners upstream of the trap site since no streambed mobilization from flood flows occurred after reproduction. The population abundance for 1+ Chinook salmon was determined for the first time in YR 2009, and equaled 22 individuals (95% CI 13 - 30). The population estimate for 1+ steelhead trout equaled 34,035 (95% CI 30,818 - 37,251), and was 1.04 times greater than emigration in YR 2008 and 10% less than emigration for the previous nine year average. 2+ steelhead trout population emigration equaled 1,913 (95% CI 1,507 - 2,320) and was 54% less than emigration in YR 2008 and 61% less than emigration for the previous nine year average. 0+ Chinook salmon, 1+ steelhead trout, and 2+ steelhead trout showed a significant, negative trend over the ten current study years.

With respect to successful watershed restoration, we expect: 1) stream temperatures to decrease in the summer, 2) a change in the age class structure of steelhead migrants to favor older, larger smolts, and 3) a general increase in smolt population abundances.

Lower Redwood Creek Final Report Abstract: Juvenile anadromous salmonid trapping was conducted for the sixth consecutive year in lower Redwood Creek, Humboldt County, California during the spring/summer emigration period (April - August). The purpose of the study was to describe juvenile salmonid out-migration and estimate smolt population abundances for wild 0+ Chinook salmon, 0+ coho salmon, 1+ coho salmon, 1+ steelhead trout, 2+ steelhead trout, and cutthroat trout using mark/recapture methods. The long term goal is

to monitor the status and trends of out-migrating juvenile salmonid smolts in Redwood Creek in relation to watershed conditions and restoration activities in the basin. These data are also utilized for Viable Salmonid Population (VSP) Analysis.

A rotary screw trap and fyke net trap collectively operated 136 out of 140 days/nights possible, and captured 52,651 0+ Chinook salmon, 60 1+ Chinook salmon, 2,489 0+ steelhead trout, 4,523 1+ steelhead trout, 241 2+ steelhead trout, 8 cutthroat trout, zero 0+ pink salmon, 33 0+ coho salmon, and 104 1+ coho salmon to total 60,109 juvenile salmonids. Catches in YR 2009 were 52% less than catches in YR 2008, and 4% less than the previous five year average catch. Average weekly trapping efficiency in YR 2009 was 20% for 0+ Chinook salmon, 12% for 1+ steelhead trout, 6% for 2+ steelhead trout, 31% for 0+ coho salmon, and 15% for 1+ coho salmon. Trap efficiencies for cutthroat trout could not be determined due to low sample sizes for marked releases. The total 0+ Chinook salmon population estimate with 95% confidence intervals in YR 2009 equaled 208,820 (194,119 - 223,521), and was 4% less than the previous five year average. Population estimates with 95% confidence intervals in YR 2009 equaled 38,923 (31,301 - 46,545) for 1+ steelhead trout; 1,796 (1,082 - 2,510) for 2+ steelhead trout; 69 (41 - 97) for 0+ coho salmon, and 478 (239 - 717) for 1+ coho salmon. The population abundance of 0+ Chinook salmon, 1+ steelhead trout, and 0+ coho salmon showed a (preliminary) non-significant trend over study years, and 2+ steelhead trout showed a significant negative trend over six study years. 1+ coho salmon showed a non-significant positive trend over study years. Monthly peaks in population emigration in YR 2009 occurred in June for 0+ Chinook salmon, May for 1+ steelhead trout, 2+ steelhead trout and 1+ coho salmon, and July for 0+ coho salmon. In general, the pattern in population abundances by week for a given species at age closely reflected trap catches by week.

REVIEW OF CURRENT RESEARCH PROJECTS

ASSESSING THE EFFECTS OF USDA CONSERVATION PRACTICES ON WETLAND ECOSYSTEM SERVICES IN CALIFORNIA'S CENTRAL VALLEY. (RWO 80)

Investigators: Dr. Walter Duffy, CACFRU
Dr. Sharon Kahara, HSU, Wildlife
Rosemary Records, HSU-SPF
Kimberly McFarland, MS Student
Luke Groff, MS Student
Stephen Zipper, MS Student

Duration: September 2006 to December 2010

Funding: USDA, Natural Resources Conservation Service (\$696,887)

California's Central Valley encompasses an area of 55,100 km², extending a distance of almost 700 km from Red Bluff in the north to around Bakersfield in the south. The Central Valley ecosystem historically consisted of grassland, prairie, and oak-grass savanna habitats. Interspersed within these primary habitats were riparian woodland, freshwater marsh, and vernal pool wetlands. These wetlands were integral in supporting the diverse flora and fauna of the historic Central Valley.

Most, if not all, these habitats in the Central Valley have been altered by human activity. Area of wetland habitats in the Central Valley prior to 1900 has been estimated to be 1.6-2.0 million ha. In the 1980's, wetland area in the Central Valley had been reduced to 153,000 ha. Human activities leading to wetland loss in the Central Valley are many and varied, but agricultural development and urbanization are chief among them.

The U. S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) administers a variety of programs intended to assist farmers and ranchers in addressing natural resource concerns on private lands. Among these programs is the Wetland Reserve Program (WRP), created as part of the 1990 Farm Bill. The WRP program focuses on restoring degraded wetlands or those that have been converted to agricultural production. In California, NRCS has focused their WRP activities on restoring a variety of wetlands, including seasonal wetlands, semi-permanent marshes, vernal pools, riparian and tidally-influenced wetlands.



This research project is assessing the response of wetland ecosystem services to conservation practices in the Central Valley. Ecosystem services we are assessing include biological diversity, storage of carbon, nitrogen and phosphorus and flood water storage capacity. Our assessment is focused on developing models describing how these wetland ecosystem services vary along climate and management gradients.

In 2009, we completed the second year of field sampling. Sampling was conducted on 45 randomly selected wetlands in the Central Valley and three wetlands in the upper Klamath Basin. Most of these were WRP wetlands, but a limited number were on National Wildlife Refuge lands. Field data collected included:

1. Biological diversity, occurrence and abundance of the following:
 - a. Amphibians
 - b. Shorebirds
 - c. Native bees
 - d. Plants
 - e. Fish (Upper Klamath Basin only)
2. Carbon, nitrogen and phosphorus storage
 - a. In soils
 - b. In plants
3. Flood storage capacity
 - a. Wetland volume

In 2010, we are repeating sampling of fish in WRP wetlands in the Upper Klamath Basin. This sampling is focused on documenting the use of WRP wetlands along the Sprague River by ESA listed shortnose suckers, as well as Klamath suckers and other species of fish.

CONSERVATION GENETICS OF THE FEDERALLY ENDANGERED TIDEWATER GOBY (*EUCYCLOBIUS NEWBERRYI*) IN NORTHERN CALIFORNIA. (RWO 79)

Investigators: Dr. Andrew Kinziger, HSU, Fisheries Biology
William T. McCraney, MS Student
Michael Hellmair, MS Student
Duration: September 2006 to December 2010
Funding: US Fish & Wildlife Service (\$126,299)

The tidewater goby (*Eucyclogobius newberryi*) is a federally endangered fish species that inhabits brackish/freshwater lagoons and estuaries in California. Tidewater goby habitats are geographic isolated from one another by long stretches of unsuitable habitat and/or physical barriers such as bars. An understanding of how the fragmented distribution of tidewater goby influences population structure is critical for proper management. The objective of this project is to use microsatellite data to evaluate migration rates, genetic structure and levels of genetic diversity among northern California populations of tidewater goby.



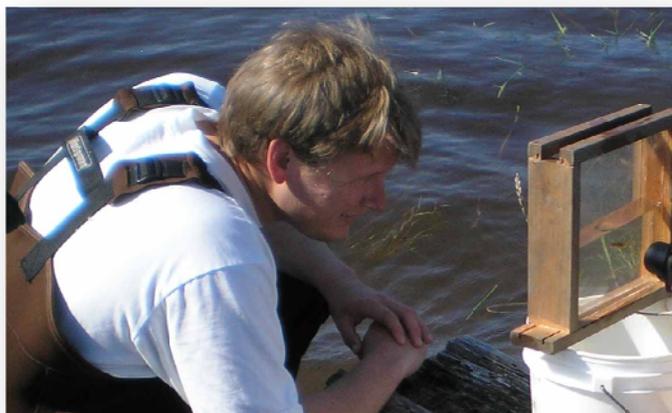
The genetic analysis of tidewater goby in northern California was been completed, and the graduate student working on the project, Tyler McCraney, has completed his thesis, and secured a position as a geneticist with NOAA in Juneau, Alaska. His M.S. thesis, entitled “Rampant drift in the endangered tidewater goby (*Eucyclogobius newberryi*): comparing genetic variation of naturally and artificially fragmented populations”, is available at: <http://dscholar.humboldt.edu:8080/dspace/handle/2148/486>.

The work has also been submitted for publication in *Molecular Ecology*, where it is in revision. An abstract of the manuscript follows:

Title: Rampant drift in artificially fragmented populations of the endangered tidewater goby (*Eucyclogobius newberryi*)

Abstract:

Habitat fragmentation and its genetic consequences are a critically important issue in evaluating the evolutionary penalties of human habitat modification. Here, we examine the genetic structure and diversity in naturally subdivided and artificially fragmented populations of the endangered tidewater goby (*Eucyclogobius newberryi*), a small fish restricted to discrete coastal



lagoons and estuaries in California, USA. We use five naturally fragmented coastal populations from a 300 km spatial scale as a standard to assess migration and drift relative to eight artificially fragmented bay populations from a 30 km spatial scale. Using nine microsatellite loci in 621 individuals, and a 522 base fragment of mitochondrial DNA control region from 103 individuals, we found striking differences in the relative influences of migration and drift on genetic variation at these two scales. Overall, the artificially fragmented populations exhibited a consistent pattern of higher genetic differentiation and significantly lower genetic diversity relative to the naturally fragmented populations. Thus even in a species characterized by habitat isolation and subdivision, further artificial fragmentation appears to have had significant population genetic consequences, and may not be sustainable.

This contract has been amended to include an analysis of the age and growth of tidewater goby in northern California. A graduate student, Michael Hellmair, has taken the lead on this project and he is currently finishing his third semester at HSU. Data collection for this project is ongoing. To date, a size stratified sample of 25 fish have been sacrificed on a monthly basis, starting in April of 2009, for determination and enumeration of daily otolith increments. Daily growth increment deposition was validated by calcein marking and recapturing several fish after a predetermined time period, then locating the fluorescent increment on the otolith and counting the increments thereafter, which corresponded to the number of days elapsed between marking and recapture. To date our analyses support daily increment deposition for the tidewater goby. Pelagic larval duration, as indicated by settlement checks identified in otoliths, is approximately 20 days, consistent with values reported in the scientific literature. Tidewater gobies, unlike many other small and short lived fishes, do not exhibit the typical linear growth, but instead show a rapidly declining rate of growth at a relatively young age, presumably in order to devote more energy to upcoming reproductive efforts. The vast majority of reproduction occurred in late spring, but spawning has continued throughout the summer and into fall, resulting in a variety of size- and age classes being present most of the year, reducing potentially devastating impacts of environmental fluctuations on the population as a whole. However, as a result of the peak in spawning activity in spring, it appears that goby populations experience an almost complete population turnover, indicated by a drastic decrease in abundance of adult individuals, followed soon thereafter by the appearance of the post-settlement juveniles. The maximum attained age is much less than one year for all gobies aged to date.

CORIXIDS - A KEYSTONE TAXON OF FRESHWATER INVERTEBRATES OF COPPER RIVER DELTA ECOSYSTEMS

Investigator: Dr. Kenneth Cummins, HSU, Fisheries Biology
David Malakauskas, Student Technician
Duration: April 2009 to September 2010
Funding: USDA Forest Service (\$10,000)

The family Corixidae is represented by a single species, *Callicorixa vulnerata*. This species occurs all over the Copper River Delta in high densities, occupying the hundreds of ponds and numerous streams that represent the freshwater ecosystems of the Delta, but its life history as well as position and importance in freshwater food webs are unknown. Aquatic ecosystems of the Copper River Delta and Chugash National Forest in which the corixid (commonly known as water boatman) occurs also include vertebrate species of special concern, such as coho salmon, dusky geese, and dusky-winged black birds.

The timing of the spawning of the salmonids, which produce a large biomass of eggs that are a major food resource for corixids, and the rearing of the juvenile salmonids, for which the corixids are a (potentially critical) food resource, would be subject to alteration under changing climate. Similarly, the role of corixids in the diet of young waterfowl could be affected by climate change.

Preliminary studies suggest that the life history pattern of the corixids involves mating and initial rearing in the ponds in the spring and early summer, followed by major growth and lipid storage in the streams where they feed on abundant and energy-rich eggs in the late summer. This life history raises questions about if, how, and when a major shift between ponds and streams occurs and how this meshes with their role in the above food webs. At present, it is not known in what stage(s) the corixids over-winter.

The goals of this study are to investigate:

1. Specific seasonal habitats used by corixids and their relative densities in these habitats.
2. Life history patterns of the corixids - seasonal size (age) distribution, time of mating and dispersal.
3. Food habits of corixids.
4. Importance of corixids as for waterfowl and fishes including juvenile salmonids, sticklebacks, and Eulacon.

Data for this study are collected in coordination with, or as an extension of, on-going research on the Delta. Seasonal collections of invertebrate samples in ponds are separated by plant type, and sampling will be expanded this summer to include wetland marshes that have no open water. Stream samples include diurnal drift collections. Results to date have demonstrated that in the fall (September-October) there is a dramatic increase in the numbers of corixids drifting at night. The most dramatic differences have been observed when the light and dark periods are sub equal (September). Food habits of the corixids are being evaluated in laboratory aquaria in experiments which offer a variety of food sources. The importance of corixids in the diets of juvenile and resident salmonids, and other fishes, and waterfowl is being evaluated through gut content (fish) and stable isotope analyses (waterfowl).



webs
Delta.

ESTIMATING SALMON AND STEELHEAD ESCAPEMENT TO REDWOOD CREEK USING A DUAL FREQUENCY IDENTIFICATION SONAR (DIDSON) IMAGING SYSTEM.

Investigators: Dr. Walter Duffy, CACFRU
Matthew Metheny, MS Student
Duration: June 2009 to March 2011
Funding: California Department of Fish and Game/FRGP (\$164,288)

The Redwood Creek watershed in Humboldt County is considered an important watershed for anadromous salmonids in northern California. It supports self-sustaining populations of coho salmon, Chinook salmon, steelhead and coastal cutthroat trout in addition to other native fishes. There are no hatcheries in the watershed, although hatchery stocks of salmon and steelhead do stray into the stream each winter. Salmon and steelhead in the Redwood Creek watershed are recognized as important for recovering populations of anadromous salmonids throughout northern California.

Our goal in this study is to evaluate the use of a dual frequency identification sonar (DIDSON) imaging system to estimate escapement of adult salmon and steelhead in California Rivers. Redwood Creek was selected for this study because 1) it supports relatively healthy populations of salmon and steelhead, 2) is intermediate in size, 3) is somewhat flashy, and 4) carries high concentrations of suspended sediment. Taken together, these attributes present a good test for operating the DIDSON to estimate escapement.

The study has two objectives; 1) to estimate the number of adult coho salmon, Chinook salmon, steelhead and coastal cutthroat trout migrating into Redwood Creek to spawn using a DIDSON and 2) develop and conduct a workshop to train California Department of Fish and Game staff in using the DIDSON.

We installed the DIDSON in Redwood Creek and began recording data on 17 November 2009 during the first storm event of the winter. Although imagery has only been partially analyzed, we have documented more than 1,300 fish passing the sensor. Number fish passing during 25 days in November and January ranged from 0 to 135 (Figure 1 below). Pulses of migrating fish were recorded during early storm events in November, while numbers passing in December and January were more often in the range of 20-40 fish. No fish were recorded on only one of 25 days included in these preliminary data.

Size of fish recorded passing the DIDSON ranged from 14 to 114 cm in length (Figure 2 below). These data on size of fish will, we think, be useful in assigning species to images. Furthermore, the detection of fish as small as 14 cm long provides some hope that the DIDSON may have application in estimating smolt migration.

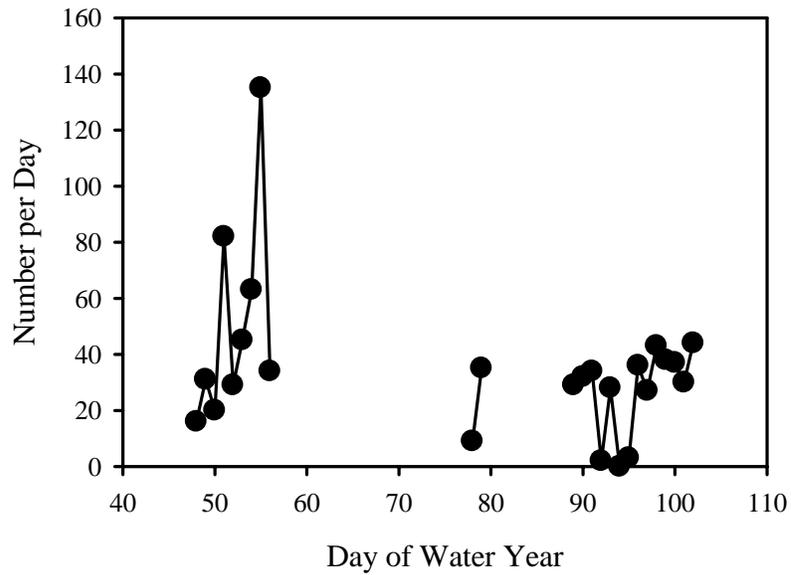


Figure 1. Number of fish migrating past the DIDSON camera in Redwood Creek during November 17, 2009 - January 9, 2010.

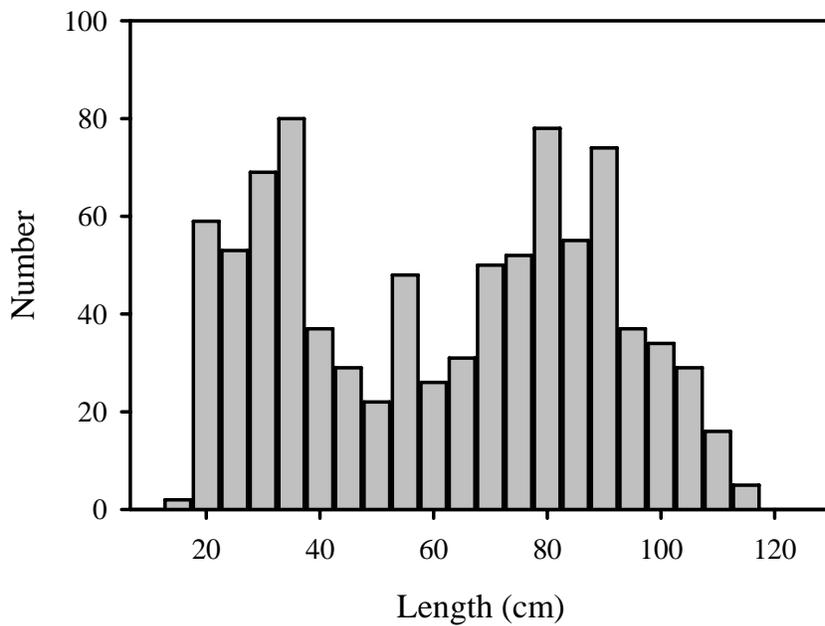


Figure 2. Size frequency distribution of fish detected by a DIDSON camera in Redwood Creek during November 17, 2009 - January 9, 2010.

Klamath REMS, Fisheries (RWO 82).

Investigators: Dr. Walter Duffy, CACFWRU
Dr. Peggy Wilzbach, CACFWRU
Olan C. Smith, MS Student
Duration: September 2008 to March 2011
Funding: U. S. Geological Survey (\$39,515)

Declining populations of Pacific salmon (*Oncorhynchus* spp.) in the Klamath River have led to concerns about water quality in the river. Water temperature in the river during summer months often approaches or exceeds physiological tolerance limits of most Pacific salmon species. Reliance of these fish on cold water has been studied extensively. While temperatures at which the physiological performance of Pacific salmon is optimal is typically 14.0 - 17.0 °C, salmon are also frequently found occupying habitats where water temperatures reach 23.0 - 24.0 °C on a daily basis. Much of the variation in tolerance to warmer water temperature in Pacific salmon is attributed to acclimation temperature.

In the Klamath River, water temperature regularly exceeds 25.0 °C during July and August. Pockets of cool water that form at tributary mouths are believed to be critical to the survival of Pacific salmon during these periods. Re-analysis of data gathered by the Yurok Tribe during 1998 confirms use of cool water patches at temperatures > 22.0 °C, but also reveals a strong temporal component in use. Furthermore, spatial distribution of refuges having high abundance (> 1000 juvenile Chinook salmon) are clumped at a few stream mouths. The periodicity in heavy use of cool water patches by Chinook salmon and their spatial clumping at limited sites suggest that habitat selection is governed by more than water temperature alone.



Objectives of this study, which is a part of a larger USGS research effort (River Ecosystem Models and Science [REMS]), are to compare feeding behavior, food availability, and temporal patterns of habitat use by juvenile Chinook salmon and steelhead among a representative

cool water patch, adjacent mainstem warm water, and tributary mouth in the lower Klamath River.

Fish will be periodically sampled in and around the confluence of Independence Creek and PIT-tagged in the summer of 2010. Re-sighting of PIT tagged fish will be accomplished using directional arrays of underwater antennae at the tributary mouth and that circumscribe the boundaries of coldwater patch. Re-sighting of PIT tagged fish will provide information on 1) diurnal timing of entry into and exit from the cool-water patches, 2) duration of residence in a patch (requires at least two detections of an individual), 3) whether individuals return to the same cool water area on multiple occasions or move to another patch. Invertebrate drift will be sampled as an estimate of prey availability and compared among the three habitat types. Diets of fish will be sampled by gastric lavage from a subset of captured fish to estimate and compare feeding success among the three habitat types. Feeding frequency of fish in the habitat types at differing times of day will be documented by underwater observation. These data will help describe the use of coldwater patches, and in combination with physical data and the development of bioenergetics models could provide a means to quantify potential energetic benefits of using cool water patches.

During the past year, a bioenergetics model for juvenile Klamath River Chinook salmon was developed. This model, along with previously developed models for juvenile coho salmon and steelhead, will be used to refine hypotheses about juvenile salmonid use of and dependence on cool water habitat patches in the Klamath River.

PRAIRIE CREEK SUB-BASIN LIFE CYCLE STUDIES.

Investigators: Dr. Walter Duffy, CACFRU
Brian Poxon, MS Student
William Youmans, MS Student
Duration: June 2008 to March 2011
Funding: California Department of Fish and Game/FRGP (\$259,287)

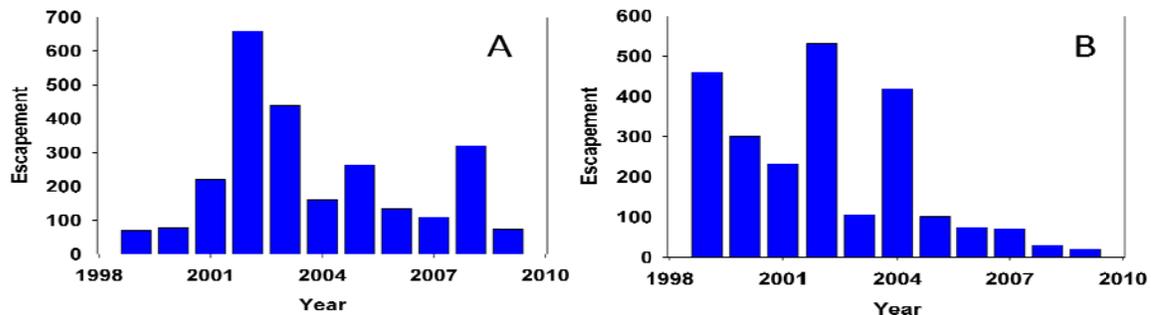
The Prairie Creek sub-basin of Redwood Creek supports self-sustaining populations of coho salmon, Chinook salmon, steelhead and coastal cutthroat trout in addition to occasional chum salmon. It has been recognized as an excellent “field laboratory” for the study of anadromous salmonids in California by the Coastal Watershed Planning and Assessment Program. Studies of fisheries in the Prairie Creek sub-basin began in the late 1940’s and extend to the present. Nearly continuous estimates of adult salmon returning to Prairie Creek have been made since 1990, while estimates of juvenile abundance and smolt production have been made each year since 1998.

The objective of this project is to gather abundance data for all salmonid species at specific life stages. These data will be used to estimate survival between life stages and evaluate long-term trends. Sampling is being conducted on a 12 km reach of Prairie Creek and a 12 KM reach of Lost Man Creek.



In the winter of 2008/2009, we estimated the escapement of adult coho salmon, Chinook salmon, steelhead and coastal cutthroat trout returning to the Prairie Creek sub-basin. Adults were captured at resistance board weirs located on Lost Man Creek and Prairie Creek. Our objective was to operate both weirs from November to April. However, due to the suspension of California bond monies, funding for the project was suspended on December 24, 2008.

In spite of this loss of funding, we continued to operate the weir on Prairie Creek to April 2009. All adult salmonids captured at the weir were PIT tagged, tagged with a secondary tag, identified by species, gender, size, and condition, and released upstream. Bi-weekly surveyor were conducted upstream of the weir. Surveyors recorded all live fish observed and those live fish previously PIT tagged. Stationary PIT tag antennas were used to record fish leaving the sample area. Adult salmonid escapement was estimated using Mark recapture of tagged fish, and area under the curve methodologies (see figure below).



Escapement of coho salmon (A) and Chinook salmon (B) to Prairie Creek, Humboldt County, California estimated using AUC of live fish observations.

Loss of bond funding prevented us from estimating salmonid smolt production from the Prairie Creek sub-basin in 2009. However, we will resume this sampling in 2010 with the objective of estimating the production of Chinook salmon pre-smolts, and coho salmon, steelhead, and coastal cutthroat trout smolts from Prairie Creek during March through June. These estimates will be derived from data gathered with continuously operated downstream migrant traps located in Prairie Creek and Lost Man Creek. Quantitative population estimates will be estimated from mark-recapture methods that provide estimates of smolt trap efficiency.

We completed sampling necessary to estimate the abundance of juvenile coho, steelhead, and cutthroat trout in Prairie Creek and Lost Man Creek in August-September, 2009. This sampling was a two stage abundance estimate, consisting electrofishing calibrated dive surveys. These data have not yet been collated, but will be reported during the coming year.

A comprehensive report of Prairie Creek sub-basin findings will be prepared in 2010. This report will analyze trends in salmonid population abundance, survival of salmonids between juvenile and smolt life stages, ocean survival of adults and efficiency of methods used to monitor salmonids in streams.

REDWOOD CREEK JUVENILE SALMONID (SMOLT) ABUNDANCE PROJECTS 2009-2011

Investigators: Dr. Walter Duffy, CACFRU
Michael Sparkman, CDFG
Lower RC Funding: California Department of Fish and Game/FRGP (\$108,972)
Duration: June 2009 to March 2011
Upper RC Funding: California Department of Fish and Game/FRGP (\$37,818)
Duration: June 2009 to March 2010

The Fisheries Restoration Grant Program will continue this project funding through 2011, with 2009 being the 6th year of the study. The long-term goal of the project is to determine the status and trends of juvenile salmonid smolt population migrating downstream past the lower Redwood Creek trapping site.

Data were collected to determine the population size, status, and trends of coho salmon, Chinook salmon, cutthroat trout, and steelhead in Redwood Creek. Peer reviewed mark/recapture techniques are used to determine population estimates. The study is designed to be long term and also encourages research and monitoring of adult populations that, when combined with the current smolt study, would allow estimates of marine and freshwater survival to be made.

A smolt trap (modified rotary screw trap) was deployed in late March, and operated 24 hours a day, 7 days a week until early to mid August. The trap was checked at 0900 every day, as well as during the evening when during periods when debris (leaves, sticks, etc.) was accumulating at concentrations that may have caused elevated mortality in captured fish. All fish captured were identified to species at age, counted and any trap efficiency trial marks were recorded. Population estimates (weekly and seasonal) were determined using multiple trap efficiency trials using peer reviewed methods. Fork lengths were recorded daily and weights were recorded every other day. Randomly selected fish were PIT tagged and released downstream of the trap site to investigate travel time and growth during downstream migration, and to investigate residence time in the estuary via Redwood National Park's sampling in the estuary. Stream temperature was recorded every half-hour using optic stowaway temperature probes.

Deliverables will include a detailed assessment and monitoring report, annual report comparing data (population estimates, size of fish, etc.) among study years, complete with tables, graphs, text, a manuscript for submission to a journal, and presentations for various agencies (NOAA, CDFG, RNP, etc).

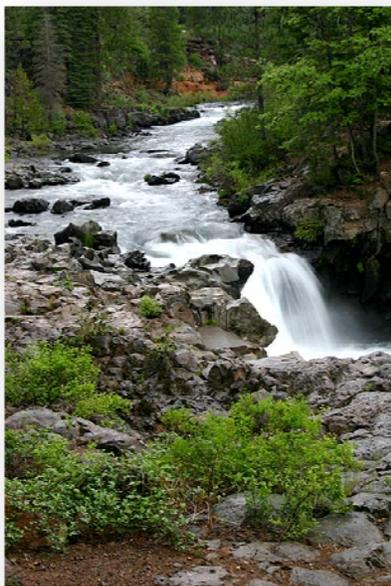
ROLE OF BARRIERS IN THE CONSERVATION OF MCCLOUD REDBAND TROUT.

Investigators: Dr. Peggy Wilzbach, CACFRU
Roman Pittman, MS Student
Duration: September 2007 to September 2010
Funding: USDI Fish & Wildlife Service (\$80,000)

In 1994, the U.S. Fish and Wildlife Service determined that potential threats to the McCloud River redband trout (*Oncorhynchus mykiss* spp.) and its habitat were sufficient to warrant classification as a Candidate species under the federal Endangered Species Act of 1973, as amended. This status reflected concern over threats imposed by land use activities and introductions of exotic salmonids, as well as threats to its genetic integrity from genetic introgression with stocking of hatchery strains of rainbow trout. In 1998, a multiple-signatory conservation agreement was established to ensure that steps are taken to reduce or remove threats that could cause it to be listed as threatened or



endangered. Due to commitments made to protect and conserve McCloud River redband trout (MRT) through this agreement, candidate status was discontinued in 2000. Among potential strategies to achieve conservation goals is isolation management, employing the use of natural or artificial barriers to protect upstream populations from direct contact with hatchery or exotic salmonids. This approach has been adopted for other threatened species or populations, and may be particularly appropriate in river ecosystems where movement corridors are well-defined and animal passage easier to control. The success of this approach hinges on providing sufficient resources in the isolated reach to meet all life history



requirements, as well as on maintenance of a sufficiently large population to promote long-term persistence. The goal of this research is to explore the feasibility of adopting an isolation management strategy for redband trout by identifying potential stream barriers and evaluating population parameters of the trout in two tributaries of the upper McCloud River to evaluate the capacity of these streams to sustain deliberately isolated stocks. Specific objectives are: 1) to identify existing and potential barriers in Tate and Trout creeks and to establish the range of flows within which these barriers are operational; 2) describe and compare population structure of the redband trout in isolated and connected reaches of the sites, and 3) estimate the minimum stream length for population viability of the trout based on density and survivorship estimates.

The graduate student working on this project has completed data collection and analysis and has prepared a draft thesis. Permit restrictions limited analysis of population parameters of the redband trout populations in the 2 streams. Data suggest that the trout experience limited growth opportunity in high elevation, low productivity reaches. Trout Creek was identified as a poor candidate for deliberate isolation because it is currently isolated from the mainstem McCloud by a percolation barrier and further barriers would fragment already limited habitat and possibly restrict seasonal movement. Tate Creek produced greater trout density and may represent a viable isolation candidate. Available habitat in this stream exceeded the estimated minimum stream length required to sustain an effective population size of 500 individuals. Differences in abundance of McCloud redband trout between the two streams were probably due to availability of warmer, high productivity habitat in the lower reaches of the larger Tate Creek watershed. Existing culverts on both streams do not significantly fragment habitat. Further study is recommended to verify the apparent short growth period and survival rate of the trout as well as the effectiveness of natural barriers.

SAMPLE, IDENTIFY, AND ENUMERATE MACROINVERTEBRATES OF CASPAR CREEK WATERSHED.

Investigators: Dr. Kenneth Cummins, HSU, Fisheries Biology
David Malakauskas, student technician

Duration: September 2007 to September 2010

Funding: USDA Forest Service (\$40,000)

Objectives of this study are to compare the present day macroinvertebrate fauna of the Caspar Creek watershed with an earlier inventory, and to provide baseline data for future assessments of the watershed under new harvest operations. Benthic macroinvertebrates were surveyed in the spring and fall of 2008. Semi-quantitative (30 second timed) samples were taken in three habitats (cobble riffles, fine sediment pools, and litter accumulations) using a D-frame 250 μ m mesh dip net. Three samples were taken from each habitat type at each site. Two sites on the North Fork, two on the South Fork, and two on the mainstem of Caspar Creek were sampled. Functional feeding group (FFG) analysis was performed on each live sample in the field, and the material was then preserved in 70% ETOH for return to the lab for microscope sorting and further identification of the invertebrates.

A taxonomic list of the invertebrates of Caspar Creek has been compiled which includes 107 taxa. This includes 92 to the generic level, 6 to the family level, 2 to the subfamily level (Chironomidae), and 7 to the level of order or higher. The Ephemeroptera, Plecoptera, Trichoptera, used to calculate the EPT Index as measure of stream health are very well represented in the invertebrate taxa of Caspar Creek: Ephemeroptera with 18 genera in 6 families, Plecoptera with 13 genera in 7 families, and Trichoptera with 18 genera in 12 families. Functional Feeding Group analyses (invertebrates separated according to their modes of food acquisition) indicate that all sites sampled on Caspar Creek in both seasons are heterotrophic, which is normal for forested streams. Shredder populations (macroinvertebrates that feed selectively on riparian plant litter appropriately colonized by stream fungi) are well represented at all sites, especially in the fall where the riparian is dominated by red alder. Scraper populations (macroinvertebrates that feed on attached algae, especially diatoms) are less well represented than shredders or collectors (macroinvertebrates that feed on fine particulate organic matter derived ultimately from the biological and mechanical conversion of riparian plant litter). This results in ratios of the groups (scrapers to shredders plus collectors) that indicate if the linkage between riparian vegetation cover and the invertebrate community is in the expected range (based on published values for relatively undisturbed forested streams in the region and elsewhere).

The final analyses under way include ANOVA comparisons of sites and seasons for the 2008 sampling and a comparison of the 2008 data to those collected by Knight over a decade earlier to determine if changes in taxonomic composition occurred. This latter task is difficult because changes in taxonomy of the invertebrates masks changes in the stream ecosystem.

NEW RESEARCH PROJECTS REVIEW

DISEASE REDUCTION IN KLAMATH RIVER: PRODUCTION OF MYXOSPORES OF *CERATOMYXA SHASTA* IN POST-SPAWNING CHINOOK SALMON CARCASSES

Investigator: Dr. Gary Hendrickson, HSU Fisheries Biology

Duration: August 2009 to September 2010

Funding: Subgrant from Oregon State University

Ceratomyxa shasta is a myxozoan parasite of salmonids that produces the disease ceratomyxosis. Several recent studies monitoring prevalence of selected fish pathogens in smolts sampled during outmigration implicated *C. shasta* as the direct cause of extensive losses in Chinook salmon. While the exact level of mortalities is unknown, estimates have suggested that as many as 40% of outmigrating smolts die as a result of *C. shasta* infections.

One management action being considered to control *C. shasta* in the Klamath Basin is the removal of spawned out carcasses. However, this will be a costly and time consuming action. At this point, we do not have a very clear understanding as to what carcass removal might actually accomplish. We need to know (1) what percentage of carcasses are infected, (2) if all infected carcasses produce myxospores, (3) when myxospores are released from decaying carcasses, and (4) how many myxospores are produced by a single decaying carcass. The overall goal of this project is to answer these questions. With this information we can determine whether or not carcass removal might be an effective management option and how it might best be applied in the Klamath Basin. This information would also be valuable for building a mathematical model that would allow us to determine how many spores/carcasses would have to be removed to make a significant change to the *C. shasta* problem in the basin.

MYXOZOAN FISH DISEASE RESEARCH AND MONITORING

Investigator: Dr. Peggy Wilzbach, CACFWRU
Nicholas Bankston, MS student
Duration: October 2009 to October 2011
Funding: National Fish and Wildlife Foundation (\$101,803)

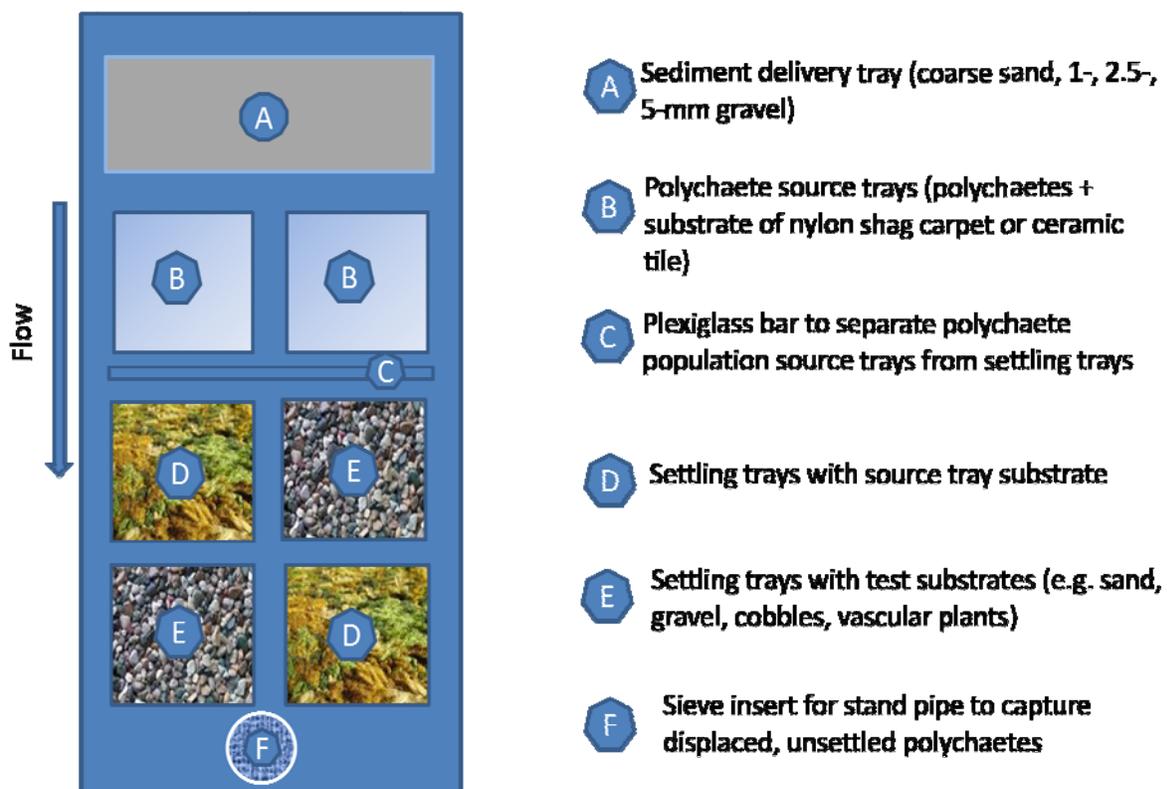
The freshwater polychaete *Manayunkia speciosa* is the intermediate host for two myxozoan parasites (*Ceratomyxa shasta* and *Parvicapsula minibicornis*) that infect and cause mortality in out-migrating juvenile salmon in the Klamath River. Polychaete densities have been found to be highly variable among seasons and years, and are likely strongly affected by hydrologic events and sediment transport. *M. speciosa* is small, reaching a maximum body length of only 4 mm, and it lacks morphological structures for directing its movement within the water column or for anchoring itself to the substrate. Because of its small size and morphological features, the polychaete is likely susceptible to displacement at high flows and mortality from bedload movement or sediment abrasion.

Recognition of the probable importance of flow and sediment dynamics in affecting distribution and abundance of polychaete populations has generated keen interest among scientists and managers in the potential for using flow and sediment manipulations as a strategy for reducing polychaete populations to enhance salmon survival. Reduction in densities of infected polychaetes would result in reduced production of the parasitic actinospores that are infectious to fish, and thus disrupt disease dynamics. One strategy that has been proposed for impacting polychaete populations has been gravel augmentation. Gravel would be introduced upstream of dense patches of polychaetes where increased flows would move the bedload over the patches. Flow and sediment manipulations, however, are likely to be effective only if polychaetes are killed by the manipulations rather than simply re-distributed as viable animals elsewhere within the system. Effects of varying velocities and particle sizes of transported sediments on viability and displacement of the polychaete are unknown.

The goal of the proposed research is to provide information on the likely effectiveness of flow and sediment manipulations in reducing populations of *M. speciosa* by evaluating the effects of varying current velocities and sediment particle sizes on its displacement and mortality in laboratory flumes. Two small recirculating flumes, each 200 cm L x 20 cm wide, will be constructed and housed indoors at Humboldt State University, and supplied with de-chlorinated city water maintained at approximately 21° C.

One set of trials will be conducted under conditions of varying current velocities but without sediment delivery, at four levels of current (10, 25, 50, and 100 cm/s). A second set of trials will be conducted with varying sediment particle sizes (coarse sand [1mm], 1cm gravel, 2.5cm gravel, and 5cm gravel) added in a tray to the upstream end of a flume at levels of velocities sufficient to move the sediments. Two additional variables will also be manipulated in experimental trials: the substrate in trays holding the introduced polychaetes (polychaete source trays, as simulated *Cladophora* or simulated boulder surfaces), and the substrate in trays in which dislodged polychaetes may settle (settling trays, with 7 levels of substrate types). Use of different substrate sizes/categories in settling trays will allow evaluation of polychaete use of and survival in secondary (non-preferred) habitat types. Each combination of treatment levels (velocity, size of transported sediments, substrate in polychaete source trays, and substrate in settling trays) will be replicated a minimum of 3 times.

In each trial, 100 polychaetes will be introduced to the flume in still water onto two settling trays. A subsample of animals from each batch used in the experiments will be held for 24 h to assess mortality resulting from handling. Following the acclimation period, current velocity will be gradually increased to the desired level. Trials will be conducted in the dark or subdued lighting, and will run for a 2-h period. The number of live and dead polychaetes remaining in the initial population source trays, in settling trays, and in the standpipe capture screen or outside the trays will be counted at the end of the experimental period. Live polychaetes collected from the settling trays and the standpipe capture screen will be placed in petri dishes with flume water and held in a cooler for 12 h and reassessed for any additional mortality. Each polychaete will be used in only 1 trial. Polychaetes used in trials will be collected live from the Klamath River, and will be maintained in lab culture until use. Inspection will ensure that only live polychaetes will be used in the experiment.



Flume set-up to evaluate effects of velocity and sediment delivery manipulations on displacement and mortality of Klamath River polychaetes.

INTEGRATED LANDSCAPE MODELING OF WETLAND ECOSYSTEM SERVICES

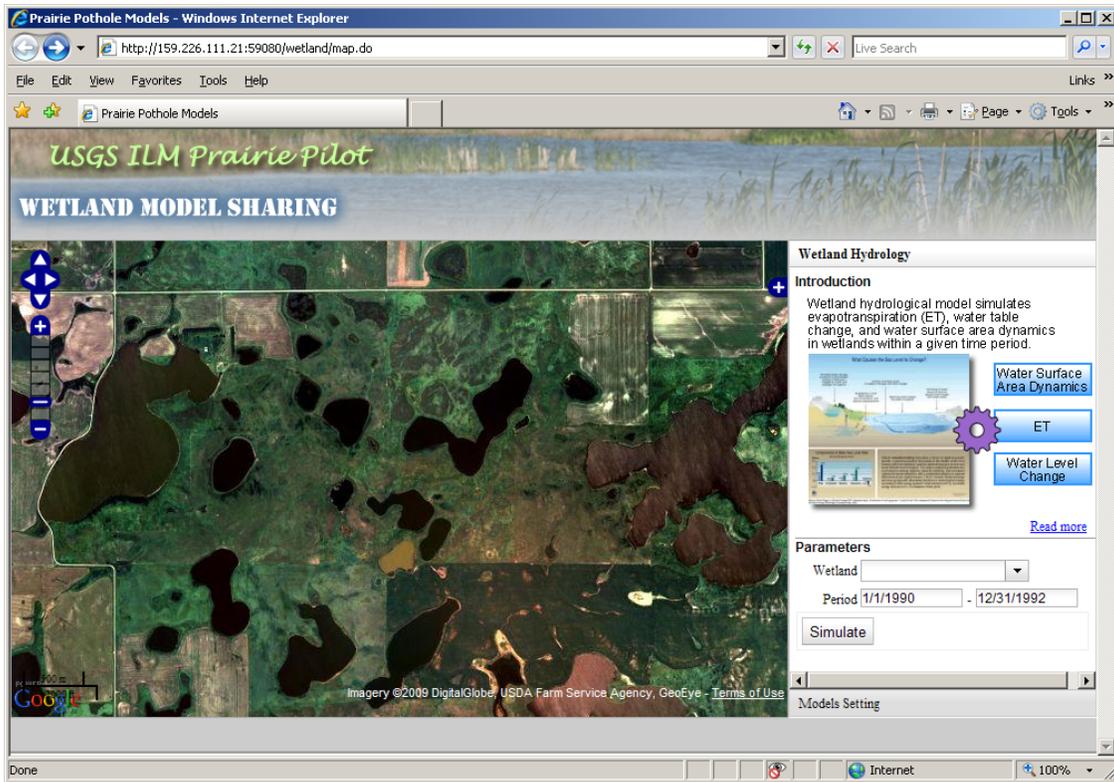
Investigator: Dr. Walter Duffy, CACFWRU
Dr. Sharon Kahara, HSU Wildlife Dept.
Ms. Rosie Records, CACFWRU
MS student, TBD

Duration: October 2010 to October 2011

Funding: USDA, Natural Conservation Service (\$75,000)

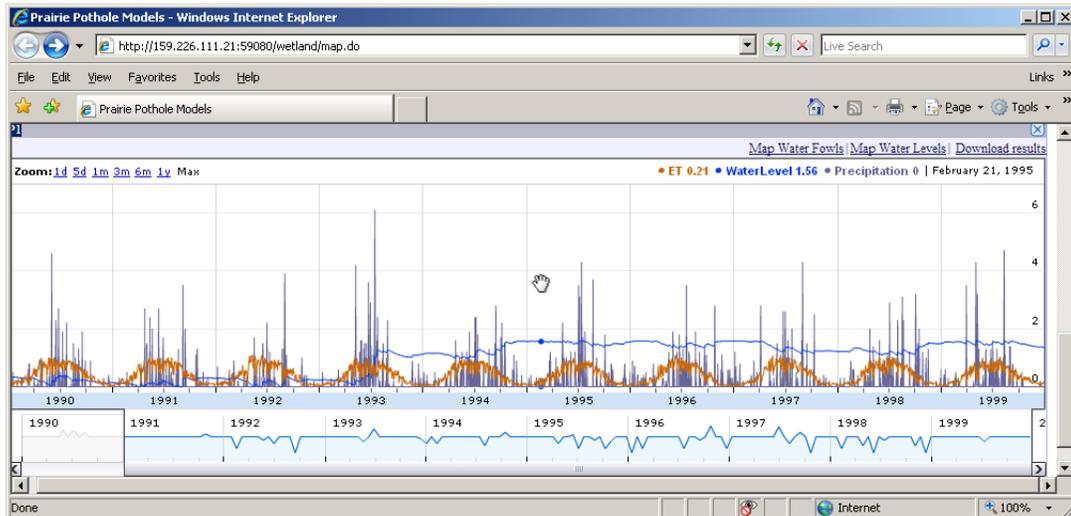
This research will be part of the U.S. Geological Survey's Science Initiative, Integrated Landscape Monitoring (ILM) Initiative. This is an initiative to develop monitoring and modeling tools to evaluate the influence of U.S. Departments of Agriculture (USDA) and Interior conservation programs on diverse ecosystem services. A prototype distributed geospatial model based on international 2008 Open GIS Consortium (OGC) standards was developed to facilitate model simulations capable of evaluating altered land-use scenarios in the prairie pothole region (PPR) (e.g., proposed land-use programs or alternate land-use or climate futures). The model is being constructed through collaboration with USDA's Natural Resources Conservation Service (NRCS) and Farm Service Agency. This is a web-based model that will be shared by numerous users who can access the model through the Internet; fairly simple scenarios can be evaluated through use of web browsers while more complex or sophisticated analyses can be performed using main-frame computers. The modeling system has a number of advantages over models that run on stand-alone computers or closed networks, including the ability to access large databases or complex computational algorithms remotely and run model simulations from anywhere in the world using portable or stationary devices. The interface for the model was developed collaboratively with the Chinese Academy of Sciences and the model currently resides in Beijing, China. However, users can access the model through the Internet (<http://159.226.111.21:59080/wetland/map.do>).

A pilot project for this modeling in the Prairie Pothole Region uses a geospatial model sharing platform, google earth as the background (see figure below), allowing users to access the model to run simulations or download information for subsequent analyses. To run model simulations, users simply click on the wetland or catchment and required weather data are obtained from the National Center for Atmospheric Research (Boulder, Colorado) through the Internet according to the coordinates of the selected wetland. Google Earth is used as the background to facilitate the selection of wetlands for analysis and visualization of simulated results. A hydrological model calculates the dynamics of evapotranspiration, pool water depths, and water surface extent according to precipitation, air temperature, soil physical conditions, and wetland catchment characteristics (see figure below). Users can then download data to files for subsequent analyses or they can display animations of water extent over any period of interest on the google earth interface.



Web-based Wetland Model Sharing Platform Interface EcoServ

(<http://159.226.111.21:59080/wetland/map.do>)



EcoServ simulated daily evapotranspiration and water table depth in wetland P1 at the Cottonwood Lake Study Area, North Dakota.

Our objectives in this research are:

1. To prepare the necessary geospatial data layers need for applying EcoServ in the Central Valley. Examples include:
 - a. Land use
 - b. Land cover type
 - c. Soil type
 - d. Precipitation
 - e. Air temperature
2. To develop algorithms relating ecosystem services to geospatial data layers. Ecosystem services addressed will include:
 - a. Amphibian habitat
 - b. Waterfowl habitat
 - c. Water storage
 - d. Pollinator habitat
3. To apply the EcoServ model to the Central Valley.
4. To refine and improve, if necessary, the EcoServ model based on new information collected in the Central Valley of California.

UNIT PROGRAM REVIEW

UNIVERSITY SERVICE AND TEACHING

Courses Taught

Fish Bioenergetics (3 units)	Duffy	Spring 2009
Restoration Ecology of Riverine Fish (3 units)	Duffy	Spring 2010
Ecology of Running Waters (3 units)	Wilzbach	Fall 2009, Fall 2008

Graduate Student Major Advisor

Duffy	Philip Colombano - MS Fisheries, Humboldt State University Stephen Gough - MS Fisheries, Humboldt State University Brian Hodge (jointly with Wilzbach) - MS Fisheries, Humboldt State University Brian Poxon - MS Fisheries, Humboldt State University Michele Wheeler - MS Fisheries, Humboldt State University Katrina Wright - MS Fisheries, Humboldt State University Matthew Metheney - MS Fisheries, Humboldt State University William Youmans - MS Fisheries, Humboldt State University Stephen Zipper - MS Fisheries, Humboldt State University
Wilzbach	Mark Ashenfelter - MS Fisheries, Humboldt State University Brian Hodge (advised jointly with Duffy) - MS Fisheries, Humboldt State University Barbara McCoy - MS Fisheries, Humboldt State University Olan Smith - MS Fisheries, Humboldt State University Roman Pittman - MS Fisheries, Humboldt State University

Graduate Committee Service (unit scientists serve as members, not major advisors)

Duffy	Luke Groff - MS Biology, Humboldt State University
Wilzbach	Dawn Alvarez - MS Fisheries, Humboldt State University Colin Anderson - MS Fisheries, Humboldt State University Scott Benson - MS Fisheries, Humboldt State University Brooke DeVault - MS Fisheries, Humboldt State University Jon Goin - MS Fisheries, Humboldt State University Josh Fuller - MS Fisheries, Humboldt State University Michelle Gledhill - MS Mathematics, Humboldt State University Erin Hannelly - MS Biology, Humboldt State University Katherine McLaughlin - MS Fisheries, Humboldt State University Marlene Meaders - MS Fisheries, Humboldt State University Susan Corum - MS Fisheries, Humboldt State University Katrina Wright - MS Fisheries, Humboldt State University Steven Zipper - MS Fisheries, Humboldt State University

TECHNICAL ASSISTANCE

Duffy	<p>For the Department of Fish and Game, he continues to serve as Chair of the Fishery Restoration Grants Program, Peer Review Committee, as a member of the California Advisory Committee on Salmon and Steelhead and as a member of the coho salmon recovery team.</p> <p>Also for the Department of Fish and Game, he participated in an advisory group that reviewed suction dredge mining regulations for California waters.</p> <p>For the Karuk Tribe, he provides periodic and ongoing assistance on technical subjects related to the Klamath River.</p> <p>For the U. S. Geological Survey, he served as an principal organizer of the Klamath Basin Science Conference.</p>
Wilzbach	<p>For the Plum Creek Timber Company, OR, she continued to provide guidance in developing an aquatic monitoring program.</p> <p>For the U. S. Forest Service, she provided assistance in predicting impacts of Iron Gate Dam removal on habitat for polychaetes (intermediate hosts for</p>

salmon pathogens), and participated as a member of the Klamath River fish health planning committee to recommend disease management strategies .

For the Idaho Fish and Game department, she provided guidance on transplantedation of a cutthroat trout project.

PROGRAM DIRECTION

Kay Brisby, the CA Unit administrative support coordinator, resigned for medical and family reasons at the end of March. She will retire in August or September when her leave has been exhausted. During this period, Interim CNRS Dean Smith graciously provided support for a half-time replacement. After discussing this position with several HSU employees, we selected Ms. Rosie Records as the half-time administrative support coordinator. Rosie's performance in her brief stint has been superior, but the demands of this position are complicated and, in part at least, we are all feeling our way.

Expansion of the unit to include a wildlife scientist continues to be a topic of interest. During the past year, a group of cooperators from the states of NJ, NV, CA and HI collaborated to advance a request for unit expansion to congress. This effort was also supported by the National Cooperators Coalition. Because of these actions, we are guardedly optimistic about possible unit expansion.

Funding for the national CRU program. Increased support is being shared with individual units, resulting in our operating funds from CRU being increased from \$1,000 in FY09 to \$20,000 in FY10.

SCIENTIFIC PUBLICATIONS

Duffy, W. G. and S. N. Kahara. Wetland ecosystem services in California's Central Valley and implications for Wetland Reserve Program conservation practices. *Ecological Applications, In Press.*

Euliss, N. H., Jr., L. M. Smith, S. Liu, W. G. Duffy, S. P. Faulkner, R. A. Gleason and S. D. Eckles. Integrating estimates of ecosystem services from conservation programs and practices into models for decision makers: the vision for CEAP Wetlands. *Ecological Applications, In Press.*

Harvey, B.C. and M.A. Wilzbach. Carcass Addition Does Not Enhance Juvenile Salmonid Biomass, Growth, or Retention in Six Northwestern California Streams. *North American Journal of Fisheries Management, Submitted.*

Duffy, W. G., E. P. Bjorkstedt, and C. S. Ellings. Predation on juvenile salmon (*Oncorhynchus* spp.) in downstream migrant traps in Prairie Creek, California. *North American Journal of Fisheries Management, Submitted.*

Naman, S.W. and M.A. Wilzbach. Predation by hatchery steelhead on naturally produced salmonid fry in the upper Trinity River, California. *In preparation (internal review)*.

Stanford, J., L. Eberle, M. Belchik, B. Cluer, M. Deas, P. Detrich, W. Duffy, L. Dunsmoor, E. Esarian, S. Foott, C. Gavette, M. Hampton, D. Hillemeier, J. Kann, K. Malone, J. Mount, P. Moyle, and G. Reeves. Conceptual Foundation for Restoration of the Klamath River. *In preparation*

Willson, S.J., M.A. Wilzbach, D.M. Malakauskas, and K.W. Cummins. 2010. Lab Rearing of a Freshwater Polychaete (*Manayunkia speciosa*, Sabellidae) Host for Salmon Pathogens. Northwest Science 84: 182-190.

Wilzbach, M.A., M.J. Ashenfelder, and S. Ricker. Movement of resident rainbow trout transplanted below a barrier to anadromy. *In preparation (internal review)*.

PAPERS PRESENTED

Duffy, W., M. Metheney, B. Youmans, W. Willey, S. Zipper, P. Wilzbach² and S. Vanderkooi. Bioenergetics of Juvenile Chinook and Coho Salmon At Klamath River Tributary Mouths. Klamath Basin Science Conference, Medford, OR. February 1-5, 2010.

Hodge, B. P., M. A. Wilzbach, W. G. Duffy and J. Hobbs. Partial Migration in Wild *Oncorhynchus mykiss* from the Lower Klamath River Basin. Twelfth Annual Pacific Coast Steelhead Management Meeting. Redmond, OR. March 9-11, 2010.

THESES OF UNIT-SPONSORED GRADUATE STUDENTS

McLaughlin, K. D. 2009. Development of a standard weight equation for juvenile steelhead trout and effects of temperature, turbidity, and steelhead trout biomass on relative weight. M.S. Thesis, Humboldt State Univ., Arcata, CA. 63 pp.

McCoy, B. L. 2008. Effect of rearing location on escapement of coho salmon (*Oncorhynchus kisutch*) at Freshwater Creek, California. M.S. Thesis, Humboldt State Univ., Arcata, CA. 41 pp.

Naman, S. W. 2008. Predation by hatchery steelhead on natural salmon fry in the upper-Trinity River, California. M.S. Thesis, Humboldt State Univ., Arcata, CA. 66 pp.

Wheeler, M. 2009. Seasonal patterns of anabolism and catabolism in juvenile steelhead: Energy partitioning in growth. M.S. Thesis, Humboldt State Univ., Arcata, CA. 50 pp.

FACILITIES AND EQUIPMENT

The unit acquired a new vehicle (Chevy HHR) through the federal government program to promote fuel efficient vehicles. The excess vehicle being used by the Fisheries Biology and Wildlife Departments was sold by GSA in September 2009. The departments have used other unit vehicles as available. The unit is on schedule to replace another vehicle in 2010.

FINANCIAL STATUS

Review current financial information and budget projections.

U. S. Geological Survey	Expended FY 2009 Oct 08 to Sep 09	Income FY 2010 Oct 09 to Sep 10	Projected FY 2011 Oct 10 to Sep 11
Base Salary	261,059	265,844	273,819
Operating Expense	6,000	15,000	15,000
Vehicle Fund	5,000	5,000	5,000
Other Funds	2,000	2,168	
Total	274,059	288,012	293,819
Humboldt State University	Expended FY 08- 09 Jul 08 to Jun 09	Income FY 09-10 Jul 09 to Jun 10	Projected 10-11 Jul 10 to Jun 11
Administrative Support Coordinator	65,202	59,746	64,568
Office Space	9,974	10,273	10,581
Support Services	3,928	4,046	4,167
Storage Space	4,637	4,776	4,919
Total	83,741	78,841	84,236
California Department of Fish & Game	Expended FY 08- 09 Jul 08 to Jun 09	Income FY 09-10 Jul 09 to Jun 10	Projected 10-11 Jul 10 to Jun 11
Operating Expense	10,606	8,000	11,000
Administrative Staff Support	2,166	4,000	4,000
Faculty Support	0	2,500	6,000
Projects - Student Support	12,984	34,500	15,000
Total	25,756	49,000	36,000
Research Work Orders & Projects	Expended Jul 08 to Jun 09	Funding (New/Incremental) Jul 09 to Jun 10	Projected Jul 10 to Jun 11
OSU Disease Reduction in Klamath	0	70,142	0
NFWF Myxozoan Fish Disease	0	51,936	49,866
USFS Copper River Corixids	0	10,000	0
CDFG Redwood Creek DIDSON	0	164,288	0
USGS Klamath REMS Fisheries	1,071	5,000	50,861
USGS Rocky Mountain Ungulates	19,235	0	0
CDFG Prairie Crk Basin Life Cycle	65,417	129,033	64,836
FS Caspar Creek Watershed	15,380	0	0
FWS McCloud Redband Trout	29,665	0	0
CDFG Half Pounder Study	29,327	0	0
RWO 80 CCV Assessment	265,505	198,114	56,860
RWO 79 Tidewater Goby	23,711	0	0
CDFG Upper Redwood Crk Abundance	38,242	37,818	0
CDFG Lower Redwood Crk Abundance	43,548	54,486	54,486
Total Projects	531,101	720,817	276,909
Total Operating & Project Funds	914,657	1,136,670	690,964

Notes

