California Cooperative Fish & Wildlife Research Unit

2011 Coordinating Meeting

May 10, 2011
Humboldt Bay Aquatic Center
921 Waterfront Drive, Eureka, CA

Klamath River

Photo credit: Friends of the River

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AGENDA

Introductions and Welcome (Chair, Joe Margraf) 9:00

Additions to the Agenda

Approval of 2010 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 (Christopher Olie Smith) 1:15

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

Adjourn.....3:15

California Cooperative Fish & Wildlife Research Unit

2010 Coordinating Committee Meeting Minutes

Thursday, May 13, 2010

The annual coordinating meeting was held at the Humboldt Bay Aquatic Center, 921 Waterfront Drive, Eureka, California. The meeting began at 9:10 am and concluded at 2:43 pm.

In attendance:

Phil Bairrington, CA Dept. of Fish & Game

Russ Bellmer (rotating annual chair) CA Dept. of Fish & Game Unit Representative

Eric Bjorkstedt, NOAA Fisheries, HSU

Randy Brown, U.S. Fish & Wildlife Service, Arcata

Ken Cummins, CA Cooperative Research Unit

Walt Duffy, Unit Leader, CA Cooperative Research Unit

Nancy Finley, U.S. Fish & Wildlife Service, Arcata

Gary Hendrickson, Chair, Dept. of Fisheries Biology, HSU

Brian Hodge, CA Cooperative Research Unit (presenter)

Joe Margraf, Supervisor, USGS Western Region/AK Cooperative Research Unit

Matthew Metheny, CA Cooperative Research Unit (presenter)

Rosie Records, CA Cooperative Research Unit

Steve Smith, Acting Dean, CNRS, HSU

Tom Williams (Natl. Marine Fisheries Service, Southwest Fisheries Science Center, via conference phone from Santa Cruz)

Peggy Wilzbach, Asst. Leader, CA Cooperative Research Unit

Russ Bellmer opened the meeting. The agenda was reviewed and no changes were requested. Minutes of the 2009 meeting were reviewed and approved (Randy Brown motioned and Phil Bairrington seconded).

COOPERATOR REPORTS

Report from Humboldt State University - Steve Smith, CNRS Acting Dean

- There has been approximately a $7M reduction to base budget, somewhat mitigated with furloughs.
- University went through program ranking and elimination process; Fisheries was considered simply as part of the process but was never under real threat of elimination.
- The Fisheries Department has been successful in hiring Darren Ward as a faculty member in freshwater fisheries ecology. He is currently working on a postdoc at Dartmouth and will start at HSU in Fall semester.

Report from U.S. Fish & Wildlife Service - Nancy Finley, Arcata Field Office

- Nancy is the new USFWS field supervisor at the Arcata Field Office. She brings experience from Great Smokey Mountains National Park and Cape Cod.
- Their office is shortly to report to the Assistant Regional Director (ARD) for Fisheries and Habitat Conservation, to streamline the process. Underneath that ARD they will put a Central Valley and a Klamath Supervisor to coordinate larger issues. Arcata, Klamath Falls, and Eureka would be supervised directly by Klamath Basin supervisor (they are looking to fill this position in 5-6 months).
- The Strategic Habitat Conservation Program is now up and running.
- The office is heavily involved in Klamath and Trinity Basin activities. Monitoring, restoration, and re-introduction plans are emphasized. Their work includes a drought plan.
- Just initiated a concept for competitive proposal submittals for Trinity Restoration Program to encourage new science and to fill priority data gaps.
- Total Trinity budget is $15M; science component is $2.13M.
- Positions opening: Seeking a biometrician; fisheries, riparian and wildlife positions; technical writing assistance. They are also advertising for Fisheries and Habitat Conservation assistant director in Sacramento.

Report from Humboldt State University - Gary Hendrickson, Dept. of Fisheries Biology Chair

- Marine Center is still moving along.
- The Fisheries elimination discussion was based on certain economic indicators picked by academic senate, and did not include revenue sources.

- Darren Ward will teach Freshwater Fisheries Ecology and Fisheries Management, and will fill some of the needs left by Terry Roelof's retirement. His position is jointly funded with NMFS through the Southwest Fisheries Science Center and Southwest Region.
- Since 2000 the cost to attend HSU for one year has nearly doubled and students currently have a Fall unit cap of 13 units.
- Ken Cummins suggested cooperator assistance in funding teaching activities of temporary staff.

Report from Natl. Marine Fisheries Service, Southwest Fisheries Science Center -Tommy Williams (on the phone from Santa Cruz)

- NOAA Fisheries in Arcata and Santa Cruz are contributors to Darren Ward's position.
- Their four economists are working on economic analysis to assist the Secretarial determination on Klamath dam removals. A crew is also working on fish biological modeling to inform economic analysis.
- They are doing temperature modeling on the Klamath with a Santa Cruz grad student looking at cool water thermal refugia areas, and also have a grant from NASA looking at temperature modeling. They are doing bioenergetics modeling for Central Valley and Klamath.
- Total or Constant Fractional Marking in California: The Fisheries Science center was asked by state, USFWS, and regional offices to look at alternative marking strategies. They have a work group including a steering committee, and are looking at a target draft due date in July and a final due date of October.
- Coop Unit data has been used in ESUs and DPSs: 5-year status review of all listed salmonids in California (much of the data comes from Redwood and Prairie Creek areas).

Report from NOAA Fisheries - Eric Bjorkstedt

- Is sitting on a number of committees, including some for Walt Duffy's students.
- He and David Hankin are co-principal investigators with UC Santa Cruz and UC Davis Ocean Protection Council to investigate marine fisheries. They will be investigating marine plankton and coded wire tags, and focusing mostly on Central Valley and some Klamath River.

Report from U.S. Geological Survey - Joe Margraf

- Bernard Shanks retired last fall. Joe Margraf now deals with 14 Units in 13 states. He has spent 30 years as a Coop Unit Leader and an Assistant Leader. He started his postdoc in this program and has a long field career to contribute to the position. He

has been Unit Leader for the Alaska Coop Unit for the past 11 years, but is retiring from that position in a few months. He started the West Virginia and Maryland Cooperative Units.

- There is a major reorganization in USGS brought in by the new administration but it is unlikely to affect day-to-day Unit operations. USGS will switch from its current "discipline" structure (i.e. water, natural disasters) and reorganize into focus areas such as "ecosystems" and "minerals/oil development" with the goal of increasing interdisciplinary collaboration.

- This year for the first time in over a decade, the Unit Program has a budget increase. They have an over 20% vacancy rate, and have been filling only the most critical positions, which has helped retain their budgetary solvency. For the first time in over a decade they are filling all viable vacancies in the program. Next year there will be a slight budget decrease. By 2011 or 2012 they could see the new Units (New Jersey and Nevada) and there is possibility of a wildlife assistant at the CA Unit.

- There are two current focus areas in the Unit program. One is in Structured Decision Making/Adaptive Resource Management area (Ken Williams is a key player in this area), and training may be available to cooperators (interested cooperators should speak to Walt Duffy). The second is a trans-boundary research approach. The Unit program has sponsored regional confabs of Units to deal with trans-boundary (i.e. cross-state) issues.

Report CA Dept. of Fish & Game - Russ Bellmer- Coop Unit Representative

- Ken Moore is retiring. John McCannon was appointed as CDFG director this year. They have begun process to get Proposition 84 funding. North Coast Marine Protection Areas took effect May 1st. Released 3 million salmon smolts at the mouth of the American River recently to examine reducing straying rates and increasing survival. Coastwide Monitoring Plan will be published in CDFG bulletin.

- Suction dredging EIR/EIS is moving through the Environmental Review process. They have just begun the SEIR Scoping meeting schedule. The first meeting is May 18th in Hemet (call Scott Barrow, DFG Fisheries Branch, 916-445-7600 for more information). A ban is in effect under Senate Bill 670 until:

  1. CDFG completes court-ordered environmental review of its permitting program;

  2. CDFG updates existing regulations governing program as necessary; and

  3. Updated regulations have taken effect.

- Fisheries Restoration Grant Program proposals due June 1st. Approximately $15M will be available to fund restoration grant projects; proposals must incorporate a climate change component. Visit http://www.dfg.ca.gov/fish/Administration/Grants/FRGP/FundSummary.asp to view recently funded projects.

- Feather, Nimbus, Warm Springs, and Mad River hatchery draft management plan EIR/EIS available at http://www.dfg.ca.gov/news/pubnotice/hatchery/

- Central Valley Steelhead Monitoring Plan is finally preparing to put out a draft. Similar to Coastwide Monitoring Strategy, and encompasses evaluation of life cycle stages and a spatial-statistical framework of sampling. A public workshop on the Plan will take place on June 2nd at the Yolo Bypass.

- CDFG is legally required to update the fisheries component of Species of Special Concern. They are doing an internal DFG review of the 64 Species Accounts in the document.

- Scientific Collecting Permits: CDFG is requiring decontamination of gear as a condition of all Scientific Collecting Permits to reduce/control the spread of invasive species. If it is not possible to devote gear to a single watershed, they recommend that decontamination occur at the sample site before gear is moved.

- Employment opportunities:

    - CDFG is hoping to hire under Proposition 84 funds.

    - They are also looking to hire some scientific aid student positions (three vacancies, summer, with flexibility). Graduate students with background in statistical, research oversight (budgets, etc.) and GIS experience preferable.

    - Seeking Delta Bay Sport Fishing Enhancement Stamp Advisory Committee applications (call Karen Mitchell, Fisheries Branch, 916-445-0826).

- CDFG anticipates supporting the CA Coop Unit at the same level as the previous year.

<u>Report from CA Dept. of Fish & Game - Phil Bairrington, Arcata Field Office</u>

- CDFG has hired a biologist through Sport Fish Restoration Act to focus on Smith River. The grants program has funded one of those projects with the DIDSON unit. According to the chairman of the Salmon Stronghold (department lead Kevin Shaffer), the Salmon Conservation Act should be approved by the end of the fiscal year. NOAA Fisheries will administer the funds for six states; funding will be focused on monitoring, will not be equally divided between states.

- Larry Preston, writer of the Hatchery Management Plan, has retired. Mad River Hatchery Genetics Management Plan is proceeding very well. The longest timeline for the Plan goes into March 2011. Mark Wheetley may be assigned more of Larry's duties and oversee the Hatchery Management Plan monitoring, and further down the road the Coho Recovery Plan and Coastal Monitoring Plan.

- Coho Recovery Plan is also proceeding well in cooperation with NMFS. Sacramento pikeminnow monitoring in Humboldt Bay has not found another Sacramento pikeminnow since the initial discovery. Ongoing invasive species problems with the quagga muscle and New Zealand mudsnail—decontamination is very important to avoid spreading these species.

- State of the Salmon lecture PowerPoints are available from Phil on request.

- Freshwater Creek watershed studies status: Freshwater Creek and Humboldt Bay tributary studies are oriented to redd surveys and adult escapement. PIT tagged fish are moving down from estuary and then from slough to adjacent slough before going back into mainstem. CDFG is finally able to get a marine survival component with PIT tagging effort.

Review of Unit Research

Walt Duffy and Peggy Wilzbach reviewed the three projects that were completed since the last meeting, as well as the status of the nine current projects (see narratives in meeting notes). They introduced the three new research projects and requested the approval of cooperators to proceed with them:

1) Disease reduction in Klamath River: production of myxospores of *Ceratomyxa shasta* in post-spawning chinook salmon carcasses.

2) Myxozoan fish disease research monitoring.

3) Integrated Landscape Modeling of wetland ecosystem services.

Joe Margraf nominated to approve the projects as described, and Steve Smith seconded the motion. All approved.

UNIT RESEARCH SUMMARY

Brian Hodge, a CACFWRU graduate student, presented on "Partial migration in wild *Oncorhynchus mykiss* from the Lower Klamath River Basin," a portion of his graduate thesis research.

Matt Metheny, a CACFWRU graduate student, presented on "Using sonar to count fish on Redwood Creek, Humboldt County, California."

2011 ANNUAL COORDINATING MEETING

Next year's meeting was tentatively set for the week of May 9-13, 2011; Tuesday, Wednesday or Thursday are preferable for Joe Margraf and Russ Bellmer.

CLOSING

Randy Brown motioned to adjourn, Walter Duffy seconded. The meeting was adjourned at 2:43 pm.

REVIEW OF PROJECTS COMPLETED IN 2010

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 were 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 µm 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.

Final Report Summary:

A taxonomic list of the invertebrates of Caspar Creek was compiled which included 107 taxa. This included 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. Ephemeroptera, Plecoptera, Trichoptera, used to calculate the EPT Index as measure of stream health were 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) indicated that all sites sampled on Caspar Creek in both seasons were heterotrophic, which is normal for forested streams. Shredder populations (macroinvertebrates that feed selectively on riparian plant litter appropriately colonized by stream fungi) were 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) were 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).

Caspar Creek was characterized as being in a stable period with regard to the macro-invertebrate fauna, and by extension using the functional group surrogate ratios, also in a stable period considering selective ecosystem attributes. Stable substrates were marginally available and the FPOM food supply for collector-filterers was poor. This has consequences for drift-feeding salmonids because many of the filtering collectors are behavioral drifters that would be reliably available to dawn and dusk drift-feeding fish. In general, Caspar Creek invertebrate taxa do not represent a dominance of behavioral drifters. Future harvest plans,

if they include alteration of the riparian zone, could have significant impact on the macroinvertebrate communities and, by extension, the resident salmonids of Caspar Creek.

Report:
http://www.humboldt.edu/cuca/documents/reports/CasparCrInvertInventoryms.pdf

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

Investigator: Dr. Kenneth Cummins, HSU, Fisheries Biology
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.

The goals of this study were 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; and 4) the importance of corixids as for waterfowl and fishes including juvenile salmonids, sticklebacks, and Eulacon.

Data for this study were collected in coordination and synthesized with on-going research on the Delta to elucidate food webs of fish and birds of special concern, and the final deliverable for this project was a powerpoint presentation given by Cummins at the Copper River Symposium in March 2011. Text and slides for the presentation, entitled: "Copper River Delta: an Integrated Expansion of Freshwater Ecological Evaluations" can be found at:

http://www.humboldt.edu/cuca/documents/reports/CopperRiverSymposium%20text.pdf

http://www.humboldt.edu/cuca/documents/reports/CumminsCRDSymposium.pdf

Findings specific to the Corixidae are described below.

Studies indicated that the Corixidae are represented in Copper River Delta aquatic habitats by a single species, *Callicorixa vulnerata*. This appears to be unique when compared to other regions of Alaska and northwest North America where, in general, three to five species would be the rule. In summer, *C. vulnerata* appears to be the most abundant and continuously distributed invertebrate in Delta ponds. Nymphs of *C. vulnerata* were found to rear in ponds and migrate *en mass* as adults to streams in late August to early September. In the autumn, *C. vulnerata* is by far the most visibly abundant invertebrate in the streams. Large waves of adults literally blanket whole areas of stream bottom where they move slowly along. This migration of adults from ponds to streams coincides with the major Coho spawning and activity and egg production. Observations suggest that the fitness of this timing for *C. vulnerata* is the availability of massive quantities of energy rich eggs for the adults during their time of reproduction. Minnow traps baited with roe for capturing juvenile salmonids in the fall also collected massive numbers of *C. vulnerata.* The energy rich egg diet should

enhance and accelerate sexual maturation of the adults and the development of eggs in the females during the fall and winter and early spring. It is not known if the adults overwinter in the frozen and snow-bridged streams, as has been observed in corixids elsewhere, with the females migrating back to ponds for egg laying in the spring. Mating flights of adults diving into the water have been observed in streams at this time. However, it is possible that adult *C. vulnerata* could migrate back to the ponds in late fall and over winter there under the ice. It is likely that *C. vulnerata* represents important dietary intake by juvenile Coho (although it may be incidental to egg consumption by the fish) in the fall and fledgling birds in the spring and summer in and around ponds.

Corixids are often the most abundant invertebrate in freshwater food webs of uplifted marsh (left) and outwash plains (right) of the Copper River Delta.

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 geographically 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 was to use microsatellite data to evaluate migration rates, genetic structure and levels of genetic diversity among northern California populations of tidewater goby. An abstract of the final report is included below:

Tidewater goby

Final Report Summary:

The objective of this project was to estimate levels of genetic differentiation, genetic diversity, and migration among geographically isolated North Coast tidewater goby (*Eucyclogobius newberryi*) populations. The data set consisted of 621 tidewater goby sampled from 13 populations including eight Humboldt Bay populations and five coastal lagoon populations. All individuals were genotyped at nine microsatellite loci and a subset of 103 individuals was sequenced at the mitochondrial control region.

Based on the genetic data, natural and artificial habitat fragmentation has caused marked divergence among North Coast tidewater goby. Thus all populations warrant conservation because they may contain unique genetic material not replicated elsewhere within the species. Additionally, the genetic structure in Humboldt Bay versus coastal lagoon populations is very different and we recommend different management approaches at the two scales.

The Humboldt Bay populations exhibited very high levels of among population genetic differentiation, extremely low levels of within population genetic diversity, and no among population migration making them vulnerable to extirpation. We recommend habitat restoration activities that would increase the potential for between population migration among Humboldt Bay populations. Migration would likely erase existing among population genetic differentiation which would potentially restore Humboldt Bay tidewater goby to the presumptive historical population structure for this system. Restoration of among population migration would also allow for re-colonization and (or) colonization of suitable habitats.

Lastly, migration should also increase within population genetic diversity which could potentially increase fitness of the Humboldt Bay populations.

Coastal lagoon populations also exhibited very high levels of among population genetic differentiation, but in contrast, contained substantial levels of within population genetic diversity with infrequent migration among lagoons. All coastal lagoon populations appear to be stable and genetically healthy with the exception of Lake Earl, which exhibited reduced levels of genetic diversity in comparison to similar coastal lagoon populations. The reduced genetic diversity observed within Lake Earl is consistent with repeated population bottlenecking. In Lake Earl population bottlenecks are most likely caused by artificial breaching. We recommend institution of breaching methods in Lake Earl that do not cause mass mortality of tidewater goby.

http://www.humboldt.edu/cuca/documents/reports/RWO79Tidewater%20Goby%20Population%20Genetics%20Final%20Report.pdf

This contract was amended beyond its original objectives to include an analysis of the age and growth of tidewater goby in northern California. A graduate student, Michael Hellmair, took the lead on this project and he is currently finishing his fourth semester at HSU. A draft of his thesis is in review by his committee. The abstract of his thesis is included below.

Life History Variation and Diet of the Endangered Tidewater Goby, *Eucyclogobius newberryi*

The fitness consequences of low genetic diversity in wild animal populations are of great concern to species conservation. The endangered tidewater goby, *Eucyclogobius newberryi*, occurs in reproductively isolated populations along the California coast that exhibit tremendous variation in genetic diversity. Otolith microstructural analysis was conducted to evaluate the relationship between genetic diversity and life history variation in two focal populations exhibiting high and low genetic diversity (H_O = 0.58 and 0.08). Daily increment deposition in sagittal otolith of tidewater goby was validated and a predominantly annual life cycle was observed in both populations (annual survivorship, $\widehat{M}$, < 3%). Back-calculation of birthdates indicate year-round reproductive activity in the population with high genetic diversity, but reveal a very narrow, single annual reproductive period in the genetically depauperate population. Analysis including genetic and demographic data from ten additional populations reveals a correlation between genetic diversity and life history variation, as expressed in variation in the duration of the reproductive period within populations of tidewater goby. The threat of reduced genetic diversity to isolated populations was dramatically illustrated through extinction of the genetically depauperate focal population following a drastic increase in salinity. Naturally, the presence of more resilient adult individuals allows tidewater goby populations to persist through these periodic environmental fluctuations with high juvenile mortality, yet a narrow population age structure, associated with reduced genetic diversity, resulted in localized extinction. These findings support the assertion that genetic and life history variation can serve as a safeguard against environmental stochasticity.

This study also documents predation by the tidewater goby upon the invasive New Zealand mudsnail, *Potamopyrgus antipodarum,* in Big Lagoon, California, USA. The gastric contents of 411 individuals, collected monthly from April 2009 to August 2010, were examined. NZ mudsnails were found in the digestive tract of tidewater goby that ranged in size from 14 mm

to 52 mm total length, corresponding to post-settlement and nearly maximal sizes of this species. Tidewater goby fully digest this hard-shelled prey, as evidenced by the presence of shell fragments and complete absence of intact shells in the hind gut. The number of ingested NZ mudsnail ranged from 1 to 27 (mean 4.4), and ranged in length from 0.39 mm to 4.0 mm. The average size of ingested snails increased with fish length ($r^2 = 0.42$, $p < 0.001$). NZ mudsnails were found in over 80% of individuals during the summer and fall of 2009, when the estimated population size of tidewater goby in Big Lagoon was over three million. This study documents the first instance of a native and endangered species that preys upon and utilizes the NZ mudsnail as a food source, and suggests that tidewater goby can exert substantial predation pressure upon NZ mudsnails and take advantage of these readily available novel prey items.

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, CACFWRU
	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 2010, we completed a second year of sampling for 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. We also completed a final report for the project and circulated the report for peer review. We received reviewer comments in spring 2011 and are addressing those comments before publishing the final report.

INTEGRATED LANDSCAPE MODELING OF WETLAND ECOSYSTEM SERVICES

Investigator:	Dr. Walter Duffy, CACFWRU
	Dr. Sharon Kahara, HSU Wildlife Dept.
	Ms. Rosemary Records, CACFWRU
	MS student, TBD
Duration:	October 2010 to October 2011
Funding:	USDA, Natural Resources 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.

Our objectives in this research are: 1) to prepare the necessary geospatial data layers (land use, land cover, soil type, precipitation, air temperature) needed for applying geospatial models in the Upper Klamath Basin and the Central Valley, 2) to develop algorithms relating ecosystem services (amphibian habitat, waterfowl habitat, pollinator habitat, water storage) to geospatial data layers, and 3) evaluate the water quality benefit of USDA conservation programs in the Upper Klamath Basin and Central Valley.

We have made progress on developing a SWAT model (Soil and Water Assessment Tool) for the Upper Klamath Basin (Figure 1). Rosemary Records has become the lead SWAT modeler for our group and attended a SWAT workshop in Texas to advance her skills. In the coming years, we will use this model: 1) to evaluate the effect of restored wetlands on water quality in Upper Klamath Lake Tributaries, 2) to evaluate the water quality response to increasing wetland restoration and best management practices, 3) to optimize spatial distribution of restored wetlands and other BMPs, and 4) to forecast how changing climate may affect the water quality benefit of restoration.

During the past year, we also developed conceptual models for amphibian habitat, waterfowl habitat, pollinator habitat, water storage and have made progress on constructing algorithms describing the response of these ecosystem services to USDA Wetland Reserve Program easements. Progress in these developments was reported at the 2010 ACES (A Community of Ecosystem Services) meeting in Phoenix, AZ in December.

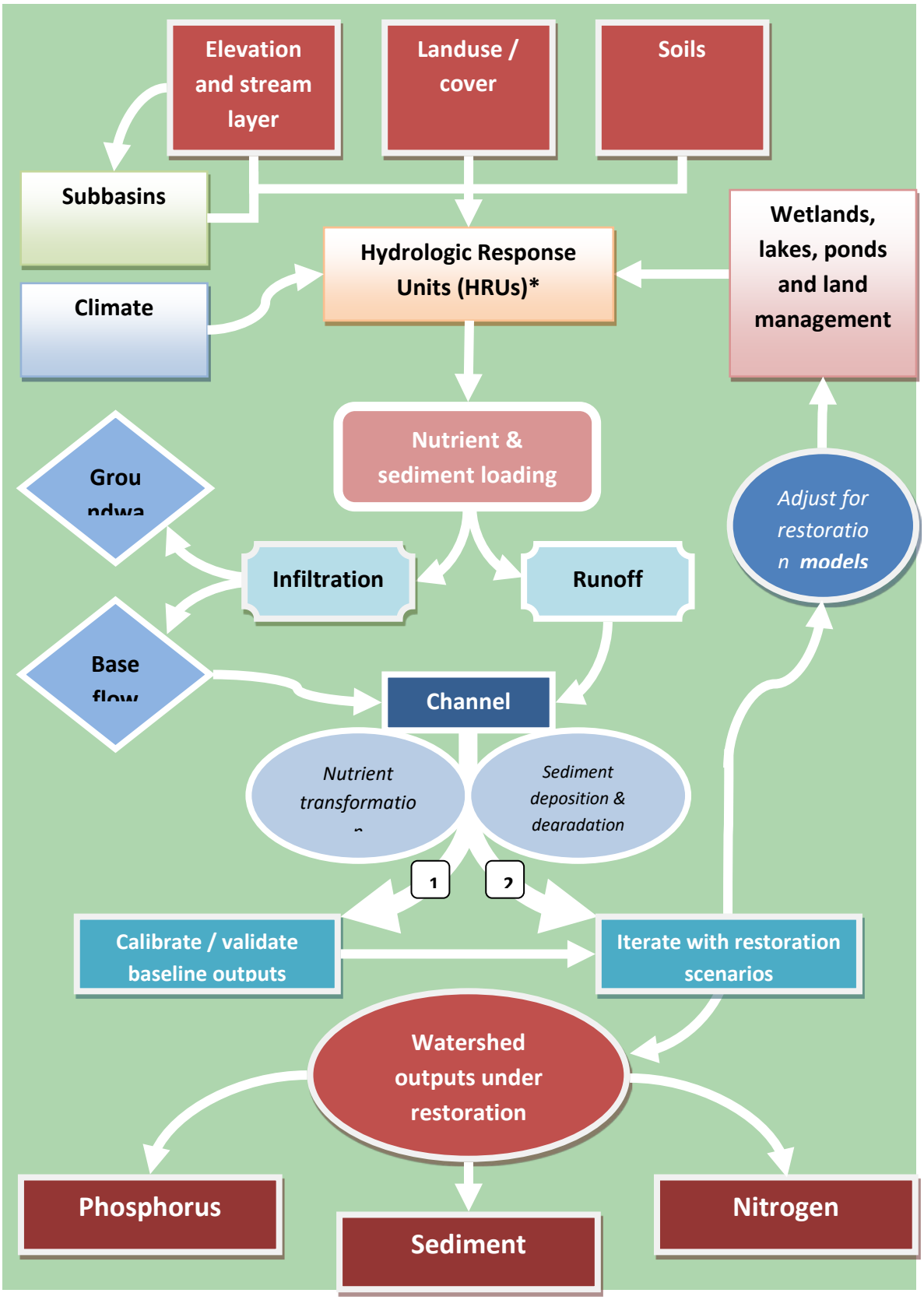


Figure 1. Conceptual representation of the Upper Klamath Basin SWAT model.

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

Investigator:	Dr. Gary Hendrickson, HSU Fisheries Biology
	Scott Benson, MS student
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.

Objectives of this project are to:

1. Determine the time and sequence of *C. shasta* production in juvenile Chinook salmon from Iron Gate Hatchery.
    a. This would include the time required for *C. shasta* DNA to be detected in water holding infected juvenile salmon, the time required for the DNA concentration to peak and when DNA can no longer be detected.
2. Estimated the number of myxospores produced by individual infected juvenile Chinook salmon relative to exposure and rearing conditions.

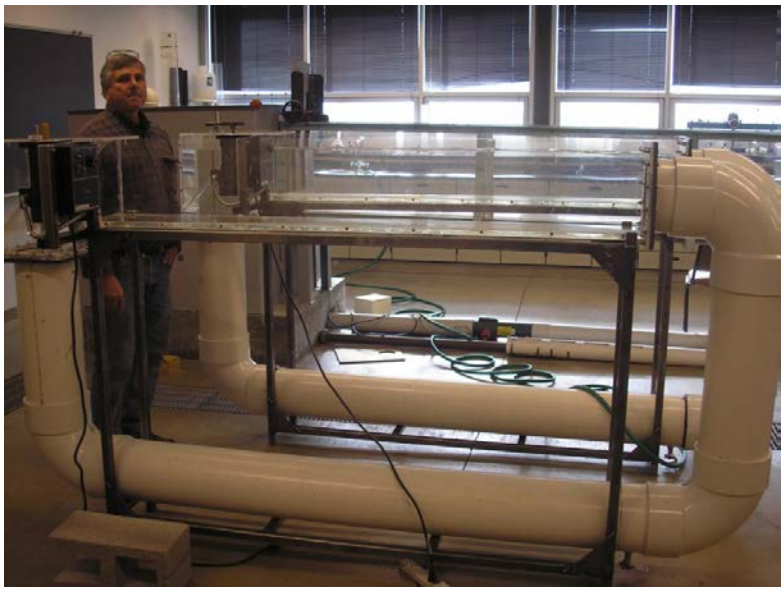
MYXOZOAN FISH DISEASE RESEARCH AND MONITORING

Investigator:	Dr. Peggy Wilzbach, CACFWRU
	David Malakauskas, PhD student, Michigan State University
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 disruption of habitats necessary for worm survival.

Recognition of the probable importance of flow in affecting distribution and abundance of polychaete populations has generated keen interest among scientists and managers in the potential for using experimental flows 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. Flow manipulations, however, are likely to be effective only if polychaetes are killed rather than simply re-distributed as viable animals elsewhere within the system.

Objectives of the research are to:
1) quantify shear needed to dislodge *Manyunkia* from preferred substrata, and measure survivorship of displaced worms in a laboratory setting
2) classify microhabitat flows in which *Manayunkia* are found
3) quantify bed load shear in the Klamath River at baseline and peak flows in areas where high abundances of *Manayunkia* occur.



Flumes constructed for use in evaluating flow effects on polychaetes. Each of the two flumes has an adjustable 125 W motor for changing water velocities. In trials to begin in summer 2011, flumes will be filled with substrate favored by *M. speciosa*, worms will be introduced, and water velocities will be increased until a given substratum is entrained in the water column. Critical shear will be calculated for the minimum velocity required to dislodge the worms.

Lab trials are expected to continue through fall 2011. Field measurements to characterize the microflow environments inhabited by the worm and to quantify bedload shear in the Klamath River will be taken concurrently with worm and substrate collections for use in lab trials. Additional current profiles will be taken in the winter to coincide with maximum flows. Data analysis and report preparation are scheduled for spring 2012.

Manayunkia speciosa is a freshwater polychaete with a wide-ranging distribution throughout North America. Photo credit: Sarah Willson.

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

Investigators:	Dr. Walter Duffy, CACFWRU
	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 conducted a one day workshop in December 2010 that was attended by 15 Department of Fish and Game and tribal biologists. Topics covered included capabilities of the technology, site selection, estimating escapement, sub-sampling and data management as well as a site visit. Feedback about the workshop was very positive.

We installed the DIDSON in Redwood Creek and recorded data during 2009/2010 and again during the winter of 2010/2011.Estimated escapement during the November 2009 – January 2010 was 2,368 Chinook salmon, 298 coho salmon, and 874 anadromous cutthroat trout or steelhead. Much of our effort during the past year has been devoted to processing data and developing a statistical analysis that will allow us to assign probabilities to individual fish when run timing overlaps (Figure 1).

Size of fish recorded passing the DIDSON ranged from 14 to 114 cm in length (Figure 2). These data on size of fish are being used 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 coho salmon and Chinook salmon migrating past the DIDSON camera in Redwood Creek during November 17, 2009 – January 9, 2010.

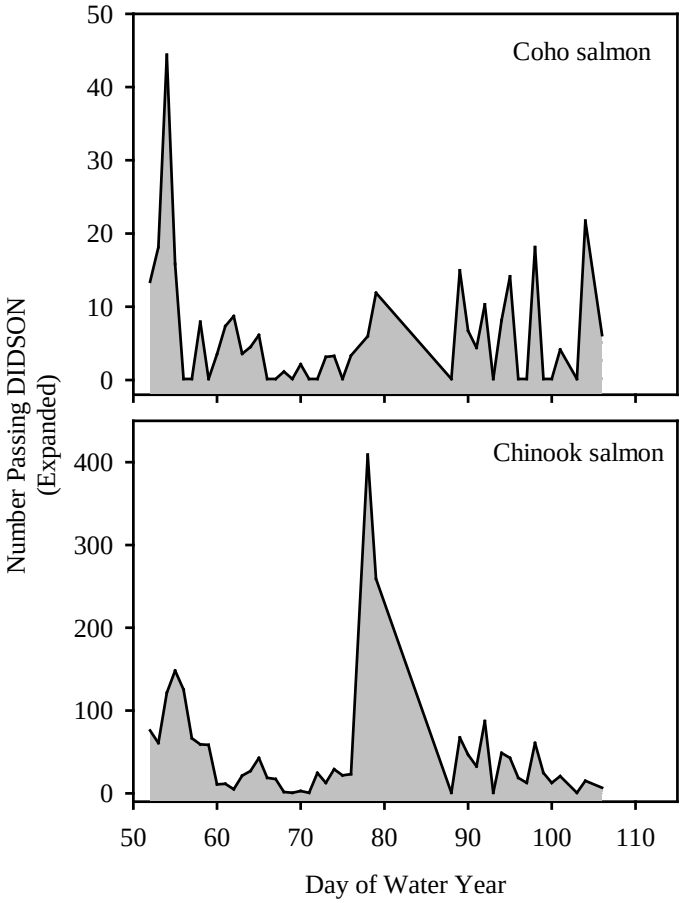
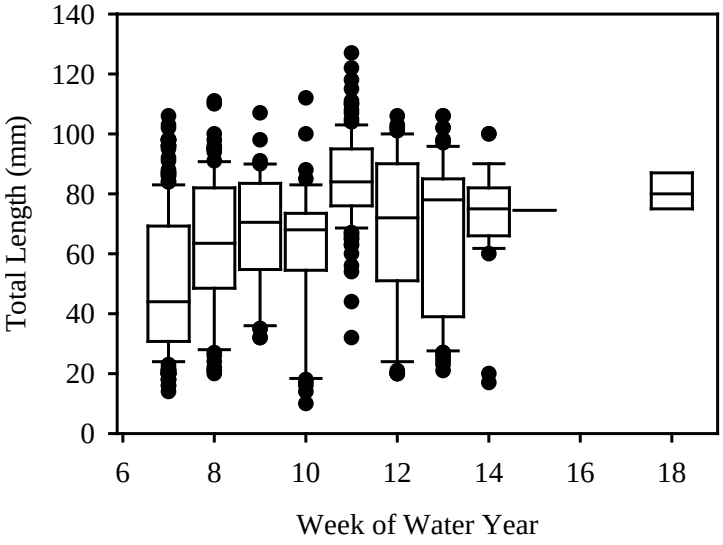


Figure 2. Size frequency distribution of fish detected by a DIDSON camera in Redwood Creek during November 17, 2009 – January 9, 2010.



PRAIRIE CREEK SUB-BASIN LIFE CYCLE STUDIES.

Investigators:	Dr. Walter Duffy, CACFWRU
	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 is 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.

During the period of sampling, abundance of juvenile coho salmon has varied from less than 2,000 in 2008 to between 6,000 and 8,000 in five of 13 years (Figure 1, top). Expanded estimates of coho salmon smolt production do not appear to be correlated with juvenile abundance (Figure 1, middle). Escapement of adult coho salmon to Prairie Creek (Figure 1, bottom) illustrate differences in cohort abundance and appear more strongly correlated with juvenile abundance than smolt production. Numbers of adult coho salmon (Figure 1) and Chinook salmon escaping to Prairie Creek increased from low numbers recorded in 2010. Weirs were not installed in 2011 so as to minimize disturbance to adult fish.

Several graduate students are contributing to improvements in methods for estimating of adult escapement. Katrina Wright developed estimates of residence time for adult coho and Chinook salmon. Brian Poxon estimated observer efficiency for adult coho and Chinook salmon in Prairie Creek. William Youmans is currently estimating the ability of the independent observer to identify and classify salmon redds. Collectively, their efforts have improved estimates of adult escapement.

In 2011 we will begin efforts to improve estimates of smolt production from Prairie Creek. This will begin with replacing fyke traps with a rotary screw trap. This rotary screw trap was installed in early April. We will evaluate its performance at the end of the season.

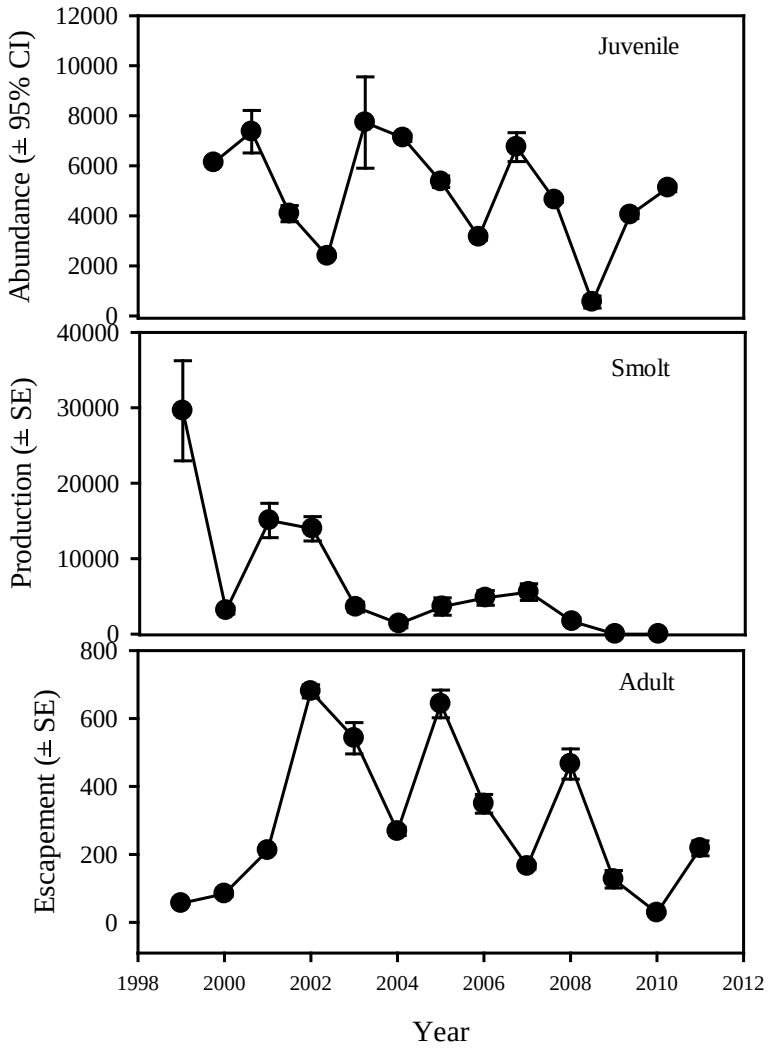


Figure 1. Estimated abundance juvenile (top), production of smolts (middle) and escapement of adult coho salmon to Prairie Creek, 1988 -2011.

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

Investigators:	Dr. Walter Duffy, CACFWRU
	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 continue to fund this project with a long-term goal of determining the status and trends of the juvenile salmonid smolt population migrating downstream from both upper and lower Redwood Creek.

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 in 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.

Estimated population size in 2010 was similar to the previous two years. Roughly 90,000 age 0+ Chinook salmon, the most abundant species, migrated from the system in 2010 (Figure 1). The timing of migration in 2010 was, however, protracted to later in the season than in previous years (Figure 2).

An annual report has been delivered that includes a detailed assessment of all species (population estimates, migration timing, size of fish, etc.) among study years. Several presentations were also given to various agencies (NOAA, CDFG, RNP).

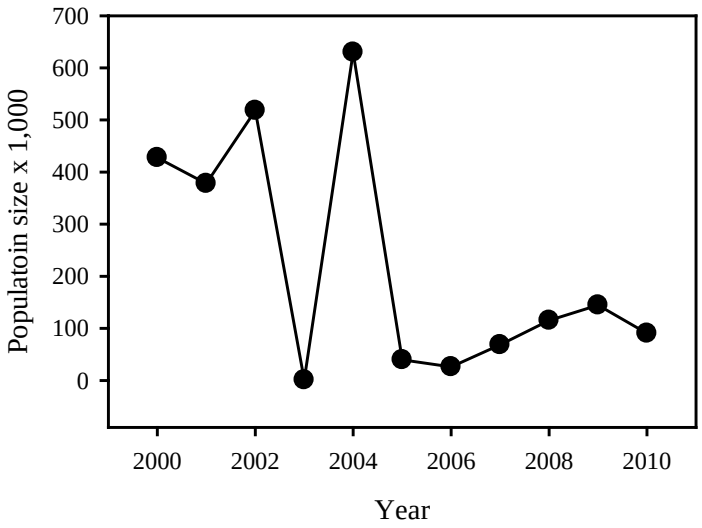


Figure 1. Estimated population size of age 0+ Chinook salmon migrating past a downstream migrant trap in lower Redwood Creek, 2000-2010.

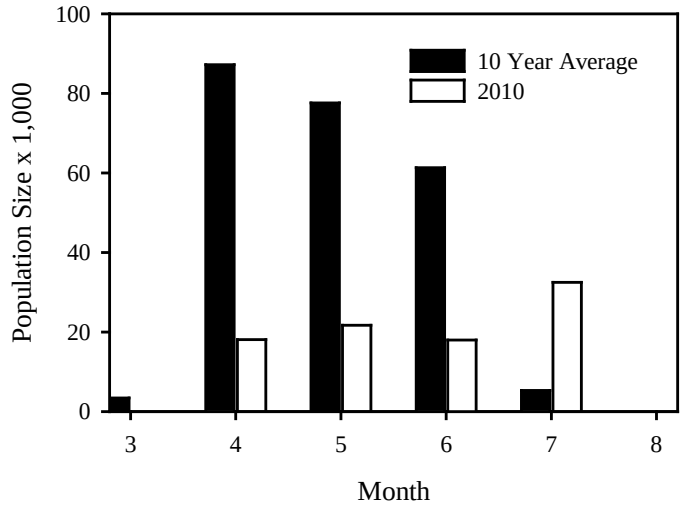


Figure 2. Monthly estimated population size of age 0+ Chinook salmon migrating past a downstream migrant trap in lower Redwood Creek. Ten year average is for 2000-2009 and compared with 2010.

ROLE OF BARRIERS IN THE CONSERVATION OF MCCLOUD REDBAND TROUT.

Investigators:	Dr. Peggy Wilzbach, CACFWRU
	Roman Pittman, MS Student
Duration:	September 2007 to May 2011
Funding:	USDI Fish & Wildlife Service ($80,000)

The goal of this research was 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 included: 1) identifying existing and potential barriers in Tate and Trout creeks; 2) describing and compare population structure of the redband trout in isolated and connected reaches of the sites, and 3) estimating the minimum stream length for population viability of the trout based on density and survivorship estimates.

McCloud redband trout

A poster describing research findings was presented at the Wild Trout Symposium (West Yellowstone, MT) in Sept 2010.

The graduate student working on this project successfully defended his thesis in March 2011, and his thesis is currently under review by the Graduate Coordinator for the College of Natural Resources and Sciences. The abstract of his thesis appears below.

Minimum Stream Length Requirements for McCloud River redband trout (*Oncorhynchus mykiss spp*) in Trout and Tate creeks, Siskiyou County, California

Roman Pittman

To evaluate the potential effectiveness of isolation management to protect and restore populations of McCloud River redband trout (*Oncorhynchus mykiss spp*), I located existing and potential barriers to fish movement, evaluated habitat, and estimated minimum Tate Creek stream lengths required to maintain genetically viable populations in two streams, Trout and Tate creeks, in the upper McCloud River basin in northern California.

Minimum stream length requirements were based on reach-scale estimates of fish density and survival. Population estimates were obtained using a modification of the Hankin and Reeves (1988) approach and from spotlight surveys. Redband trout were the only salmonid species observed in Trout Creek while Tate Creek contained redband trout and brook trout (*Salvelinus fontinalis*). Redband trout densities in summer 2009 were approximately 378 km^{-1} and 652 km^{-1} in Trout and Tate creeks, respectively. Estimates of minimum stream length needed to maintain a population of 2,500 individuals with densities observed in 2009 ranged from 7.35

to 13.23 km on Trout Creek and from 4.26 to 7.67 km on Tate Creek. Abundance differences in streams were probably due to availability of warm, retentive, high productivity habitat in the lower reaches of the larger Tate Creek watershed. Trout Creek was determined to be a poor candidate for deliberate isolation because a percolation barrier isolates it from the upper McCloud River and further barriers would fragment already limited habitat. Although trout from the lower reach of Tate Creek showed morphological evidence of hybridization, the stream supported a higher trout density and available habitat exceeded estimated minimum stream length. As such, it may represent a viable isolation candidate, with sufficient resources to support growth of translocated populations with greater genetic purity. Existing culverts on both streams do not appear to significantly fragment habitat.

Klamath REMS, Fisheries (RWO 82).

Investigators: Dr. Walter Duffy, CACFWRU
Dr. Peggy Wilzbach, CACFWRU
Christopher Olie 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 coho salmon among a representative cool water patch, adjacent mainstem warm water, and tributary mouth in the lower Klamath River.

Lower Klamath River

In June 2010, field research began with the installation of an array of 6 passive integrated transponder (PIT) tag antennas and a MUX were set up. Two of the antennas were placed in a pool near the mouth of Independence Creek, and 4 were placed in the cold-water mixing zone in the Klamath created by the outflow of the creek. Between July and September of 2010, 620 juvenile salmon (534 Chinook, 72 coho, and 14 steelhead) were tagged with PIT tags and re-released. These tagged fish (as well as other tagged fish released by other researchers upstream) were recorded over 24,000 times by the array of antennas. Feeding rates for 508 individual fish were assessed during snorkel surveys during both high and low main-stem temperatures, by visually observing and counting individual feeding events for a period of up to 5 minutes per fish. Gut fullness was measured using gastric lavage on 281 fish from both the tributary pool, and the cold-water mixing zone habitats. Additionally, 39 separate drift and benthic samples were taken using drift nets as well as Serber samplers, at both high and low water temperatures. Water temperature was monitored hourly on a 24 hour basis using a total of 50 remote temperature loggers distributed in the tributary pool, the cold water mixing zone, and upstream of the mixing zone in the Klamath.

Currently data is being formatted for analysis, but preliminary analysis suggests a significant difference in gut fullness between the tributary pool habitat and the cold-water mixing zone habitat on the Klamath. Based on a preliminary look at the data from the antennas, there appears to be only limited movement of individual fish between the habitats, though it is unclear at the moment whether there is a temporal pattern to the movement. Currently, efforts on data analysis are focusing on determining appropriate sample sizes for the second season of field research to determine how to most effectively utilize resources.

NEW RESEARCH PROJECTS REVIEW

HABITAT USE, MOVEMENT, AND SURVIVAL OF JUVENILE COHO SALMON IN THE SHASTA RIVER

Investigators: Dr. Peggy Wilzbach, CACFWRU
Chris Adams, MS Student
Duration: September 2010 to September 2012
Funding: California Department of Fish and Game

The Shasta River, a highly productive spring fed system in a high desert setting, provides unique habitat for anadromous salmonids and historically supported large numbers of coho salmon. However, hydrology of the river has been greatly influenced by irrigation practices, and the population status of the federally endangered coho salmon in the Shasta River is now dire. The California Department of Fish and Game began studies of summer rearing habitat and seasonal movements of Shasta River juvenile coho salmon using PIT tags and remote detection systems in 2007. The proposed research would extend the effort, to study habitat use, movement, and reach-specific survival of the 2010 cohort. Results will be used in evaluating recent restoration activities and guiding those of the future.

Objectives of the proposed research are to:

1) identify areas where juvenile coho salmon are rearing

2) document and compare growth of tagged individuals among different rearing habitats.

3) evaluate temperature effects on displacement and summer survival of juveniles, and estimate reach-specific survival of smolts as they migrate from rearing areas out of the Shasta River in the spring of 2012.

Deployment of remote detection systems and capture and tagging of fish will begin in spring 2011, and continue through fall 2012. Research will constitute the master's thesis research of California Department of Fish and Game employee Chris Adams.

Solar-powered remote detection system on the Shasta River. Photo credit: Chris Adams

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

Investigators:	Dr. Walter Duffy, CACFWRU
	MS Student, TBD
Duration:	April 2011 to August 2013
Funding:	California Department of Fish and Game/FRGP ($60,197)

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 continue evaluating the use of a dual frequency identification sonar (DIDSON) imaging system to estimate escapement of adult salmon and steelhead in California Rivers. Specific objectives are: 1) to estimate escapement of coho salmon, Chinook salmon, steelhead and coastal cutthroat trout to Redwood Creek during 2011-2013, 2) refine logistic models used to assign species to targets, and 3) develop protocols for management of data gathered with the DIDSON.

PRAIRIE CREEK SUB-BASIN LIFE CYCLE STUDIES.

Investigators:	Dr. Walter Duffy, CACFWRU
	Tancy Moore, MS Student
Duration:	April 2011 to August 2013
Funding:	California Department of Fish and Game/FRGP ($194,221)

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.

CONSERVATION GENETICS OF THE FEDERALLY ENDANGERED TIDEWATER GOBY (*EUCYCLOBIUS NEWBERRYI*): COMPARISON OF TEMPORAL COLLECTIONS AND INSIGHTS INTO DRIFT AND MIGRATION

Investigator:	Dr. Andrew P. Kinziger
	MS Student
Duration	May 2011 to May 2013
Funding	U.S. Fish & Wildlife Service ($77,364)

The tidewater goby (*Eucyclogobius newberryi*) is a federally endangered fish species) ranging from the Smith River in northern California to Agua Hedionda Lagoon in southern California. The tidewater goby inhabits brackish/freshwater lagoons and estuaries that are positioned linearly along the California coast. Lagoons and estuaries inhabited by tidewater goby are separated from one another by 1-20 km. Tidewater gobies have no explicit marine stage and ocean habitats between these estuaries and lagoons are not inhabited by stable populations of goby; however, rare periodic migrants occur in ocean habitats. There is only one known record of tidewater goby from coastal oceanic waters. Many coastal lagoons inhabited by tidewater gobies are physically isolated from the ocean by sand bars that rarely open to the ocean (~0-5 openings annually) making dispersal into and out of the lagoons contingent upon lagoon openings. Given the fragmented nature of tidewater goby geographic distribution it is convenient to view this species as composed of metapopulations experiencing periodic local extirpation with subsequent recolonization from regional source populations.

Currently, there is uncertainty regarding metapopulation dynamics of tidewater goby populations from Humboldt Bay, California. Previous investigations of the federally endangered tidewater goby in the north coast region of California showed that artificially fragmented populations within Humboldt Bay exhibited higher genetic differentiation and lower genetic diversity relative to naturally fragmented populations. It was unclear whether these patterns were the result of multi-decadal isolation and lack of migration among geographically separated populations or if periodic recolonization of fragmented habitats combined with founder effects (e.g., metapopulation dynamics) were responsible. Determining which process is operating will provide insights into the extent of migration between discrete and isolated Humboldt Bay tidewater goby populations. Such information is key for management because it would indicate the likelihood of re-colonization of extirpated populations.

The objective of this research will be to determine levels of genetic diversity, genetic structure, and stability in genetic structure through time (2006 to 2010 or 5-6 generations) in the north coast tidewater goby (*Eucyclogobius newberryi*).

UNIT PROGRAM REVIEW

PROGRAM DIRECTION

Leslie Farrar joined the Unit as in August 2010 and assumed the duties of Unit administrative support coordinator. We thank Interim CNRS Dean Steven Smith for graciously providing administrative support during the period between the retirement of Kay Brisby and Leslie's arrival.

The Unit is excited to report statistical support for graduate students will become available soon. This support is the result of a new collaborative working arrangement with the U.S. Fish and Wildlife Service and the Unit. While details have not been agreed upon, the Service intends to allow a biometrician at the Arcata office to consult with students. The Unit has agreed to provide scientific review of selected documents and perhaps other science expertise to the Service.

Expansion of the unit to include a wildlife scientist continues to be a topic of interest on several fronts. Cooperators from the states of NJ, NV, CA and HI continue to collaborate to advance a request for unit expansion to congress. In recent months, the state of North Dakota has also expressed interest in joining this coalition. The National Cooperators Coalition continues to support these efforts. The Department of Fish and Game has also expressed interest in expanding the California Unit to include UC Davis. This request has not been acted on, to our knowledge.

Funding from the national CRU program remained at $20,000 this FY. These funds allow the Unit to contribute to a vehicle fund and allow the Unit to periodically purchase a new vehicle, as well as purchase supplies and equipment not identified in contracts.

Facilities and Equipment: The unit acquired a new vehicle (Ford F150 pickup). Other facilities remain unchanged.

UNIVERSITY SERVICE AND TEACHING

Courses Taught

Restoration Ecology of Riverine Fish (3 units)	Duffy	Spring 2010
Introduction to Fisheries	Duffy	Spring 2011
Ecology of Running Waters (3 units)	Wilzbach	Fall 2009, Fall 2010

Graduate Student Major Advisor

Duffy	Philip Colombano – MS Fisheries, Humboldt State University
	Stephen Gough – MS Fisheries, Humboldt State University
	Brian Poxon – MS Fisheries, Humboldt State University
	Katrina Wright – MS Fisheries, Humboldt State University
	Matthew Metheny - 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
	Brooke DeVault – MS Fisheries, 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

THESES OF UNIT-SPONSORED GRADUATE STUDENTS

Hodge, B. 2010. Life history variation in *Oncorhynchus mykiss* from the lower Klamath River. M.S. Thesis, Humboldt State Univ., Arcata, CA. 99 pp.

Gough, S.A. 2010. A Comparison of escapement estimate methods plus escapement-recruitment relationships for Chinook salmon and coho salmon in a coastal stream. M.S. Thesis, Humboldt State Univ., Arcata, CA. 63 pp.

Groff, L. A. 2010. A spatial model for predicting unrecognized populations of the Oregon spotted frog (*Rana pretiosa*) toward the southern extent of its geographic range. M.S. Thesis, Humboldt State Univ., Arcata , CA. 41 pp.

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TECHNICAL ASSISTANCE

Duffy

Department of Fish and Game, serves as Chair of the Fishery Restoration Grants Program, Peer Review Committee.

Department of Fish and Game, serves as a member of the California Advisory Committee on Salmon and Steelhead.

Department of Fish and Game, serves as the science representative on the coho salmon recovery team.

Department of Fish and Game, serves as a member of an advisory group reviewing suction dredge mining regulations for California waters.

Karuk Tribe, he provides periodic and ongoing assistance on technical subjects related to the Klamath River.

U. S. Geological Survey, appointed as a member of the Klamath Basin Leadership Team.

Wilzbach

For a multi- party group including Oregon State University, Humboldt State University, US Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Game, she participated as a member of the Klamath River fish health planning committee to evaluate research needs for developing disease management strategies.

For the USFWS, she reviewed proposals for the Trinity River Restoration Program.

For NMFS, she served as a peer reviewer of the draft biological review team report concerning the southern boundary of the Central California Coast coho salmon ESU.

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SCIENTIFIC PUBLICATIONS

Harvey, B.C. and M.A. Wilzbach. 2010. Carcass Addition Does Not Enhance Juvenile Salmonid Biomass, Growth, or Retention in Six Northwestern California Streams. *North American Journal of Fisheries Management* 30: 1445-1451.

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