California Cooperative Fish & Wildlife Research Unit

2012 Coordinating Meeting

May 9, 2012
Humboldt State University
1 Harpst Street, Arcata, CA

Smith River, CA

Photo credit: Friends of the River

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May 9, 2012
Humboldt State University, Behavioral & Social Sciences Building, room 508

AGENDA

Introductions and Welcome (Chair, Steve Smith) 9:00
Additions to the Agenda
Approval of 2011 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 catered..... 11:45

Unit Research Summary (continued)
Research Presentation (Chris Adams) 1:00
Current Research Projects Review (Duffy & Wilzbach) 1:45
New Research Projects (Duffy & Wilzbach) 2:00

Unit Program Review 2:30
University Service and Technical Assistance
Cooperative Agreement and Program Direction
Accomplishments
Facilities and Equipment
Financial Status

Adjourn.....2:45

California Cooperative Fish & Wildlife Research Unit

2011 Coordinating Committee Meeting Minutes

Tuesday, May 11, 2011

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:

Russ Bellmer, CDFG-Sacramento

Randy Brown, USFWS-Arcata

Walt Duffy, Unit Leader, CA Cooperative Research Unit

Nancy Finley, USFWS-Arcata

Gary Hendrickson, HSU-Fisheries Department

Nick Hetrick, USFWS-Arcata

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

Seth Ricker, CDFG-Arcata

Rosie Records, CA Cooperative Research Unit

Olie Smith, CA Cooperative Research Unit

Steven Smith, HSU-CNRS

Peggy Wilzbach, Asst. Leader, CA Cooperative Research Unit

Joe Margraf opened the meeting. The agenda was reviewed and no changes were requested. Minutes of the 2010 meeting were reviewed and approved with no additions or corrections (Russ Bellmer motioned and Gary Hendrickson seconded).

COOPERATOR REPORTS

Report from Russ Bellmer, CDFG-Sacramento

- Neil Manji is now regional manager for Region 1. He is still working closely with the fisheries department. New branch chief is Stafford Lehr; he has over 25 years in the department working on fisheries issues and comes to us from Region 2.
- Budget cuts have been fairly intense; fisheries branch has no travel funds, but is trying to implement exemptions for "critical" travel—i.e. travel related to fish health.
- Working with COAST, which has a new internship which will pay 10 biology majors to work for CDFG at $2,500 for the summer (as a pilot experimental program). There were over 60 applicants but few from Humboldt State, which they hope to address in the future with earlier promotion of the program.
- Met with Sonke Mastrup last week about getting CDFG's wildlife component involved in the Coop. They have not yet been able to issue a new grant to the Coop but intend to do so and are exploring means to implement this.
- They have a number of Ph.D.s in CDFG and would like to work their expertise and research into the Coop in whatever ways are useful to the Coop (both from fisheries and wildlife sides of CDFG). CDFG would like to see broader geographic cooperative endeavors from the Coop.
- Kevin Schaeffer and CDFG are arranging meetings at several locations in the state to address procedures, coordination, facilitation and responsibilities for salmonid monitoring.
- Pete Adams and others compiled a publication for California Fish & Game Bulletin (#180, see http://libraries.ucsd.edu/apps/ceo/fishbull/) which is a summary of their statewide coastal monitoring plan. Monitoring plans have been expanded to include Central Valley so that Valley plans are consistent with Coastal methods and procedures (with some exceptions), and CDFG expects this to greatly improve state-wide monitoring plans for salmonids (including steelhead).
- Coastal monitoring plan is now state-wide. Technical team should have their first conference call by the end of the month. CDFG, NOAA and USFWS are the three directors, and they should have their first meeting by the end of June. This is the culmination of over 15 years of work.
- Coop will follow up on
    - Working with CDFG's scientists
    - Widening Coop's geographic scope
        - Russ Bellmer can give us a list of potential opportunities

Report from Seth Ricker, CDFG-Arcata

- Have been establishing a monitoring program for three anadramous salmonid species, which they hope to be a coastal monitoring program including adult research and life cycle monitoring.
- Last year CDFG established an adult monitoring program encompassing Prairie Creek (a tributary of Redwood Creek) and Humboldt Bay. Prairie Creek fits life cycle monitoring station model well, and has been surveyed along the mainstem for number of adults spawning and number of juveniles coming out. CDFG is moving the downstream trap near confluence of Redwood Creek, and spawning surveys being conducted throughout Redwood Creek.
- CDFG would like to see their relationship with the Coop continue with a structured monitoring program to ensure that downstream monitoring protocols are carried out consistently and that data management is integrated appropriately.
- Approximately six graduates have come through CDFG in the past decade. This will be affected in future by the state budget to the extent that Fisheries Restoration Grant Program (FRGP) is affected, which has been a primary source of funding for this work. CDFG is primarily focused on monitoring and will be forced to assess the program in light of budget trimming.
- Freshwater Creek has been focused on juvenile estimates. Has established itself as a life cycle monitoring station—at this point they are funded for two years out. There is one graduate student working with Darren Ward assessing overwinter survival and habitat attributes, and another student working with Dave Hankin assessing spawner surveys and efficiencies of protocol and how they may be improved statistically. A similar assessment was recently conducted by one of Walter Duffy's student at Prairie Creek. They have been working with Mike Sparkman to ensure regional consistency.

Report from Nancy Finley, USFWS-Arcata

- Their office was supposed to be re-organized under ARD for fisheries but this was changed, counter to expectations in 2010. They are still managed under Ecological Services ARD. Fisheries ARD is Dan Castleberry, who has been heavily involved in Bay Delta issues.
- Last year it was suggested that they be supervised by Klamath Basin supervisor but will not happen. Klamath Basin coordinator position is currently being advertised and will no longer supervise the Klamath offices.
- Recent projects include Landscape Conservation Cooperatives, or LCCs. Rick Kearney is Assistant Regional Director for Science Applications and is based out of Sacramento, manages California LCC. The California LCC has been focusing on work that will support decision making and conservation actions in light of a changing environment. This includes vulnerability assessments or habitat assessments that identify how species or processes may react in different future scenarios that include climate change information. We're also looking at how sea level rise will impact tidal marshes and shoals and the birds that inhabit those areas. We're developing downscaled information from global climate models to assist managers at a regional scale. We're

also supporting development of online tools to assist in regional conservation planning for topics such as fisheries and invasive species.

- Mike Carrier is North Pacific LCC coordinator, based out of Portland, Oregon. A scoping session for LCC was held this past summer. Research interests were focused on aligning existing datasets and on physical data (e.g. bathymetry in relation to sea level rise), somewhat in preference to biological data. The Coop Unit's research associate Sharon Kahara and Humboldt State University spatial analysis professor put in a proposal for a recent LCC RFP. FWS's Strategic Habitat Conservation (SHC) Program also submitted a response to the LCC RFP addressing habitat mapping and landscape scale consistency.

- Trinity River has been an important part of recent USFWS work. USBR has secured an Executive Director for Trinity Program, Robin Schrock who comes from USGS. USFWS hired a Science Coordinator, Ernie Clarke, who came from Everglades Restoration Program. Need to review existing and ongoing programs and implement more adaptive management.

- This is the first year the Trinity Program has instituted a competitive proposal process for outside the partner group. The call for proposals for 2012 can be expected in late summer.

- USFWS does not have a budget and does not anticipate it until early June. They are undergoing structural reorganization for procurement and fiscal side of agency. They are planning for a 10% cut for 2010-2011, and another 10% cut for 2011-2012.

- They have advertised for a biostatistician who is expected to work directly with the Coop Unit to provide statistical support to Coop Unit students and to support Klamath, Trinity Program and other FWS programs. They have selected a candidate and hope to hire soon, and applicant pool has a number of excellent candidates. They are in need of a data manager with ecology background for Strategic Habitat Conservation Program; it will be hired under a Biological series.

- Flows on the Trinity this year were increased up to 11,000 CFS for a few days this month as an experiment.

- Ren Lohoefener, the Regional Director, is working on a Tribal youth initiative to encourage Basin youth participation in science, and has recently received funding to establish scholarships for college-level programs. USFWS would like to link to Student Career Experience Program (SCEP) and to Humboldt State, as well as a more structured internship program, and USFWS would appreciate assistance with implementing this.

<u>Report from Nick Hetrick, USFWS-Arcata</u>

- Klamath River: They are on a fast-track for secretarial Determination process.

- Pacific Lamprey Initiative: USFWS is leading the development of the California Plan, which they hope to have developed by the end of the year. Damon Goodman is the lead.

- Through the Trinity Program they contracted with Carl Schwartz and a post-doctorate at Simon-Fraser and developed a statistical tool for generating population estimates at rotary screw trap on the Klamath to address issues of missing data (i.e. periods under which trap is not functioning). They have successfully generated outmigration data for 6 years on the Klamath and 19 years on the Trinity, and are happy to share the tool with other Cooperators. A report describing the approach can be found at: http://www.fws.gov/arcata/fisheries/reports/technical/TR_Final_Report.pdf.

- Last year they made a motion to open Fish Health Meeting to Upper Klamath Basin stakeholders, and the next meeting will be moved up to Klamath Falls.

- Have recently had meetings with Wiyot and Karuk, and have yet to schedule a meeting with the Yurok to confer about how and what type of assistance they would like from USFWS.

- USFWS has hired a biostatistician to provide support to Coop, and in turn the Coop will provide assistance from students and with report reviews.

Report from Steve Smith, HSU-CNRS

- Last year HSU was in the process of considering programs for elimination and eliminated German and Applied technology. Computing science and computing information systems were consolidated but not eliminated.

- January state budget estimations show HSU taking a "manageable" hit. The University has been positioning itself for a long-term reduction in budget. HSU levied a "material, services and facilities" fee of $140 per semester for this money, supplying about $2M, about $1M of which goes to CNRS. Approximately 2/3 of these funds are used to offset funding for technicians in the college—e.g. hatcheries and greenhouses.

- $500M budget cut is estimated, but if a $1B cut to the CSU system were to occur it could reduce the CSU budget by as much as a third. The University historically has hired 15-20 new faculty a year. Re-hires have been slowed to about six per year as a means of addressing budget shortcuts.

- Steve Smith has been appointed as the permanent Dean (was serving as temporary until recently).

- A small steering committee is meeting for Marine Facility; they are hoping to advertise early in fall to hire a full-time director.

Report from Gary Hendrickson, HSU-Fisheries Department

- Darren Ward was hired last year; he works half-time as a faculty member and half-time through NMFS.

- Last year the Department began a complete program review and has substantially revised the curriculum with a greater emphasis on conservation; however, changes will likely not be fully implemented for 2-3 more years.

- CDFG scientists with interest in working with the HSU and the Coop Unit would be welcome and would have the opportunity to serve on graduate committees, etc.

Report from Joe Margraf, USGS

- Wildlife Management Institute (WMI) is working on bringing financial status up. About two months ago hired a new western position, Christian (Chris) Smith, recently retired from Montana Fish and Game, and prior to that from Alaska Fish and Game.
- USGS's reorganization has changed the agency's discipline-based structure (e.g. biology, mapping) to thematic areas to promote cross-discipline access to important areas of expertise. The Unit program is in Ecosystems/Ecosystem Services area. In addition, there are no longer Regional offices.
- Federal budget: Unit employees were instructed not to work or to allow use of federal vehicles if federal furloughs were implemented. FY 2010 budget had a large boost to fill long-open vacancies. Stance of the main office is that they will cut back in other areas before they significantly cut back funding to Units.
- Mike Scott, Idaho, has announced his retirement for June, and a list has been begun for his replacement. Chris Grue in Washington and John Bissonette in Utah have announced their retirement for a year from now.
- Unit Program's primary focus is on adaptive management. They are asking that new hires have some level of interest in this area, and they have been working to increase awareness in this area among cooperators in coordination with National Conservation Training Center (NCTC). They have been working with Oregon State University to develop a remote, delivery-based system. Oregon Unit just hired Jim Peterson; his expertise is in Structured Decision Making.
- Are still offering to take Cooperators out to NCTC for those interested; some trainings are available in Sacramento for those with travel caps.
- Unit Program is not currently expecting drastic budget cuts.

Overview of completed projects and review of new projects

Walt Duffy and Peggy Wilzbach reviewed the four projects completed in the last year as well as ongoing projects, and introduced four new research projects to be approved:

1) Habitat use, movement, and survival of juvenile Coho salmon in the Shasta River
2) Estimating salmon and steelhead escapement to Redwood Creek using a Dual Frequency Identification Sonar (DIDSON) Imagining System
3) Prairie Creek Sub-Basin Life Cycle Studies
4) Conservation genetics of the federally endangered Tidewater Goby (*Eucyclobius newberryi*): Comparison of temporal collections and insights into drift and migration

Nancy Finley noted that USFWS would like to coordinate for more comprehensive monitoring for tidewater goby. Seth Ricker commented that there is an opportunity for these new projects to overlap with existing state programs, and suggested that this be emphasized at the outset of the research.

Russ Bellmer nominated to approve the projects unanimously as described, and Nancy Finley seconded the motion. All approved.

UNIT RESEARCH SUMMARY

Christopher Olie Smith, a CACFWRU graduate student, presented on "Feeding behavior of juvenile salmonids at the confluence of Independence Creek and the Klamath River," a portion of his graduate thesis research.

2012 ANNUAL COORDINATING MEETING

Next year's meeting was tentatively set for the second or third week of May, 2012.

CLOSING

Russ Bellmer motioned to adjourn, Joe Margraf seconded. The meeting was adjourned at 2:48 pm.

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."

REVIEW OF PROJECTS COMPLETED IN 2011

ROLE OF BARRIERS IN THE CONSERVATION OF MCCLOUD REDBAND TROUT

Investigators:	Dr. Peggy Wilzbach, CACFWRU
	Roman Pittman, MS Student
Duration:	September 2007 to September 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

Estimates of minimum stream length needed to maintain a population of 2500 individuals with densities observed in 2009 ranged from 7-13 km on Trout creek and from 4-8 km on Tate Creek. 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 did not significantly fragment habitat.

Research findings were 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. His thesis is available at:
http://www.humboldt.edu/cuca/documents/theses/Pittman%20final%20thesis.

PRAIRIE CREEK SUB-BASIN LIFE CYCLE MONITORING 2009-2012

Investigators:	Dr. Walt Duffy, CACFWRU
	Brian Poxon, MS Student
	Bill Youmans, MS Student
Duration:	June 2008 to March 2012
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.

During the 2008 – 2011 period, abundance of juvenile coho salmon varied from 4,000 – 5,100. Production of coho salmon smolts from Prairie Creek was approximately 2,500 in both 2008 and 2010. Sampling downstream migration of salmon smolts was not undertaken in 2009 due to suspension of state bond funding. Escapement of adult coho salmon to Prairie Creek was low during this period, ranging from 28 in 2010 to 218 in 2011. Chinook salmon escapement was also depressed during this period.

MS student Brian Poxon investigated the ability of observers in enumerating adult coho and Chinook salmon in Prairie Creek and will defend his thesis soon. MS student Bill Youmans is estimating the ability of the independent observer to identify and classify salmon redds. A final report was prepared and submitted to the funding agency in April 2012.

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 August 2011
Funding:	USDA, Natural Resources Conservation Service ($696,887)

California's Central Valley encompasses an area of 55,100 km^2, extending 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, of 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 conservation programs, including the Wetland Reserve Program (WRP). The WRP program focuses on restoring degraded wetlands or those that have been converted to agricultural production. In California, WRP has been applied primarily on restoring seasonal wetlands, semi-permanent marshes, vernal pools, riparian and tidally-influenced wetlands.

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

Key research findings were: 1) carbon storage was highest in moderately managed wetlands, 2) nutrient storage was greater in Klamath wetlands than Central Valley wetlands, 3) more than 200 bird species used WRP wetlands, and 4) native pollinator diversity was positively correlated with the amount of uplands within WRPs.

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 2011

The Fisheries Restoration Grant Program funded 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. Mark-recapture techniques were used to determine population estimates. The study was 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.

Estimates of the number of fish migrating past the lower trap ($\pm$ 95% C.I.) were as follows: age 0+ Chinook salmon 147,719 ($\pm$ 111,520), age 1+ Chinook salmon 15 ($\pm$ 5), age 1+ steelhead 205,011 ($\pm$ 3,480), age 2+ steelhead 5,587 ($\pm$ 1,493), age 0+ coho salmon 884 ($\pm$ 245), age 1+ coho salmon 113 ($\pm$ 97), and coastal cutthroat trout 118 ($\pm$ 45).

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).

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.

The goal of this study was 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 had 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. Logistic regression models were developed to assign probabilities of assigning fish to species when multiple species were present. These models incorporated date and fish size.

Estimated escapement during November 2009 – March 2010 was 2,435 Chinook salmon, 375 coho salmon, 775 steelhead and 400 coastal cutthroat trout. Realistic escapement estimates could not be made for the 2010-2011 season due to damage to equipment.

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 2011
Funding:	Subgrant from Oregon State University ($70,142)

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 that has been considered to control *C. shasta* in the Klamath Basin is the removal of spawned out carcasses. The purpose of this project was to determine the time and sequence of *C. shasta* production in juvenile Chinook salmon from Iron Gate Hatchery. The resulting information on pre- and post-mortality parasite production provides insight into parasite production in adult carcasses, which are too large to effectively study in sufficient numbers in a laboratory setting.

Juvenile Chinook salmon were obtained from Iron Gate Hatchery, exposed to Klamath River water for 72 hours in cages, and reared at 20°C in separate 5 gallon tanks at the HSU fish pathology lab. Tanks had no recirculation and no connection to one another. Full water changes were given every day. Every other day 1 liter water samples were drawn from each tank and filtered through 5 µm nitrocellulose filter discs, which were then stored at -35°C. If fish died, sampling was continued until the carcass was fully decomposed. Membranes were sent to Oregon State University (Corvallis, OR) where they were assayed with qPCR to detect and quantify *C. shasta* DNA. This experiment was repeated twice in 2010 and twice in 2011, during the summer when parasite abundance is highest.

Parasite DNA reached a concentration of 1 spore per liter in water samples taken a few days before the fish died, likely due to sloughing of damaged intestinal tissue. On the day of death there was typically a sharp peak in parasite DNA, followed by a second, higher peak within two weeks of death. Wet mount preparation of intestinal material from fresh carcasses showed many fish produced myxospores by the time of death. The exact number of myxospores in water samples is unknown because parasite DNA detected in the assay could have come from other developmental stages as well.

Time of decomposition created a lag between the time of host death and peak parasite DNA release, but it is uncertain whether active parasite development occurred during that time. Further investigations into production in adult carcasses should consider a temporal lag between death of the fish and peak parasite production.

REVIEW OF CURRENT RESEARCH PROJECTS

INTEGRATED LANDSCAPE MODELING OF WETLAND ECOSYSTEM SERVICES (RWO 84)

Investigator:	Dr. Walter Duffy, CACFWRU
	Dr. Sharon Kahara, HSU Wildlife Dept.
	PhD student, Rosemary Records, CSU
	MS student, TBD
Duration:	September 2011 to June 2012
Funding:	USDA, Natural Resources Conservation Service ($70,000)

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.

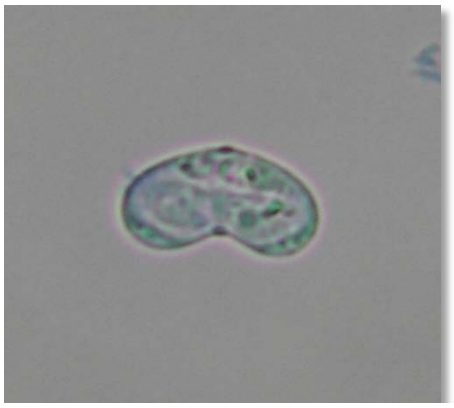
We have made progress on developing a SWAT model (Soil and Water Assessment Tool) for the Upper Klamath Basin. Rosemary Records has developed a SWAT model for the Sprague River. In the coming years, we will use this model: 1) to evaluate the effect of restored wetlands on water quality in Upper Klamath 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 continued developing 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 on the SWAT modeling was presented at the 2011 Soil and Water Conservation Society meeting in Washington, DC in June.

DISEASE REDUCTION IN KLAMATH RIVER: PRODUCTION OF MYXOSPORES OF *CERATOMYXA SHASTA* IN FALL RUN CHINOOK SALMON CARCASSES IN THE KLAMATH RIVER BASIN

Investigator:	Dr. Gary Hendrickson, HSU Fisheries Biology Nick Campise, MS student
Duration:	August 2010 to September 2012
Funding:	National Oceanic and Atmospheric Administration Subgrant from Oregon State University ($70,142)

Ceratomyxa shasta is a myxosporean parasite of salmonids in the Pacific Northwest of North America. Its high prevalence and virulence in out-migrant juvenile fish threatens the long-term survival of salmon in the Klamath River. Before infecting fish, *Ceratomyxa shasta* necessarily infects the polychaete worm, *Manayunkia speciosa*. Infection is initiated when the worm ingests the parasite myxospore. Infection in the worm culminates in the development of the actinospore life stage which is infective to fish. Quantity of spores produced by each host type has been a topic of intense interest to researchers. Logic would suggest that quantity of parasites released into the watershed would be directly related to incidence of infection and magnitude of disease related fish mortality in the basin.



***Ceratomyxa shasta* myxospore**

Although concerns have been primarily related to infection in juvenile salmon, parasite surveys conducted on post-spawned Chinook salmon carcasses have identified fish that harbor large quantities of potentially viable myxospores. Identifying characteristics of carcasses related to number of myxospores present in the descending intestine is the primary objective of this study. The density of myxospores observed in each carcass will be compared to fish size, level of decomposition and sex. Effects of location and date collected as well as relative time post death will also be investigated. Myxospore densities in infected intestinal contents will be estimated from myxospore counts made microscopically in hemocytometer counting chambers. To determine the effect of time after host death on myxospore density, densities in incubating intestinal content samples will be monitored through time in the HSU fish pathology laboratory.

Some questions we hope to answer are:

- Can *C. shasta* continue to develop into myxospores after the death of the fish host i.e. will myxospore densities increase over time in an infected carcass?
- How prevalent and severe are infections in adult Chinook salmon in the Salmon and Scott Rivers?
- Can infection status of a carcass be predicted by known host traits?

Samples will be processed through Summer of 2012. Thesis submission is scheduled for Fall of 2012.

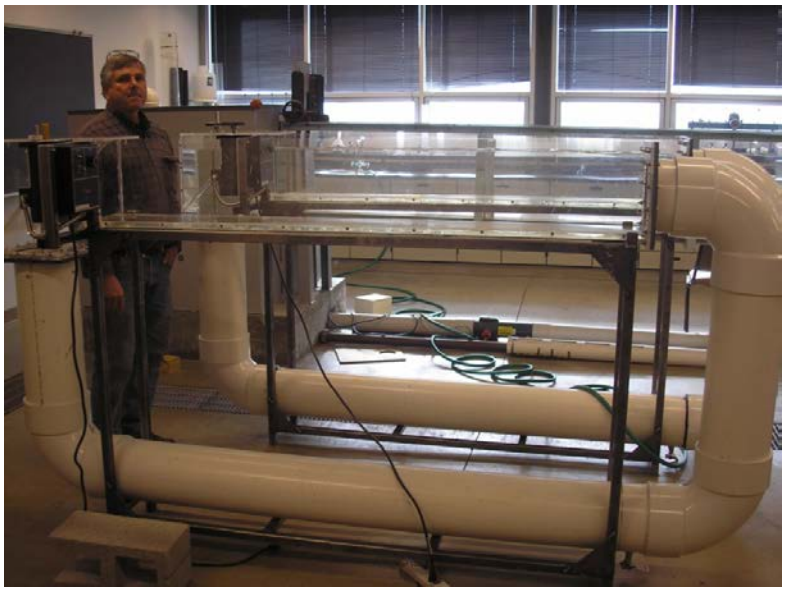
MYXOZOAN FISH DISEASE RESEARCH AND MONITORING

Investigator:	Dr. Peggy Wilzbach, CACFWRU
	David Malakauskas, PhD student, Michigan State University
Duration:	October 2009 to March 2013
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; and
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.

KLAMATH REMS, FISHERIES (RWO 82)

Investigators: Dr. Walter Duffy, CACFWRU
Dr. Peggy Wilzbach, CACFWRU
Christopher Olie Smith, MS Student
Duration: September 2008 to September 2012
Funding: U. S. Geological Survey ($60,375)

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 ^{o}C, salmon are also frequently found occupying habitats where water temperatures reach 23.0 - 24.0 ^{o}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 ^{o}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 ^{o}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.

Lower Klamath River

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.

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.

Due to the later than usual water year, the 2011 field season equipment was installed at the end of July. The same locations were used for all equipment except the two PIT tag antennas in the pool area of Independence Creek which were placed in the middle of the pool as opposed to the outflow in order to more effectively read tags of fish present in the pool. During the 2011 season, 334 additional PIT tags were placed in coho and Chinook (steelhead were excluded during the second season). In addition to these tags, 423 coho were tagged by collaborating Karuk biologists in the pool habitat. Due to altered antenna placement, these fish were recorded over 80,000 times by the array between August and October. Gut contents were measured from 164 coho and Chinook using gastric lavage, and drift invertebrate density was measured with 67 samples using drift nets at three locations at two different times of day. As in the previous season, water temperature was monitored hourly on a 24 hour basis using a grid of 50 temperature loggers in 3 different sites as before. During twice daily snorkel surveys, we observed the feeding rates of 331 coho and Chinook.

Data has been collected from several agencies in the Klamath River basin and has been formatted for analysis. Non-parametric tests have shown a significant difference in food availability between the pool habitat and the mainstem mixing zone, and there appears to be an interaction with time of day. The altered placement of the antennas in the pool allowed for a better ability to record movement between sites, and a multinomial model is being constructed to test for the effects of several predictor variables. The multinomial model has been mostly constructed in R, and has been test run with some success on subsets of the data. Currently work is being done to de-bug the R code for the multinomial model as well as to use more non-parametric tests (Wilcoxon and Kruskal-Wallace) to test for feeding differences between species, locations, and times of day/temperatures. Future work will be directed toward the reporting of these analyses once they have been completed.

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 Trout, INC. ($10,000)

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. This research continues the effort, to evaluate habitat use, movement, and reach-specific survival of the 2010 cohort. Research constitutes the master's thesis research of Chris Adams. Results will be used in evaluating recent restoration activities and guiding those of the future.

Specific objectives of the research are to:

1) identify areas where juvenile coho salmon are rearing;

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

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.

To date, approximately 500 juvenile coho were captured and PIT tagged in the upper Shasta River in the spring and summer of 2011. In addition, approximately 250 juvenile coho were captured and tagged at the Shasta River/Klamath River confluence. About fifteen remote PIT tag detection stations have been in operation at key locations throughout the watershed for the duration of the study, and a portion of tagged individuals have been physically recaptured throughout the study for growth analysis. Temperature loggers were deployed and downloaded on a biweekly basis throughout the study. Periodic field notes summarizing detection data have been distributed to a number of involved of agencies, stakeholders, and land owners. Data base structure and organization has been refined, and queries have been built for analysis of data, once the collection period is complete.

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
	Matthew Metheny, MS Student
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 use of a dual frequency identification sonar (DIDSON) imaging system to estimate escapement of adult salmon and steelhead in Redwood Creek. 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.

The DIDSON was installed in Redwood Creek in November 2011 and will be operated through June 2012. Data have not yet been analyzed for the 2011-2012 season. However, the DIDSON was operated almost continuously through late-February when a series of large storms forced us to retrieve the equipment for several periods. We anticipate being able to develop estimates of escapement for all four species from these data, although steelhead estimates may be hampered by late season flow events.

PRAIRIE CREEK SUB-BASIN LIFE CYCLE STUDIES

Investigators:	Dr. Walter Duffy, CACFWRU Tancy Moore, MS Student
Duration:	April 2011 to August 2014
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.

In 2011 we sampled to estimate smolt production, juvenile abundance and adult escapement. Sampling was conducted in cooperation with the Department of Fish and Game.

Location of the DMST was moved from mid-basin to the mouth of Prairie Creek and a screw trap was deployed rather than fyke nets. Population abundance of species passing the downstream migrant trap were: age 0+ coho salmon 654, age 1+ coho salmon 8,446, age 0+ Chinook salmon 15,031, age 1+ Chinook salmon 2, age 0+ trout 1,228, age 1+ steelhead 3,756, age 2+ steelhead 1,195 and coastal cutthroat trout 1,205.

MS student Tancy Moore lead the juvenile abundance sampling. In addition to sampling the upper reaches of Prairie and Lost Man creeks, she conducted sampling of lower Prairie Creek to gather preliminary data to be used in shaping her thesis research. Duffy lead the adult escapement surveys. Neither juvenile abundance nor escapement estimates are available at this writing.

GENETIC ANALYSIS OF TIDEWATER GOBY TISSUE SAMPLES (RWO 83)

Investigator:	Dr. Andrew P. Kinziger Conrad Newell, MS Student
Duration	May 2011 to May 2013
Funding	U.S. Fish & Wildlife Service ($73,004)

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*).

Progress to date includes field collection of genetic tissues from 721 tidewater goby from approximately 15 locations. All collections have been genotyped at nine microsatellite loci. Presently data are being prepared for analysis.

NEW RESEARCH PROJECTS REVIEW

ECOLOGY AND DISTRIBUTION OF COASTAL CUTTHROAT TROUT IN NORTHERN CALIFORNIA

Investigators: Dr. Peggy Wilzbach, CACFWRU
Dr. Walter Duffy, CACFWRU
2 MS students

Projected Duration: January 2013 to May 2017
Funding: California Department of Fish and Game

Coastal cutthroat trout (*Oncorhynchus clarki clarki*) (CCT) are an integral part of the native salmonid heritage in California and an important component of the sport fishery, but they are the least studied of the anadromous salmonids. Because they are not commercially harvested, much of the information needed to manage the fish is often gathered only incidentally while sampling for other commercially caught Pacific salmon species. This often results in a lack of statistical power to make inferences regarding trends in populations. In addition, because juvenile CCT are sometimes morphologically indistinguishable from juvenile steelhead whose native range overlaps that of CCT, and because of difficulties in distinguishing among the different life-history forms that CCT can exhibit, even the scarce scientific literature on CCT may not be reliable.

The California Cooperative Fish and Wildlife Research Unit at Humboldt State University and the California Department of Fish and Game propose to engage in a collaborative research and monitoring program to address critical information needs for coastal cutthroat trout populations in northern California, including: a) better understanding of the life history complexity of CCT in major drainages of northern California, including the incidence of anadromous vs. other forms; and b) updated information on distribution and abundance.

Specific objectives of this anticipated 4-yr study include:

1) ***Existing information:*** We will compile and synthesize available information on the distribution and abundance of coastal cutthroat trout from watersheds which have established full life-cycle salmonid monitoring programs in place, including the Freshwater Creek watershed which drains to Humboldt Bay, and the Prairie Creek/Redwood Creek basin.

2) ***Smith River:*** We will assess the spatial distribution and abundance of coastal cutthroat trout in the Smith River watershed. The Smith River is considered to be California's most important producer of coastal cutthroat trout. The exceptionally clear water of the undammed Smith River has enabled fish censusing by underwater observation, and a census led by the Smith River Alliance has been ongoing for a decade. It is qualitative in nature, however, and increased precision in estimates could be made with some changes in

methodologies, including protocols to enable estimation of observer efficiency. We will work with the Smith River Alliance and Department of Fish and Game to improve the statistical rigor of their annual volunteer-based survey of adult cutthroat trout and salmon and spatially extend the survey to the lower river that has not in the past been surveyed.

3) ***Estuaries:*** We will initiate an adult coastal cutthroat trout sampling program within the Klamath River and Smith River estuaries to collect a set of otoliths for analysis of life history information. We propose to use ololith microchemistry (strontium isotope ratios) to identify the relative contribution of differing life histories (anadromous, potadromous, freshwater resident and estuarine resident) within these populations, which collectively make up about 50% of the coastal cutthroat trout numbers in northern California (Gerstung 1996). As well, to the extent that sub-basins differ in geological signatures, otolith analysis may also be used to identify the sub-basin of origin for these individuals.

In the Smith River Estuary, we will also deploy PIT tags in adult coastal cutthroat trout to provide information on their migration through the watershed. A limited number of remote PIT tag antenna will be operated by the Department of Fish and Game that will provide information on segments of the watershed being used by coastal cutthroat trout as well as migration timing.

4) ***Lagoons:*** We will initiate a sampling program to establish population sizes of coastal cutthroat trout in coastal lagoons, including the Lake Earl/Lake Talawa complex, Stone Lagoon and Big Lagoon. This program will include a Department of Fish and Game lead creel survey of anglers to assess fishing pressure and rate of harvest on these lagoons.

EFFECTS OF RIPARIAN CANOPY OPENING ON AQUATIC PRODUCTIVITY

Investigators:	Dr. Peggy Wilzbach, CACFWRU Drs. Bret Harvey and Gordon Reeves, USFS Dr. Lee Benda, Earth Systems Institute Dr. Lowell Diller and Mr. Matt House, Green Diamond Resource Company
Duration:	June 2012 – May 2015
Funding:	Green Diamond Resource Company

Current management prescriptions to protect or restore health of aquatic ecosystems from timber harvest impacts are premised on a view that aquatic biological resources require continuous buffers of unbroken mature and late seral riparian forests. While riparian canopy closure may restore streams with cold water temperatures and high levels of large wood, reduction in light to the stream may diminish aquatic production. Previous studies of the investigators and others have established that small-scale (100 m) canopy openings in forested 2nd and 3rd order streams increased primary and secondary production without adversely impacting stream temperature.

With initial seed money provided by Green Diamond Resource Company for what is envisioned as a long-term (5 yr.+) study, the investigators are planning to evaluate, at a sub-basin scale, the amount and spatial pattern of light gain which optimizes production of salmonid fishes, amphibians, and macroinvertebrates without sacrifice to the beneficial functions that riparian vegetation provides to stream and terrestrial ecosystems. The research will be conducted entirely on lands within Green Diamond ownership.

A two-stage study design will be employed to establish thresholds for potential adverse water quality effects at the stream reach scale before transitioning into the sub-basin level experiment. In the initial stage, the treatment and control areas will be alternating reaches of control intact unmodified riparian forests and treatment reaches of varying lengths and canopy removal within the Ah Pah Creek drainage. This study design will allow assessment of treatment effects on the response variables (i.e., growth and abundance of selected aquatic organisms) while evaluating potential adverse impacts to such as elevated water temperature and turbidity, and loss of future potential LWD recruitment. In addition, the manipulations of riparian forests will be designed to maximize increased sunlight reaching the stream while minimizing potential adverse impacts. To the maximum extent possible, canopy removal will occur on stable reaches with limited loss of future potential LWD recruitment. For example, treatment reaches will be located to avoid steep unstable stream banks and trees that are likely to recruit as LWD to the stream will not be removed. Particular sites to be selected for canopy opening will be guided by temperature modeling in GIS (NetMap program) of existing lidar data.

The first stage of the project, which is scheduled to begin in summer 2012, will be located in mainstem Ah Pah Creek, tributary to the Klamath River. While conducting the first stage of the experiment, which is expected to require at least two years to complete, pre-treatment data will be gathered for the selected sub-basins that will be included in the sub-basin level experiment. Overall experimental design will follow a standard before-after-control-impact (BACI) study design.

Once the study is launched, all commercially valuable trees felled in the treatment areas that can be recovered will be sold and the proceeds will go into a fund to support the study. With funds in hand, graduate students and other researchers will be recruited to participate in this unique opportunity to conduct large-scale and long-term experimental research.

Careful placement of canopy openings may increase aquatic productivity without damaging the protective functions of stream riparian zones.

STRATEGIC PLANNING FOR RESTORATION OF THE UPPER KLAMATH RIVER BASIN UNDER CLIMATIC UNCERTAINTY

Investigators:	Dr. Walt Duffy, CACFWRU Dr. Mazdak Arabi, Colorado State University, Engineering Dr. Steve Fassnacht, Colorado State University, Natural Resources PhD Student, Rosemary Records, CSU MS Student (TBD)
Duration:	July 2012 – June 2014
Funding:	U.S. Geological Survey, Northwest Climate Science Center

Water quality and quantity in the Upper Klamath River Basin (UKRB) of southern Oregon are of critical importance to agriculture, Native American tribes, and the viability of threatened and endangered fish populations. Upper Klamath Lake (UKL) is a large, shallow lake which receives approximately half of its inflow from the three main tributaries, the Sprague, Williamson, and Wood rivers. The lake's current hypereutrophic condition is hypothesized to be driven by agricultural conversion and wetland drainage in the UKRB.

Poor water quality conditions in UKL have been implicated in mortality of federally listed and culturally important sucker species. Furthermore, with UKL situated near the headwaters of the Klamath River, its water quality has a negative effect on the entire downstream Klamath Basin ecosystem, including the recovery of federally listed coho salmon, as well as use of the river by Native Americans, domestic water users and recreationists. Water quantity, particularly seasonal availability of stream discharge and minimum stream flows, are among other important management considerations. The Klamath Basin Restoration Agreement (KBRA) identifies the need to provide 30,000 acre feet of water for irrigation and environmental flows. Stakeholders in UKRB have identified an improved understanding of the potential of wetland restoration and best management practices to reduce nutrient loading to UKL as a priority science need. They also recognize the need to understand the influence of climate and restoration on ecological processes within the Klamath Basin (see Documentation of Management Relevance).

Objectives: The need to improve water quality, while balancing water availability and demand within socioeconomic constraints argues for watershed-scale management in the UKRB. Future conditions for regional climatic drivers in the UKRB are uncertain. However, under a given set of climatic conditions, a unique set of cost-effective watershed management options can be identified that minimize vulnerability of water resources and costs (Pareto-optimal solutions). We propose to identify the optimal type, extent and landscape position of restored wetlands and best management practices in the Sprague, Williamson, and Wood river basins that minimize nutrient export to the UKL and maximize water availability while minimizing implementation costs under present and future climatic conditions. We also propose to elucidate UKRB watershed-scale management options that will be resilient under future climatic scenario.

FUNCTIONAL ASSESSMENT OF RIPARIAN/WETLAND COMMUNITIES IN THE WHISKEYTOWN NATIONAL RECREATIONAL AREA

Investigators: Dr. Walt Duffy, CACFWRU
Dr. Sharon Kahara, Wildlife Department
MS Student (TBD)

Duration: September 2012 – August 2014
Funding: National Park Service

Whiskeytown National Recreation Area consists of Whiskeytown Lake and 39,000 acres surrounding the lake that support a diverse assemblage of wetland and riparian habitats. Little information currently exists for management is available concerning the distribution, condition, or trend of wetlands in these three national park units. Existing wetland information is currently limited to National Wetland Inventory (NWI) maps derived from coarse-scale 1980's aerial photographs. These maps typically overlook scattered small wetlands such as vernal hillside seeps that are among the most vulnerable to impacts. Moreover, these maps provide no information on condition of wetlands in the parks. Wetlands in the parks are immediately vulnerable to a range of cumulative impacts, including non-native species invasions, air-borne or water-borne pollutants, hydrologic alterations, and excess visitor use. This project will address these information needs and threats by assessing condition and function in a priority-based probabilistic sample of wetlands in the three parks.

Objectives of this project will be to provide:

(1) corrections and additions to existing NWI maps,

(2) management recommendations specific to individual wetlands in the park,

(3) strategies for addressing larger scale wetland conservation issues (e.g., non-native species),

(4) a quantitative baseline essential for future monitoring of wetland condition,

(5) classifications of wetland site potential, and

(6) location of degraded wetlands in need of restoration.

The synthesis of information proposed in this project will help managers take a strategic rather than reactive approach to mitigating threats to park wetlands, and to better determine the spatial and temporal scales at which to attack the problem(s).

EVALUATING GRASSLAND AND WETLAND ECOSYSTEMS IN THE NORTHERN GREAT PLAINS

(RWO 85)

Investigators:	Dr. Walt Duffy, CACFWRU Dr. Matt Johnson, Wildlife Department Dr. Ned Euliss, Wildlife Department/USGS MS Student, Russ Bryant MS Student (TBD)
Duration:	September 2011 – December 2016
Funding:	U.S. Geological Survey

The U.S. Geological Survey (USGS), Northern Prairie Wildlife Research Center (NPWRC) is engaged in an on-going research effort to better understand grassland, wetland, and riverine ecosystems and their associated biotic communities in the northern Great Plains (NGP). NPWRC's research programs specifically focus on identifying and understanding threats to NGP ecosystems and developing and evaluating conservation measures that abate those threats. The first phase of this research will investigate native bee pollinators, land use and agricultural pesticides.

It is widely known but often ignored that pollinators are critical to sustain healthy ecosystems and prosperous human populations. However, a report on the Status of Pollinators in North America, combined with intense media coverage of honey bee colony collapses beginning in 2006, sparked a renewed and widespread interest in the role of honey and native bees in the pollination of agricultural crops, maintaining functioning ecosystems and enhancing biodiversity. Additionally, a recent report demonstrates that the need for pollination is on the increase at the same time that pollinator numbers and insect pollinated plants are declining. Agricultural practices, urban development, and fallow land-use practices have disrupted habitat for bees, both in terms of essential nutrition provided by forage and nesting sites, especially for native bees. Pesticides are a concomitant problem that can have detrimental effects on bees when they forage on contaminated flowers. Healthy pollinator populations depend on landscapes that provide ample and nutritious sources of non-contaminated pollen and nectar-yielding flowers. However, no field studies have quantified the availability of specific flowers or cover types across the landscape or the influence these factors have on the health of thousands of native pollinators.

Objectives for this first phase of research are:

1. Evaluate and compare abundance and diversity of native pollinators within native prairie FWS lands and CRP lands.

2. Document foraging behavior, vegetation visited, and the pollen diet of native pollinator species.

3. Document the seasonal changes in the vegetation community and pollinator populations.

4. Evaluate risk from agrichemical contamination of pollen on native prairie FWS lands and CRP lands.

UNIT PROGRAM REVIEW

PROGRAM DIRECTION

Statistical support for graduate students has become available with the hire of Dr. Nicholas Som, a statistician from U.S. Fish & Wildlife Service. Dr. Som also joined the Cooperative Unit in September 2011 as an affiliated scientist.

Leslie went to USGS headquarters last May for training in policies and procedures.

Funding from the national CRU program was reduced to $8,000 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: 2 recirculating artificial flumes for hydrological studies, each measuring approx. 3 m x 1 m x 0.4 m, with adjustable 125 W motor for changing water velocities. Flumes are housed in Environmental Engineering.

UNIVERSITY SERVICE AND TEACHING

Courses Taught

Restoration Ecology of Riverine Fish (3 units)	Duffy	Spring 2012
Ecology of Running Waters (3 units)	Wilzbach	Fall 2011

Graduate Student Major Advisor

Duffy	Philip Colombano – MS Fisheries, Humboldt State University
	Brian Poxon – 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
	Tancy Moore - MS Fisheries, Humboldt State University
Wilzbach	Chris Adams – MS Fisheries, Humboldt State University
	Mark Ashenfelter – MS Fisheries, Humboldt State University
	Christopher "Olie" Smith – MS Fisheries, Humboldt State University
	David Malakauskas – PhD Entomology, Michigan 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
	Rosemary Records – PhD Geosciences, Colorado State University
Som	Tancy Moore - MS Fisheries, Humboldt State University
Wilzbach	Shari Anderson – MS Fisheries, Humboldt State University
	Scott Benson – MS Fisheries, Humboldt State University
	Josh Fuller – MS Fisheries, Humboldt State University
	Michelle Gledhill – MS Mathematics, Humboldt State University
	Jeffrey Hayes – MS Forestry, Humboldt State University
	Meiling Roddam – MS Fisheries, Humboldt State University
	William Youmans – MS Fisheries, Humboldt State University
	Steven Zipper – MS Fisheries, Humboldt State University

OTHER UNIVERSITY SERVICE

Duffy Co-Taught MOCC boat training course to nine HSU students and staff

Wilzbach Chair, Tuition Waiver Committee, College of Natural Resources and Sciences, Humboldt State University, 2007 to present

Member, Graduate Advisory Council

Member, IACUC Committee

THESES OF UNIT-SPONSORED GRADUATE STUDENTS

Ashenfelter, M.J. 2012. Movement of resident rainbow trout (*Oncorhynchus mykiss*) transplanted below barriers to anadromy in Freshwater Creek, California. M.S. Thesis, Humboldt State University, Arcata, CA.

Groff, L. A. 2011. 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 University, Arcata, CA. 41 pp.

Pittman, R.G. 2011. Minimum stream length requirements for McCloud River redband trout (*Oncorhynchus mykiss spp*) in Trout and Tate creeks, Siskiyou County, California. M.S. Thesis, Humboldt State University, Arcata, CA. 56 pp.

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

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

California Resources Agency, member Advisory Group, California Fish & Wildlife Strategic Vision: Recommendations for Enhancing the State's Fish and Wildlife Management Agencies.

Trinity River Restoration Program, peer reviewer of proposals submitted to program.

US EPA, member of team assembled to review wet meadow wetland rapid assessment protocols.

Wilzbach USFWS/NMFS/CDFG/Oregon St Univ/Humboldt State University, serves as a member of the multi- party Klamath River fish health planning committee to evaluate research needs for developing disease management strategies.

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

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

SCIENTIFIC PUBLICATIONS

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).

Wilzbach, M.A., M.J. Ashenfelter, and S. Ricker. 2012 Movement of resident rainbow trout transplanted below a barrier to anadromy. *Transactions of the American Fisheries Society, 141:294-304.*

Moore, J.W., Hayes, S.A., Duffy, W.G., Gallagher, S., Michel, C.J., and Wright, D. 2011. Nutrient fluxes and the recent collapse of coastal California salmon populations. Canadian Journal of Fisheries, 68:1161-1170.

Thorsteinson, L., VanderKooi, S., and Duffy, W., eds., 2011, Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010: U.S. Geological Survey Open-File Report 2011-1196, 312 p.

Thorsteinson, L., Grimes, C., and Duffy, W., 2011, An overview of the Klamath Basin Science Conference, Pages 1-30 *in*: Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010: U.S. Geological Survey Open-File Report 2011-1196, 312 p.

Stanford, J., Duffy, W., Asarian, E., Cluer, B., Detrich, P., Eberle, L., Edmondson, S., Foott, S., Hampton, M., Kann, J., Malone, K., and Moyle, P., 2011, Conceptual Model for Restoration of the Klamath River, Pages 151-184 *in*: An overview of the Klamath Basin Science Conference, Pages 1-30 *in*: Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010: U.S. Geological Survey Open-File Report 2011-1196, 312 p.

Duffy, W. and Thorsteinson, L., 2011, Synthesis of information needs and science priorities, Pages 185-198 *in*: Proceedings of the Klamath Basin Science Conference, Medford, Oregon, February 1–5, 2010: U.S. Geological Survey Open-File Report 2011-1196, 312 p.

Duffy, W., Kahara, S. and Records, R., eds., 2011. Conservation effects assessment project—wetlands assessment in California's Central Valley and Upper Klamath River Basin. Open-File Report 2011-1290, U.S. Geological Survey, Reston, VA, 128 p.

Groff, L.A., Duffy, W.G., Kahara, S.N. and Chapin, S.J. Temporally irregular breeding of western spadefoot toads (*Spea hammondii*) in managed wetlands. Northwestern Naturalist (in press).

PAPERS PRESENTED

Hodge, B., P. Wilzbach, and W. Duffy. The steelhead half-pounder life history: paradox or hedge bet? Western Division American Fisheries Society, Mar 29, 2012, Jackson, WY.

Malakauskas, D., S. Willson, M.A. Wilzbach, and N. Som. Effect of flow manipulation on polychaete dislodgement in a laboratory flume. Klamath River Fish Disease Workgroup, Mar 27, 2012, Klamath Falls, OR.

Records, R., W. Duffy and S. Kahara. Soil and nutrient runoff modeling in the Sprague River, Oregon using Soil and the Water Assessment Tool (SWAT). Soil and Water Conservation Society, June 15, 2012, Washington, DC.

Duffy, W.G. Current population status of coho salmon in Northern California. California Assembly and Senate, Joint Committee on Fisheries and Aquaculture, August 16, 2011, Sacramento, CA.

Duffy, W. G., E. P. Bjorkstedt, and C. S. Ellings. Predation on juvenile salmon (*Oncorhynchus* spp.) in downstream migrant traps in Prairie Creek, California. Annual Meeting of the American Fisheries Society, September 6, 2011, Seattle, WA.

UNIT STAFF

Walter Duffy, Unit leader
Peggy Wilzbach, Assistant Unit Leader
Leslie Farrar, Unit Administrative Support

Research Associates and Cooperators
Sharon Kahara
Nick Som, Affiliate Scientist
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Rosemary Records, PhD, CSU
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Student Technicians
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