# California Cooperative Fish & Wildlife Research Unit

Lost Man Creek, Humboldt County, California

## 2016 Coordinating Meeting

May 10, 2016

Humboldt State University

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# California Cooperative Fish & Wildlife Research Unit
# 2016 Coordinating Meeting

**May 10, 2016**
**Humboldt State University, BSSB room 508**

## AGENDA

**Introductions and Welcome** (Chair, Joe Margraf).....8:30

Additions to the Agenda

Approval of 2015 Meeting Minutes

**Unit Program Review**.....8:45

Financial Status, including discussion of Coop support from CDFW

Program Direction

University Service and Technical Assistance

Accomplishments

Facilities and Equipment

**Unit Research Summary** .....9:30

Completed Projects Review

Current Research Projects Review

New Research Projects

**Cooperator Reports and Research Needs** .....10:30

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.

**Adjourn**.....12:30

**Executive Session**

Optional meeting of voting representatives in absence of Coop Staff.

# California Cooperative Fish & Wildlife Research Unit
# 2015 Coordinating Committee Meeting Minutes
# Tuesday, May 5, 2015

The annual coordinating meeting was held at Humboldt State University, 1 Harpst Street, Arcata, California. The meeting began at 9:05 am and concluded at 3:30 pm.

In attendance:

Philip Bairrington, CDFW, Arcata

Russ Bellmer, CDFW, Sacramento

John Diebner-Hanson, CA Cooperative Fish & Wildlife Research Unit

Leslie Farrar, CA Cooperative Fish & Wildlife Research Unit

Micaela Szykman Gunther, HSU, Wildlife Department

Nick Hetrick, USFWS, Arcata

Andrew Kinziger, HSU, Fisheries Department

Tony LaBanca, CDFW, Arcata

Joe Margraf, USGS Western Region Cooperative Research Units Program

Scott Osborn, CDFW, Sacramento

Chris Smith, Wildlife Management Institute

Steven Smith, HSU, CNRS

Nick Som, USFWS, Arcata

Peggy Wilzbach, CA Cooperative Fish & Wildlife Research Unit

Rick Zechman, HSU, CNRS

Joe Margraf served as chair and opened the meeting. Introductions were made. The agenda was reviewed with no changes suggested. Minutes of the 2014 meeting were reviewed and approved with no additions or changes.

**COOPERATOR REPORTS**

Report from Andrew Kinziger, HSU-Fisheries Department

- The Assistant Unit Leader position has been approved and has been posted to USA Jobs. The university will advertise broadly through their network of affiliates and will circulate specifics and a link to the posting ASAP.

- The department is in transition at the moment. Dave Hankin will retire at the end of this semester and two senior faculty members enrolled in the early retirement program, Kristine Brenneman and Tim Mulligan, plan to fully retire in 2017. The department has hired Andre Buchheister as a quantitative fisheries scientist, who is currently employed as a postdoc at Chesapeake Biological Laboratory at University of Maryland. Andre will start with the university in January 2016. Rafael Cuevas-Uribe was hired last year, and brings aquaculture expertise to the department.

- Fisheries is currently in a five year review process and is seeking agency input regarding strategic plan and direction. The department currently has about 90 majors and could increase enrollment to 110 – 120. The current count is three full time faculty with four listed in the fall 2015 catalog.

- Nick Som has provided excellent service in teaching a Modern Statistical Modeling course dual listed for undergraduates and graduate students that is applicable to the major.

Report from Micaela Szykman Gunther, HSU – Wildlife Department

- In the past nine years since Micaela has been in the department, the Wildlife program has grown to 450 majors, doubling in size. No faculty lines were added during this enrollment growth. A new tenure track position in conservation biology has been approved for next year with a start date of 2016, bringing the total faculty count to eight, which is an historical high. Last year's hires of Tim Bean and Daniel Barton have increased activity in the department with additional grad students and proposals being submitted. The program has imposed impaction in which higher standards for admission have been implemented. Two tracks are available to students: applied (two-thirds of students choose this track) and conservation ecology (one-third).

- The Wildlife Department solicits support for the addition of a 3rd Coop Unit position, to be filled by a large game wildlife biologist. This would assist in meeting information needs of local agencies.

Report from Steve Smith, HSU-CNRS

- HSU's new president, Lisa Rossbacher, started July 2014. She has led the campus through a strategic planning process which is coming to a close. The university operated with an interim provost for the past year. The provost search failed to produce a new hire, but a new search is underway with a planned start January 2016.

- Enrollment has flattened this past year within the College of Natural Resources and Sciences. The flattening was intended, as the program cannot continue to grow without

new base funding. Flattening has been achieved by implementing impaction within the Departments of Wildlife, Biology, Botany, and Zoology. These programs are still too large with impaction, and need to be further reduced because of constraints imposed by space and course offerings. To date, impaction has not affected diversity of the student body in CNRS programs. Several other CSU campuses exercise impaction for specific programs.

Report from Nick Som, USFWS, Arcata

- David "Randy" Stewart, post-doc position, will start mid-June. He is currently a post-doc at the Wyoming Cooperative Unit. He will have an association with USFWS and the Coop Unit working on salmonid modeling in the Klamath River. His skillset complements those of the rest of the team which is working on the model.

Report from Nick Hetrick, USFWS, Arcata

- Nick Som has increased his involvement with the university and is teaching an HSU course this semester in modern statistical modeling, as well as serving on graduate student committees and providing students with statistical guidance. Nick's service is consistent with the long-term plan of the USFWS for greater involvement with the university community, which could include graduate student supervision in the future.

- Wildlife interests of the USFWS are well represented by Bruce Bingham, field supervisor for wildlife. Bingham was unable to attend today and plans to attend next year's meeting.

- Program funds for the Klamath are largely allocated to the Trinity and Eel River Basins. The Service is involved in the Trinity River Restoration Program which is undergoing transition. A flow release will occur soon to relieve drought conditions. Klamath juvenile fish health issues have emerged recently. Latest research indicates that 35% of the juvenile fish are infected with C. shasta; as drought conditions continue, 100% of the population is expected to be infected. This level of disease severity hasn't been seen since 2005. The Klamath Basin Regional Agreement (KBRA) is still in committee, but if this is passed there may be many opportunities for the university to work on monitoring restoration and research.

- The search for a new facility for the Arcata office is continuing with possibility of relocating to an HSU- owned building on Samoa Blvd. which is attractive to the service.

- Pacific lamprey initiative, Northcoast Implementation Plan, has been implemented to remove passage barriers and retrofit existing fishways at low head hydropower facilities to be lamprey-friendly. Staff are working with CDFW in developing protocols using the Van Arsdale as a template. The initiative may bring more research opportunities for the university as well.

Report from Russ Bellmer, CDFW-Sacramento

- The Fisheries Restoration Grant Program (FRGP) grant process closed March 30 and is now in internal review.

- CDFW no longer participates in the Council on Ocean Affairs, Science and Technology (COAST) internship program (see: http://www.calstate.edu/coast/about/).
- Brochure was distributed: California Coastal Monitoring Program for Salmon and Steelhead. Specifics on drought related issues can be found at www.wildlife.ca.gov/drought.
- CDFW is putting together a priority list for research from within the department for fisheries and also wildlife division, which will be provided to the Coop Unit.
- A workshop for practitioners on use of ARIS, the next generation of sonar imaging technology, for enumeration of returning adult salmon, is being planned for fall 2015. Location of the meeting has not yet been established.
- The Coho Help Act allows individuals and entities to request approval from the CDFW for Coho Salmon enhancement projects in lieu of other permits the project proponent would otherwise need to obtain. Once a project is approved, no further permitting required. CDFW is also introducing a voluntary drought initiative to protect sturgeon.
- The scientific permit process is being revisited with website set up for comments and suggestions. A formal review will follow with plans for the new law to be in place by January 2016. Discussion ensued regarding cost and time delays for students.

Report from Philip Bairrington, CDFW - Arcata

- Coastal projects are well established and going well including database management. Mad River Hatchery Monitoring Plan has been submitted to NOAA for processing; review will be over September 2015. Arcata office hires many HSU students for field work.
- ARIS, the updated DIDSON, has been deployed on the Mad River for 12 months resulting in great data. The resolution is 8x greater than DIDSON. It may not be able to deploy during drought conditions. The need for access to CDFW database by the university and other entities engaged in collaborative research projects with the Department is acknowledged.

Report from Scott Osborn, CDFW - Sacramento

- The drought may present an additional funding stream from the wildlife program of the Department to support Coop Unit-based research; opportunities are being explored.

Report from Chris Smith, Wildlife Management Institute

- This is the first time that a representative from the Wildlife Management Institute (WMI) has been able to attend our annual cooperator's meeting. WMI works specifically with the Wildlife part of Cooperative Units and promotes those units within the system. It is instrumental in supporting new chief and deputy chief of Cooperative Unit Program and now that those hires have been made, is collaborating with the National Cooperative Coalition focusing on lobbying congress for federal appropriations which will allow the program to expand. This could result in an additional Wildlife position

with this unit or filling vacant unit and assistant unit leaders in other units. WMI has ability to lobby at state as well federal levels. It works with Landscape Conservation Cooperatives (LCC) and is trying to make connections between the research needs of the LCC's and the Cooperative Units. Funding is available to support fish as well as wildlife research within this program.

Report from Joe Margraf, USGS

- Budget remains stagnant which influences ability to hire and to fill vacancies. Sequestration resulted in an 8% cut and a budget has not been passed, remaining at status quo. Vacancy rate is around 27 currently which represents about 25% of work force. Operating expenses have not been provided to the units since 2012 – 2013. The only funds available are for mandated safety obligations.

- New chief, John Organ, was hired in August 2014 and deputy chief, John Thompson in September.

- The Assistant Unit Leader position was posted to USA Jobs last week as a federal employee only option. This will be corrected to open to all U.S. citizens at headquarters. The position will be open for 45 days after which time HR at headquarters will review for minimum qualifications and files from the applicant pool will be released to cooperators possibly by August. University and state cooperators may advertise the position in professional journals or job boards, at their own expense. The whole process usually has a six month window. Discussion followed regarding logistics of the hire from reviewing applications, interviews, relocation etc. Responsibility for the review, interview, logistics and selection of candidates is under the control of the voting Cooperators.

- Confirmation was given that the unit is a Fish and Wildlife Research Unit.

- Margraf will assume Presidency of the American Fisheries Society in 2016.

**Review of current, completed projects and review of new projects**

Due to time constraints, current and completed projects were not reviewed. Peggy Wilzbach introduced nine new research projects to be approved:

New project review:

1. Research and development in support of the Klamath Basin Stream Salmonid Simulator S3 Model (RWO 88)
2. Eel River monitoring plan
3. Redwood Creek DIDSON adult steelhead monitoring 2016-2018
4. Redwood Creek DIDSON adult Coho Salmon monitoring 2016-2020
5. Lower Redwood Creek salmonid smolt abundance 2017
6. Prairie Creek Coho Salmon 2015-2019
7. Townsend's Big Eared Bat statewide assessment
8. Rangewide Giant Kangaroo Rat surveys
9. Characterizing the diet of Marbled Murrelets with next generation sequencing

Joe Margraf nominated to approve the projects unanimously as described. All approved.

**UNIT RESEARCH SUMMARY**

John Dieber-Hanson, Fisheries Biology master's student, presented on "Effects of large woody debris and low-velocity rearing habitat on overwinter survival and movement of juvenile Coho Salmon (*Oncorhynchus Kisutch*) in coastal northern California streams" a portion of his research in preparation for his master's thesis project.

Peggy was appointed Unit Leader and priority consideration was extended to the California Unit to authorize the recruitment of an Assistant Unit Leader.

**2015 ANNUAL COORDINATING MEETING**

Next year's meeting was set for Tuesday, May 10, 2016 via email after the meeting.

**CLOSING**

A call was made and approved to adjourn the meeting. The meeting adjourned at 3:30 pm.., and an executive session followed immediately afterward.

# REVIEW OF PROJECTS COMPLETED IN 2015

## ASSESSING THE BENEFITS OF USDA CONSERVATION PROGRAMS IN THE UPPER KLAMATH RIVER BASIN & CENTRAL VALLEY OF CALIFORNIA ON ECOSYSTEM SERVICES (RWO 84)

| | |
|---|---|
| Investigator: | Dr. Sharon Kahara, HSU Wildlife Department |
| | Dr. Mazdak Arabi and Ms. Rosemary Records, Colorado St University |
| Duration: | September 2011 to June 2015 |
| Funding: | USDA, Natural Resources Conservation Service ($212,264) |

Heavy wetland losses in the Upper Klamath River Basin (UKRB) and Central Valley of California (CVC) have impacted ecosystem services. In the UKRB of southern Oregon, wetland losses have contributed to poor water quality in Upper Klamath Lake. The Lake's water quality conditions result in kills and low juvenile recruitment of endangered fish species, the Lost River sucker and shortnose sucker. Wetland restoration through programs such as the Wetlands Reserve Program (WRP) is considered important for reducing nutrient and sediment loads to Upper Klamath Lake and thus improving lake water quality. Climate change in the mid-21st century in the Upper Klamath Basin could result in changes in streamflow amount and timing. Streamflow and climatic changes could also influence wetland extent by altering evaporation, precipitation and flooding patterns.

We used a watershed model calibrated for the Sprague River, one of three main tributaries to Upper Klamath Lake, to assess historic water quality benefits of wetlands, and potential future changes to flow, sediment, and nutrients under future climate and hypothetical wetland losses. Our findings suggested that at the outlet of the Sprague River watershed (1) present-day wetlands and riparian zones have reduced nutrient loading by 27% and sediment by 9%; (2) mid-21st century nutrient loads could increase significantly during the wet season, or be similar to historic conditions; (3) the combined impact of climate change and wetland losses on nutrient loads could be large, even if the effects of climate alone are small; (4) in-stream total phosphorus (TP) concentrations from hypothetical wetland losses under future climate would increase most during large floods; and (5) hypothetical loss of riparian wetlands in both headwaters and lowlands could increase outlet TP loads by a similar amount under future climate, but these increases would likely occur for distinct reasons.

In the CVC, restored wetlands are believed to provide many of the ecosystem services lost when wetlands were drained for agriculture and urban development. While intensively managed restored wetlands and flooded croplands of the CVC undoubtedly support millions of wintering waterfowl and waterbirds, benefits to non-target wildlife during other times of the year are less clear. Multi-year droughts are expected to occur more frequently in the CVC, potentially impacting water availability for wetland management. We conducted 640 bird surveys on restored wetlands experiencing varying levels of management in the summers of 2008 and 2009. Greater than 91,000 individual migratory and resident birds representing 193 species and 10 foraging guilds were recorded. Unlike in the fall and winter months, management intensity was not the primary determinant of avian occupancy or diversity in the summer. Results indicated that wetland area, vegetation zone complexity, proportion of

shallow emergent vegetation, proportion of deep emergent vegetation and adjacent grain crops all positively influenced occupancy by most avian guilds.

We also modelled habitat quality for waterfowl, shorebirds and upland birds in the CVC. Our models indicated that most bird habitat lies in northern CVC in the Sacramento subbasin. However, the northern CVC is also prone to significant fluctuations in habitat availability, particularly for wetland dependent waterfowl and shorebirds. Wetlands Reserve Program easements supported approximately 1% of waterfowl habitat, 0.7% of shorebird habitat and 1.3% of upland bird habitat in the CVC between 2007 and 2014.

Products:

Records, R.M., M. Arabi, S.R. Fassnacht, and R.T. Bailey. Watershed-scale modeling of riparian biogeochemistry: a hydrologic connectivity framework. Oral presentation, AGU-Hydrology Days Conference, Colorado State University. Fort Collins, 2015.

Records, R.M., S. Fassnacht, M. Arabi, and W.G. Duffy. Hydroclimatic and landscape controls on phosphorus loads to hypereutrophic Upper Klamath Lake, Oregon, U.S. Poster presentation, Annual Meeting of the American Geophysical Union, San Francisco, California. December 2014.

Records, R. M. 2013. Water quality benefits of wetlands under historic and potential future climate in the Sprague River watershed, Oregon. M.S. Thesis, department of Geosciences, Colorado State University. Fort Collins, Co.

Records, R.M., M. Arabi, S.R. Fassnacht, W.G. Duffy, M. Ahmadi, and K.C. Hegewisch. 2014. Climate change and wetland loss impacts on a western river's water quality. Hydrology and Earth Systems Sciences 18:45009-4527, doi:10.5194/hess-18-4509-2014.

***Pasture in the Wood River watershed adjoining the Sprague River watershed.***

**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 |
| | Russ Bryant, MS Student |
| Duration: | September 2011 – December 2015 |
| Funding: | U.S. Geological Survey ($195,000) |

***Bee pollinating the prairie wildflower Anise Hyssop.***

Pollinators are critical for the proper functioning of natural ecosystems and they benefit or are required by many agricultural crops. Despite their importance, little information is available to enhance restoration efforts or manage habitats to benefit pollinators, especially for native species. This study described abundance, richness, and diet breadth of native invertebrate pollinators in native and restored prairie grasslands in the Prairie Pothole Region of eastern North Dakota. Native pollinator assemblages were compared between native grasslands managed by the US Fish and Wildlife Service and restored grasslands within the Conservation Reserve Program. Together these grasslands compose the largest land area of potential pollinator habitat in the U.S. Prairie Pothole Region. Species abundance, richness, and pollinator/plant interactions were monitored biweekly from May to September in 2012 and 2013 using vane traps and trapping of pollinators visiting individual flowers. Differences in native pollinator abundance or richness between native and restored prairie grasslands were not detected. However, abundance decreased and species turnover was higher in the restored grasslands relative to native grassland sites in 2013. Pollinator/plant interactions and numbers of unique linkages were higher in native grasslands, reflecting a higher diversity of blooming forbs. Analyses suggested that restored grasslands within the Conservation Reserve Program may not be as effective as are native grasslands at providing stable pollinator habitat. Pollen loads of individual pollinators were analyzed to identify plant species (n=53) that could be added to seed mixtures to diversity native and restored sites for pollinators.

Products:

Bryant, R.B. 2015. An assessment of the native invertebrate pollinator community and floral sources in grasslands of eastern North Dakota. M.S. thesis, College of Natural Resources and Sciences, Humboldt State University.

**ASYMMETRIC INTROGRESSION BETWEEN COASTAL CUTTHROAT TROUT AND STEELHEAD IN THE SMITH RIVER BASIN, CALIFORNIA**

Investigators: Dr. Margaret Wilzbach, CACFWRU
Sam Rizza, MS Student
Duration: Jan 2013 to May 2015
Funding: California Department of Fish and Wildlife/Heritage and Wild Trout

Introgression between sympatric Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*, CCT) and steelhead (*Oncorhynchus mykiss irideus*, SH) was assessed from 7 sub-basins of the Smith River in northern California. Population, individual and genomic level introgression was determined using a panel of 65 diagnostic single nucleotide polymorphisms, of which 59 are mapped to 26 of 28 known linkage groups. Among hybrids, first-generation hybrids (F1s) were rare (2%) and the frequency of backcrosses was asymmetric, with backcrosses to SH infrequent (<1%), and backcrosses to CCT relatively common (17%). Mitochondrial DNA of 14 of 15 F1 hybrids was of steelhead origin, suggesting that hybridization was driven by sneak-mating of male CCT with female SH. Genomic clines analysis located nine loci across three known linkage groups that deviated from a neutral model of introgression. Genome-wide differential introgression was

***Putative Coastal Cutthroat Trout in the Smith River, California.***

documented along with non-random patterns of introgression among linkage groups. These findings suggest genomic blocks are inherited in recent CCT and SH hybrids and subsequently undergo decay as repeated rounds of recombination break up linkage group associations. Chromosome rearrangements known to suppress recombination are suspected in CCT and SH hybrids, and may preserve genomic regions fundamental to isolation. Analysis of geometric

morphometrics and phenotypic characteristics revealed distinct CCT and SH morphologies. However, first-generation hybrids and backcrosses expressed non-distinct morphologies that overlapped with parental types, creating challenges in visual field identification.

This project constituted the master's thesis research of Sam Rizza. Sam defended his thesis in June 2015.

Products:

Rizza, S. F. Asymmetric introgression among Coastal Cutthroat Trout and steelhead within the Smith River (CA) basin. Oral Presentation, 49th Annual Meeting California-Nevada Chapter, American Fisheries Society, Santa Cruz, California. April 2015.

Rizza, S.F. 2015. Asymmetric introgression between Coastal Cutthroat Trout and steelhead: variable introgression by linkage group. M.S. Thesis, College of Natural Resources and Sciences, Humboldt State University. 61 pg.

Rizza, S.F., A.P. Kinziger, J.C. Garza, and M.A. Wilzbach. Asymmetric introgression between Coastal Cutthroat Trout and steelhead in the Smith River Basin (CA). Annual Meeting American Fisheries Society, Portland, Oregon. August 2015.

## DISTRIBUTION AND RELATIVE ABUNDANCE OF JUVENILE COHO SALMON IN THE REDWOOD CREEK BASIN, HUMBOLDT COUNTY, CALIFORNIA

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Teri Moore, CDFW |
| Duration: | June 2013 to March 2016 |
| Funding: | California Department of Fish and Wildlife/FRGP ($48,866) |

*Juvenile Coho Salmon in Redwood Creek.*

Occupancy modeling was used to describe spatial structure during the summers of 2013 and 2014 of juvenile Coho Salmon in the Redwood Creek Basin in northwestern California. Modeling was based on underwater census each year of a spatially balanced, randomly selected reaches over approximately 50 km of stream. During both years, juvenile Coho Salmon were detected primarily in the lower section of Redwood Creek (22% of detections in 2014) and throughout the Prairie Creek sub-basin (77% of detections in 2014). Remaining detections were in the middle section of Redwood Creek, in locations either within or immediately downstream from tributaries with cooler water than the mainstem. During 2013, juvenile Coho Salmon occupied 39 percent of the sample frame area for Redwood Creek, with a 53% probability of being detected if present in a given sample pool. Median count per occupied pool was 14 fish. In 2014, juvenile Coho Salmon were more widely but less evenly distributed, and were generally more abundant in

core areas. Percent area occupied was 56%, the probability that a given reach was occupied was 80%, and median count per occupied pool was 14. Probability of detecting juvenile Coho Salmon if present in a given sample pool exceeded 90% in both years.

Spatial structure was also described from the same survey reaches for young of year Chinook Salmon, young of year and 1+trout, and Coastal Cutthroat Trout > 150 mm fork length. Reach-specific habitat attributes were summarized, including pool lengths, widths, and depths, cover rank and area, and counts of large woody debris per pool.

Products:

Moore, T.L. and M.A. Wilzbach. 2016. Distribution and relative abundance of juvenile Coho Salmon in the Redwood Creek Basin, Humboldt County, California. Final Report to the California Department of Fish and Wildlife Fisheries Restoration Grant Program, Project P1210320.

## COMPARISON OF BENTHIC INVERTEBRATE COMMUNITY STRUCTURE AND DIET COMPOSITION OF STEELHEAD (*Oncorhynchus mykiss*) IN DRY CREEK, CALIFORNIA

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Andrea Dockham, MS Student |
| Duration: | January 2013 – December 2015 |
| Funding: | Sonoma County Water Agency (student stipend) |

***Diet sampling using gastric lavage***

Dry Creek, located in Sonoma County, is a major producer of salmonids in the Russian River watershed because of its year round release of cold clear water from Warm Springs Dam. However, morphological changes associated with the dam, including channel incision, armoring of the streambed, high current velocities, and bank erosion, have reduced habitat availability for rearing fish and potentially, the community structure of benthic invertebrates. In this thesis project, the structure of benthic invertebrate assemblages and diets of juvenile steelhead were compared among four stream reaches differing in distance from the dam, with an expectation that differences in invertebrate abundance would track previously documented differences in fish growth. Invertebrate assemblages differed among reaches. However, steelhead diet composition did not correspond with reach-specific benthic invertebrate assemblages, perhaps because benthic assemblage structure does not adequately represent food availability to the fish.

Dockham successfully defended her thesis in April, 2016.

Products:

Dockham, A. 2016. Comparison of benthic invertebrate community structure and diet composition of steelhead trout (*Oncorhynchus mykiss*) in Dry Creek, California. M.S. Thesis, College of Natural Resources and Sciences, Humboldt State University. 82 pg.

Dockham, A. and M.A. Wilzbach. Comparison of benthic invertebrate community structure and diet composition of steelhead trout (*Oncorhynchus mykiss*) in Dry Creek, California. Poster presentation, 21st Annual Meeting California Aquatic Bioassessment Workgroup, 1st Annual California Chapter Society of Freshwater Science. 2014.

Dockham, A., and M.A. Wilzbach. Comparison of benthic invertebrate community structure and diet composition of steelhead trout (*Oncorhynchus mykiss*) in Dry Creek, California. Oral presentation, 33rd Annual Salmonid Restoration Conference, Salmonid Restoration Federation Meeting, Santa Rosa, California. 2015.

**PRAIRIE CREEK FISHERIES AND AQUATIC ECOSYSTEM SYNTHESIS**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CAFWRU |
| | Matthew Metheny, Research Associate |
| | John Deibner-Hanson, MS Student |
| Duration: | June 2014 - October 2015 |
| Funding: | Redwood National Park ($12,573) |

The Prairie Creek watershed is almost entirely situated within the Redwood National and State Parks, which is a World Heritage Site and part of the California Coast Range Biosphere Reserve. The creek in the upper watershed flows through undisturbed forest of late seral coast redwood and provides outstanding habitat for fisheries and aquatic resources, often serving as a reference site in studies evaluating land use impacts on aquatic resources.

This project identified and located historic and current datasets, reports, theses, and publications on fisheries and aquatic resources in Prairie Creek, including maps and GIS data, and developed an annotated bibliography on fisheries and aquatic ecosystems in Prairie Creek. Information included in the bibliography are study reach location, study dates, focus of study, type of data collected, and key findings of the study. The bibliography contains 335 references, dating back to the 1950's, and was compiled in the publicly available Zotero research tool. Based on bibliographic materials, fisheries and aquatic information was synthesized into a "State of the Knowledge" report for the Prairie Creek watershed. The report provided background on environmental setting and land use history within the watershed; provided a synopsis of life histories and population status of salmonid fishes; listed species occurrences of non-salmonid fishes, amphibians, aquatic macroinvertebrates, and common benthic algae; assessed salmonid habitat conditions relative to recovery criteria; and summarized existing data and data gaps. In addition, Coop Unit staff conducted a large, woody debris inventory of the mainstem and several tributaries of Prairie Creek for Redwood National Park.

***Prairie Creek drains old growth redwood forest.***

Products:

Wilzbach. M.A. 2016. State of the Fisheries and Aquatic Resources of Prairie Creek. Final Report to Redwood National and State Park, Cooperative Agreement P13AC00848.

Metheny, M.D. and M.A. Wilzbach. 2015. Fisheries and aquatic resources of Prairie Creek: an annotated bibliography. Compiled in Zotero; access available with permission from Wilzbach (wilzbach@humboldt.edu)

Wilzbach, M.A. Fisheries and Aquatic Resources of Prairie Creek. Oral Presentation to the Prairie Creek Technical Advisory Committee, Orick, California. 2016.

**EEL RIVER MONITORING PLAN**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Matthew Metheny, Research Associate |
| Duration: | August 2014 – October 2015 |
| Funding: | California Trout, Inc. ($5,022) |

Many factors impair watershed health in the Eel River Basin, which drains an area of over 3,600 square miles. Finding consensus on recovery actions among a diverse group of stakeholders has been challenging. The Eel River Forum is a coalition of 22 agency, tribal, and conservation partners focused on prioritizing actions and policy reforms to recover salmonid populations in the Eel River basin. California Trout and the Eel River Forum developed the Eel River Action Plan to identify priority recovery actions for immediate funding and implementation. HSU Coop staff assisted California Trout in drafting a chapter for the Eel River Action Plan describing ongoing and proposed basin-wide monitoring of watershed health. The objective of this project was to identify and summarize current monitoring activities, and to recommend monitoring to fill information gaps. A copy of the completed Eel River Action Plan will be available through the California Trout website http://caltrout.org/regions/north-coast-region/keystone-initiative-eel-river-recovery/eel-river-forum/.

Products:

Metheny, M.D. 2015. Final Report to California Trout. Eel River Monitoring Project.

# REVIEW OF CURRENT RESEARCH PROJECTS

## RESEARCH AND DEVELOPMENT IN SUPPORT OF THE KLAMATH BASIN STREAM SALMONID SIMULATOR S3 MODEL (RWO 88)

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Nicolas Som, USFWS |
| | Christopher Manhard, Research Associate |
| Duration: | October 2014 – December 2016 |
| Funding: | USFWS ($161,239) |

The Stream Salmonid Simulator (S3) Model is a Decision Support System being developed by the U.S. Fish and Wildlife Service, in close collaboration with the U.S. Geological Survey Columbia River Research Laboratory, Dr. Thomas Hardy from Watershed Systems Group, Inc., and Texas State University. An S3 model in development for the Klamath River represents a synchronized series of sub-models that reflect the array of physical and biological processes that interact to affect the growth, movement, and survival of fish at a given life stage. A benefit to this method of model construction lies in the ability to update sub-models as new data, new analyses, or new scientific discoveries arise. The S3 model is constructed to: 1) link habitat and flow to population dynamics; 2) operate on spatial scales fine enough to capture habitat quality gradients within the basin; and 3) run on temporal scales that capture variability resulting from flow management actions.

The current S3 model tracks causes of mortality throughout the sub-adult life history of Chinook salmon (redd scour, habitat limitations, disease, water quality, etc.) over time within the 233-mile section of the main stem Klamath River spanning from Keno Dam in Oregon to its confluence with the Pacific Ocean in California. The model is being extended into the Trinity Basin, with the addition of an ocean component and IBM-type upstream adult migration sub module. These improvements will transform the S3 model into a basin-wide, full life cycle model. Future development of the S3 model will also include its expansion to incorporate Coho Salmon, as requested by NOAA Fisheries and the Bureau of Reclamation.

Specific objectives of this component of the project include:

1. evaluating best practices for assigning flow-to-habitat relationships for large river systems such as the Klamath; and

2. developing a Coho Salmon movement sub-model for use within the S3 model that accurately reflects the diverse movement and life history strategies exhibited by the species.

Work to complete these objectives is being conducted by a post-doctoral researcher Chris Manhard, who began in January 2016.

**OVERWINTER SURVIVAL, MOVEMENT, AND GROWTH OF JUVENILE COHO SALMON IN RELATION TO LARGE WOODY DEBRIS AND LOW VELOCITY HABITAT IN NORTHERN CALIFORNIA STREAMS**

Investigators: Dr. Margaret Wilzbach, CACFWRU
John Diebner-Hanson, MS student
Duration: January 2013 - March 2016
Funding: California Department of Fish and Wildlife/Coop Unit Support ($135,000)

*Surveying large woody debris in west branch of Mill Creek, CA.*

This thesis research will evaluate relationships between emigration, survival, and growth of juvenile Coho Salmon with features of overwinter habitat (large woody debris, slow velocity habitat) in three basins of central and northern California. The study is a component of a larger effort to coordinate sampling methods and data analysis among California Department of Fish & Wildlife (CDFW) and Humboldt State University (HSU) scientists who have been independently monitoring Coho Salmon in coastal northern California for a series of years. A goal of this collaborative effort is to develop an understanding of relationships between habitat and survival of juvenile Coho Salmon to help interpret regional trends and direct effective restoration actions. Comparison of overwinter survival among multiple basins characterized by different land use and habitat type may allow assessment of the commonality of factors limiting freshwater survival of Coho Salmon at the southern edge of their distribution.

Specific objectives are to:

1. compare overwinter survival, emigration, and growth of juvenile Coho Salmon between fall tagging and spring outmigration among individual reaches and basins in northern California; and
2. evaluate relationships between overwinter survival, emigration, and growth with volume of large woody debris (LWD), low-velocity rearing area and off-channel habitat units among basins and reaches.

Fish movement, growth, and survival will be estimated from fall tagging, PIT antenna operation and outmigrant trapping data that is being collected by CDFW and Coop Unit crews in each of the three streams. Multi-state models are being developed to estimate movement and survival of juvenile Coho Salmon within each of the streams; models will be compared among streams to evaluate the significance of winter habitat features.

Thesis completion is expected in December 2016.

**LOWER AND UPPER REDWOOD CREEK JUVENILE SALMONID (SMOLT) ABUNDANCE**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Michael Sparkman, CDFW |
| Duration: | June 2013 to March 2017 |
| Funding: | California Department of Fish and Wildlife/FRGP ($224,818) |

***Rotary screw trap in lower Redwood Creek.***

Juvenile anadromous salmonid trapping was conducted for the 12th consecutive year in 2015 in lower Redwood Creek (RC), Humboldt County, California during the spring/summer emigration period (March – August). Trapping in 2015 was initiated earlier than previous study years to account for the earlier migration and subsequent production from adult Chinook Salmon returns in September and October 2014. The purpose of the study is to describe juvenile salmonid out-migration and estimate smolt population abundances for wild 0+ Chinook Salmon, 1+ Chinook Salmon, 1+ Steelhead Trout, 2+ Steelhead Trout, and Coastal Cutthroat Trout using mark/recapture methods. The long term goal is to monitor the status and trends of out-migrating juvenile salmonid smolts in RC in relation to watershed conditions and restoration activities in the basin, provide data for Viable Salmonid Population Analysis, and to make RC a Life Cycle Monitoring station by combining sonar counts of adults with smolt abundance estimates.

A rotary screw trap and fyke net/pipe trap collectively operated 132 out of 138 days/nights possible, and captured 175,966 0+ Chinook Salmon (ocean type), 10 1+ Chinook Salmon (stream type), 39,779 0+ Steelhead Trout, 8,535 1+ Steelhead Trout, 1,596 2+ Steelhead Trout, 211 juvenile Coastal Cutthroat Trout, 1 0+ Pink Salmon, 100 0+ Coho Salmon, and 496 1+ Coho Salmon to total 226,694 juvenile salmonids. Eight adult Coastal Cutthroat Trout were also captured, and for the first time of record one Eulachon and four Staghorn Sculpins were captured. Average weekly trapping efficiencies were 50% for 0+ Chinook Salmon, 50% for 1+ Chinook Salmon, 14% for 1+ Steelhead Trout, 12% for 2+ Steelhead Trout, 29% for Coastal Cutthroat Trout, 28% for 0+ Coho Salmon, and 38% for 1+ Coho Salmon. The 0+ Chinook

Salmon population abundance in 2015 equaled 295,664 individuals (95% CI = 284,021 – 307,308), and was 1.3 times greater than the previous 11 year average. Based upon a much higher abundance determined in mid/upper RC (N = 575,353) in 2015, we suspect high flows in March and early April caused considerable mortality to an estimated 260,000 fry that migrated downstream prior to these fry stressor flows. 1+ Chinook Salmon abundance equaled 17 individuals (95% CI = 8 – 25), and was 99% less than abundance in 2014. 1+ Chinook Salmon abundances in a given year were positively related to 0+ Chinook Salmon abundances the previous year ($p < 0.05$). Low abundances over the current 12 year period indicate 1+ Chinook Salmon are relatively rare in RC. Population abundances (with 95% confidence intervals) in 2015 equaled 56,020 (49,180 – 62,860) for 1+ Steelhead Trout, 18,155 (13,912 – 22,397) for 2+ Steelhead Trout, 303 (191 – 416) for 0+ Coho Salmon, 1,923 (1,542 – 2,304) for 1+ Coho Salmon, and 825 (561 – 1,089) for juvenile Coastal Cutthroat Trout. Although abundance of 1+ Coho Salmon smolts in 2015 was the highest of record, abundances across all years were consistently low. The abundances of 1+ Steelhead Trout, 2+ Steelhead Trout, juvenile coastal Cutthroat Trout, and 1+ Coho Salmon were greater than average, and indicate that drought conditions during the summer of 2014 did not drastically reduce survival.

Effect of study year on population abundance over the 12 years was not significant for 0+ Chinook Salmon, 1+ Chinook Salmon, 0+ Coho Salmon, 1+ Coho Salmon, 1+ Steelhead Trout, and 2+ Steelhead Trout ($p > 0.05$). Juvenile Coastal Cutthroat Trout increased in abundance over study years ($p < 0.05$). The average size (FL, Wt) of 0+ Chinook Salmon and 0+ Coho Salmon over study years was negatively related to population abundances ($p < 0.05$), suggesting density-dependent effects.

The two most important months for migration in 2015 were May/June for 0+ Chinook Salmon, 1+ Steelhead Trout, and juvenile Coastal Cutthroat Trout, and April/May for 1+ Chinook Salmon, 0+ Coho Salmon, 1+ Coho Salmon, and 2+ Steelhead Trout. 0+ Chinook Salmon, 1+ Steelhead Trout, 2+ Steelhead Trout, juvenile Coastal Cutthroat Trout, and 0+ Coho Salmon showed increased migration earlier in the migration period, which may indicate a response to drought conditions. Considerably more 1+ Steelhead Trout emigrated downstream than 2+ Steelhead Trout each study year, suggesting stream habitat conditions are limiting the abundance of the older age class, or favoring a change in the life history to a younger smolt age.

Product:

Sparkman, M. D., R. Park, L. Osborn, and M.A. Wilzbach. 2016. Lower Redwood Creek juvenile salmonid (smolt) abundance project, study year 2015: a report to the Fisheries Restoration Grants Program (Project No. P1210322). CDFW AFRAMP, study 2a7: 85 p.

**PRAIRIE CREEK JUVENILE SALMONID (SMOLT) ABUNDANCE PROJECT**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU<br>Peter Drobny, MS Student<br>Nick Van Vleet, MS Student |
| Duration: | June 2013 – March 2017 |
| Funding: | California Department of Fish and Wildlife/FRGP ($268,236) and Coop Unit Fund |

***Snorkeling in Prairie Creek.***

This project continues the long-term monitoring of juvenile salmonid populations in Prairie Creek that has been in place since 1998. The Prairie Creek sub-basin of Redwood Creek is a stronghold for Coho Salmon production within the basin, and serves as an important reservoir for recovery of salmonids within Redwood Creek. The Prairie Creek sub-basin is a life cycle monitoring station as described in the CDFW's California Coastal Salmonid Monitoring Plan, as it combines monitoring of juveniles and smolts with estimates of returning adults from redd counts. The focus of the study over the past year was to determine overwinter survival (apparent) and growth of juvenile Coho Salmon, and estimate population abundances of Coho Salmon, Chinook Salmon (*O. tshawytscha*), Steelhead Trout (*O. mykiss*), and Cutthroat Trout (*O. clarki clarki*) smolts emigrating from the Prairie Creek basin in 2015.

Juvenile Coho Salmon in Prairie Creek were marked with PIT tags during 2014 to monitor fall/winter redistribution and estimate overwinter survival and growth. The Cormack-Jolly-Seber model and Program MARK were used to estimate overwinter survival using plate and loop designed pit tag antenna arrays and rotary screw trap captures. A separate estimate of overwinter survival was determined using the rotary screw trap and mark/recapture experiments to determine overwinter survival as well. We found that 5.6% of the pit tagged juvenile Coho Salmon were detected migrating past the lower antenna during fall and winter before the smolt trap was deployed. Apparent overwinter survival of juvenile Coho Salmon using pit tag antennas and trap captures equaled 33% (95% CI = 29 – 38%), compared to the trap derived estimate of 29% (95% CI = 23 – 34%). On average, pit tagged juvenile Coho Salmon experienced 0.14 mm increase in length per day, and overwinter growth in 2014/15 was very similar to growth in 2013/14.

The project is conducted in cooperation with CDFW biologist Michael Sparkman, who supervised the smolt trap operation. A five foot diameter rotary screw trap was operated from February 26 – July 25, 2015 to estimate smolt abundances, and captured 329 0+ Coho Salmon, 11,355 1+ Coho Salmon, 10,900 0+ Chinook Salmon, 3 1+ Chinook Salmon, 939 0+ trout, 2,288 1+ Steelhead Trout, 783 2+ Steelhead Trout, 1 0+ Pink Salmon, and 2,398 juvenile Coastal Cutthroat Trout to total 28,996 individuals. An additional 35 adult Coastal Cutthroat Trout (FL > 250 mm) and two Eulachon (*Thaleichthys pacificus*) were also captured. Number of pit tagged 1+ Coho Salmon captures equaled 168, and comprised 1.4% of the total 1+ Coho Salmon catch. The population abundance (with 95% CI's) of 0+ Coho Salmon equaled 1,601 (1,033 – 2,169), and for 1+ Coho Salmon equaled 21,536 (20,260 – 22,813). Population abundances equaled 22,562 (20,795 – 24,328) for 0+ Chinook Salmon, 7,786 (7,023 – 8,549) for 1+ Steelhead Trout, 4,520 (3,513 – 5,527) for 2+ Steelhead Trout, and 8,572 (7,425 – 9,719) for juvenile Coastal Cutthroat Trout. Trends in smolt abundances from 2011 – 2015 were not significant ($p > 0.05$), except for 1+ Steelhead Trout, which showed a positive increase over time ($p < 0.05$). The two most important months for migration in 2015 were March/April for 0+ Coho Salmon and 2+ Steelhead Trout, March/May for 0+ Chinook Salmon, and April/May for 1+ Coho Salmon, 1+ Steelhead Trout, and juvenile Coastal Cutthroat Trout.

Daily captures and weekly population abundances of pit tagged 1+ Coho Salmon closely reflected the pattern for the population of 1+ Coho Salmon smolts for the second year in a row, and indicate that pit tagging juvenile Coho Salmon did not affect migratory behavior during the smolt migration period.

M.S. Student Peter Drobny defended his thesis March 2016, evaluating the effects of fish length, habitat attributes, and densities of Coho Salmon and trout on overwinter survival of juvenile Coho Salmon. He found that survival increased with fish length and decreased with intraspecific density. Density of small (<150 mm) trout, large (>150 mm) trout, and habitat attributes did not have a detectable effect on affect survival.

Products:

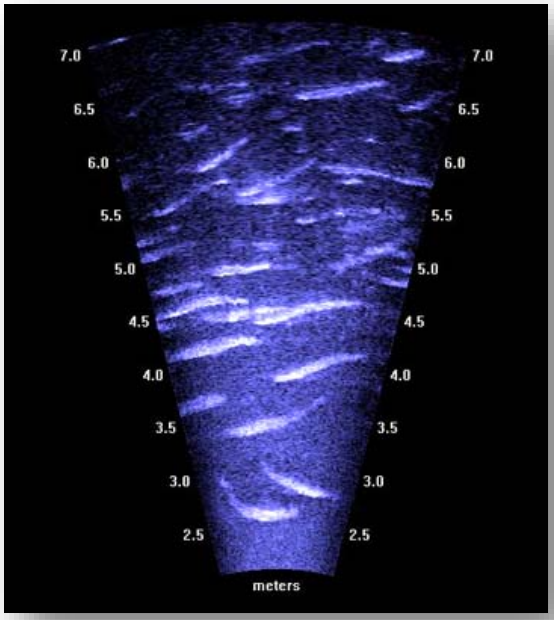
Drobny, P. 2016. Influence of intra- and inter-specific salmonid densities and habitat on overwinter survival of juvenile Coho Salmon in Prairie Creek. MS thesis. College of Natural Resources and Sciences, Humboldt State University, Arcata, CA.

Wilzbach, M.A., M.D. Sparkman, P.Y. Drobny, M.E. Gordon, and C.M.G. Boone. 2016. Prairie Creek Monitoring Project, 2015 Season: a report to the Fisheries Restoration Grants Program Project P1210321. 98 pg.

**REDWOOD CREEK LIFE CYCLE MONITORING (ADULT STEELHEAD ESCAPEMENT) DIDSON 2015 – 2017**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Matthew Metheny, Research Associate |
| Duration: | July 2015 – March 2017 |
| Funding: | California Department of Fish and Wildlife/FRGP ($27,241) |

We have deployed a DIDSON (Dual Frequency Identification Sonar - video) system in Orick, CA for the past six years to count adult salmonids migrating upstream to spawn in Redwood Creek. Each year, thousands of fish have been documented passing the camera site. The information from the DIDSON system is used along with spawning surveys, downstream smolt trapping, and PIT tag arrays to comprise a salmonid life cycle monitoring station. This life cycle monitoring station provides the California Department of Fish and Wildlife with key information on salmonid survival rates in different freshwater and marine environments. Adult counts from the DIDSON have shown recent strong returns of Chinook Salmon to Redwood Creek which are close to de-listing targets set by the National Marine Fisheries Service. In contrast, Steelhead and Coho Salmon numbers remain below Endangered Species Act targets for recovered populations. Preliminary analysis shows that a typical number of salmonids have passed the sonar camera so far during the migration season of 2015-2016.




***DIDSON sonar image.***

**PHASE II: MONITORING THE ENDANGERED TIDEWATER GOBY (*EUCYCLOBIUS NEWBERRYI*) USING ENVIRONMENTAL DNA IN WATER SAMPLES: FIELD TESTS**

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|---|---|
| Investigator: | Andrew Kinziger, HSU Fisheries Department |
| | Margaret Wilzbach, CACFWFRU |
| | Molly Schmelzle, MS Student |
| Duration: | January 2015 to December 2017 |
| Funding: | USFW ($92,255) |

This research examined the application of environmental DNA (eDNA) as a non-invasive and sensitive monitoring tool for endangered Tidewater Goby in aquatic habitats located along northern California's coastline. Specifically, an eDNA approach was compared to traditional seining methods and analyzed within a statistical framework that allowed for direct comparison between method specific detection probabilities. Numerous experimental and

*Sampling water for eDNA.*

empirical studies have shown that eDNA can detect a range of freshwater and select marine species. However, these studies neither quantitatively nor explicitly addressed the performance advantage of eDNA approaches for detecting rare and cryptic species over traditional field methods using detection probability estimates.

eDNA techniques were additionally evaluated across a range of coastal habitats, including lagoons, sloughs, and estuaries and over the entirety of the north coast region to indicate the strength of eDNA to be applied at large geographical scales and within a diversity of tidal habitats. An auxiliary objective was to use quantitative polymerase chain reaction (qPCR) to estimate relative site abundance from eDNA water samples using standard curve analysis. Biologically relevant covariates were also statistically assessed both as effects for detection and DNA concentration. A species specific qPCR genetic assay was developed for north coast Tidewater Goby populations and was tested exhaustively against ten common co-occurring species.

At 29 sites, a total of 254 paired seine hauls and water samples were collected for eDNA analysis. The number of paired collections at each location depended on habitat size and site characteristics, ranging from two to 23 samples taken at equal intervals. Each water sample was tested for Tidewater Goby DNA using six replicate qPCR assays designed specifically to tidewater goby. A multimethod occupancy analysis was performed to evaluate method specific detection probabilities, ($p_{eDNA}$ and $p_{seine}$) using all detection history data for inference. Overall detection for eDNA was compared to for seining. The probability of detection using eDNA methods was double the rate of detection for seining within a framework accounting for imperfect detection. An eDNA approach detected Tidewater Goby at 19 locations as opposed to 14 with seining, including two locations where they have not been detected previously, two extant locations where they were not detected with a seine haul, and one location considered to be locally extirpated based upon previous field surveys. The results indicate that eDNA is a highly sensitive and efficient monitoring technique compared to traditional field sampling methods. An eDNA approach will benefit Tidewater Goby monitoring efforts and better inform management of its distribution and relative abundance. The Tidewater Goby's

***Davis Lake, California.***

endangered status and occurrence in difficult to sample habitat warrants significant consideration and eDNA techniques offer a new monitoring future.

Products:

Schmelzle, M.C. 2015. Using occupancy modeling to compare environmental DNA to traditional field methods for regional-scale monitoring of an endangered aquatic species. MS thesis. College of Natural Resources and Sciences, Humboldt State University, Arcata, CA.

Schemlze, M. Occupancy models to compare environmental DNA to traditional seining methods for monitoring of endangered species. Oral presentation, 145th Annual Meeting of the American Fisheries Society. Portland, Oregon.

Schemlzle, M.C. and A.P. Kinziger. 2016. Using occupancy modeling to compare environmental DNA to traditional field methods for regional-scale monitoring of an endangered aquatic species. Molecular Ecology Resources DOI:10.1111/1755-0998.12501.

## EXPORT OF INVERTEBRATE DRIFT FROM HEADWATER STREAMS

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Jon Hollis, MS Student |
| Duration: | January 2015 – December 2016 |
| Funding: | Green Diamond Resources Company ($48,900) |

The great majority of the total length of river networks is comprised of low-order, headwater streams. Populations of salmonid fishes are often unable to maintain year-round residence in these small streams, because the streams have insufficient water volume or physical barriers are present. Fishless headwater streams are critical components of a river network, serving as a source of sediments, water, woody debris, nutrients, and invertebrates to downstream waters. However, the importance of the invertebrate subsidies provided by fishless headwater streams is often underappreciated. A greater understanding of how these subsidies are used by fish and contribute to biological production in downstream reaches is needed to enhance riparian management practices. To address this issue, we are assessing the role of fishless headwater streams as donors to downstream food supplies for Coastal Cutthroat Trout (*Oncorhynchus clarki*) in headwater systems of the lower Klamath River. From June 2015 through April 2016 we sampled invertebrate drift from six fishless headwaters located in the sub-basins of Tectah Creek, Ah Pah Creek, and Tarup Creek. Additionally, we collected drift samples and trout diet samples from adjacent fish-bearing stream reaches.

***Hollis retrieving a drift sample from a headwater tributary to Tectah Creek.***

Our objectives are to:

1.) quantify the magnitude, taxonomic composition, energy content and seasonal variation of invertebrate drift exports from fishless headwaters of the Lower Klamath River;

2.) evaluate the distance travelled by drifting invertebrates in fishless headwaters at seasonal base flows; and

3.) assess the use of invertebrate prey subsidies by fish and their potential contribution to fish growth.

At present, four rounds of field sampling have been completed (summer, fall, winter, and spring) and preliminary laboratory analysis is underway. Drift was collected over a 24-h period during each sampling event. Preserved samples will be measured and identified to lowest feasible taxonomic resolution in the laboratory, and energetic content of samples will be estimated from taxa-specific regressions of length and mass. Diets of cutthroat trout occupying downstream reaches were sampled by gastric lavage to compare taxonomic composition between drift and fish diet samples. The potential contribution of the invertebrate subsidy to fish growth will be approached through bio-energetic modeling. Our findings will be used to evaluate the role fishless headwaters play in stream food webs and their importance to salmonid production. We expect laboratory and data analysis to be completed by the end of the 2016 fall semester.

Research constitutes the thesis research of Fisheries MS student Jonathan Hollis. The study is part of a larger multidisciplinary project investigating stream ecosystem response to riparian management, and includes scientists from Green Diamond Resource Company, Humboldt State University, Oregon State University, and the U.S. Forest Service.

***Stoneflies are common inhabitants of invertebrate assemblages in headwater streams.***

**TOWNSEND'S BIG EARED BAT STATEWIDE ASSESSMENT**

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|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Joseph Szewczak, Wildlife, Humboldt State University |
| | Dr. Mike Morrison, Texas A & M University |
| Duration: | April 2015 – December 2017 |
| Funding: | California Department of Fish and Wildlife/USFWS ($129,799) |

***Joe Szewczak in the field with student.***

The goal of this project is to provide information that can be used to update the status of Townsend's big-eared bat (*Corynorhinus townsendii*) in California, including an evaluation of historic data and the conducting of new surveys of distribution and abundance.

Specific project objectives include:

1. gather all existing data on the distribution, abundance and site characteristics of the bat;
2. conduct re-surveys of historic sites for current occupancy; and
3. conduct surveys in a selection of habitat occupancy and abundance.

The sampling scheme has two primary components. First, all historic roost sites (maternity and hibernacula) that may be currently operational (e.g., those which have not be abandoned because of mine closure) will be surveyed for current activity and condition. Second, a stratified random sampling scheme will be used to generate a probabilistic model of bat occupancy and abundance across its range in California. An adaptive sampling scheme will then be used for the occupancy survey.

**GIANT KANGAROO RAT POPULATION MONITORING IN PANOCHE VALLEY**

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|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Tim Bean, Wildlife Department, Humboldt State University |
| | Student, Nathan Alexander, MS Student |
| Duration: | November 2015 – June 2016 |
| Funding: | California Department of Fish and Wildlife ($20,939) |

Giant kangaroo rat (GKR), *Dipodomys ingens,* are a keystone species throughout their range including the Carrizo Plain, The current four year drought and the associated lack of vegetative growth have resulted in precipitous declines in GKR populations, especially during the past two years. For example, on the Carizzo Plain, GKR densities declined from 51 gkr/ha in 2011 to 2 gkr/ha in 2014. Kit fox populations have followed this decline and now fewer than 200 kit foxes are estimated to reside on the Carizzo Plain National Monument.

***Juvenile Giant Kangaroo Rat (Dipodomys ingens). Photo credit: Nathan Alexander***

The goal of the project is to increase GKR survival and production by providing supplemental food at three locations in the Ciervo-Panoche Natural Area. The overall project concept is to reduce the population declines for GKR and to test the effectiveness of a supplemental feeling program. Supplemental feeding will no longer be needed when more normal rainfall returns and GKR numbers recover.

# NEW RESEARCH PROJECTS REVIEW

## HABITAT SELECTION IN AN ARCTIC SEABIRD: IMPLICATIONS FOR CLIMATE CHANGE

Investigators: Dr. Margaret Wilzbach, CACFWRU
Dr. Mark Colwell, Wildlife Department, Humboldt State University
Student, Aaron Gottesman, MS Student
Duration: September 2015 – December 2019
Funding: USGS, Alaska Science Center ($40,225)

***Semipalmated Sandpiper (Calidris pusilla) In breeding plumage.***

Semipalmated Sandpipers (*Calidris pusilla*) are one of the most abundant shorebirds in the Western Hemisphere, and breed widely across the North American arctic. As one of the 233 bird species deemed most in need of conservation action by the North American Bird Conservation Initiative, the Semipalmated Sandpiper population is currently of interest due to unaccounted declines in staging numbers over the past 35 years and for potential of an overall population decline in response to climate changes in the Arctic. In the past three decades, accelerated warming and expansion of the growing season has led to altered vegetative composition of the tundra to favor tree and shrub growth and reduction of grasses and sedges. Effect of these changes on habitat use in the breeding grounds of this bird are unknown. The objective of this research is to characterize habitat use of the Semipalmated Sandpiper to determine wetland features associated with habitat selection and use. The study will be conducted in the Colville River Delta in the arctic slope of Alaska.

## DEVELOP A TIDEWATER GOBY SURVEY METHOD USING ENVIRONMENTAL DNA

Investigators: Dr. Margaret Wilzbach, CACFWRU
Dr. Andrew Kinziger, HSU Fisheries Department
Student, Michael Sutter, MS Student
Duration: March 2016 – December 2017
Funding: Cal Trans ($88,183)

Caltrans Districts 1, 4, 5, 7, 11, and 12 are often required to initiate Endangered Species Act (ESA) Section 7 consultations with U.S. Fish and Wildlife Service (USFWS), on behalf of the Federal Highway Administration (FHWA), for projects that may affect the federally listed Tidewater Goby, a fish species whose current range is patchy and fragmented along the entire coastline of California. Current field survey approaches required by USFWS have relatively low detection rates for Tidewater Goby. Researchers at Humboldt State University (HSU) are in the initial stages of developing an innovative approach for monitoring Tidewater Goby using

environmental DNA (eDNA) techniques. Analyses to date have indicated that eDNA approaches have nearly double the detection probability in comparison with traditional survey approaches for Tidewater Goby. The objective of this project is to continue to development of eDNA approaches for monitoring Tidewater Goby presence/absence. The goal is to provide USFWS an innovative and improved set of tools for detecting Tidewater Goby. The new eDNA technique will help the USFWS develop a survey protocol that detects Tidewater Goby with higher confidence. Ultimately, improved survey techniques will help Caltrans save money and avoid delays during maintenance and construction by minimizing endangered species consultations to those situations where they are necessary.

While the results to date indicate that eDNA approaches are much more sensitive for detecting Tidewater Goby than traditional seining techniques, eDNA approaches have not been tested to the extent necessary to illustrate their efficacy for presence/absence detection or abundance estimation of Tidewater Goby. The objectives of this project are to continue to develop eDNA survey methods for Tidewater Goby, including:

(i) Develop methods for water filtration in the field rather than in the laboratory. Field filtration is essential because it would allow application of eDNA approaches at field sites that are geographically distant from HSU (e.g., southern California). Currently water samples are collected in the field are transported to the lab for filtration, this approach is impractical for field collection sites that are geographically distant from the lab.

(ii) Develop quantitative Polymerase Chain Reaction (qPCR) assay(s) allowing for range-wide detection of Tidewater Goby using eDNA approaches. Existing eDNA assays for Tidewater Goby were designed specifically for populations in Del Norte, Humboldt, and Mendocino Counties. Given the large variation in mitochondrial DNA exhibited by Tidewater Goby across its geographic range, the applicability of our current assay range-wide is uncertain.

(iii) Conduct presence/absence surveys for Tidewater Goby across the species entire range in California and analyze using an occupancy modeling approach. Previous surveys have been restricted to northern California (Del Norte, Humboldt and Mendocino Counties) only. Data will be analyzed using a hierarchical occupancy modeling approach to meet the detection probability standards of the USFWS.

**REDWOOD CREEK CHINOOK SALMON MONITORING AND LIFE CYCLE MODEL**

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|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Mark Henderson, CACFWRU |
| Duration: | July 2017 – June 2020 |
| Funding: | California Department of Fish and Wildlife/FRGP ($681,055) |

This proposed project will provide funding to continue monitoring adult and juvenile salmonids in Redwood Creek to provide sufficient data to build a life cycle model for the Chinook Salmon population. The objectives of this project are to: 1) Enumerate total numbers of Chinook returning to spawn in the Redwood Creek basin using DIDSON sonar; 2) conduct spawning ground surveys in Redwood Creek above Prairie Creek to estimate total numbers of redds which are constructed; and 3) install and operate a rotary screw trap in Redwood Creek to monitor the

abundance and condition of juvenile salmonids outmigrating from Redwood Creek. Data on smolt and adult abundance will be combined into a life-cycle model to estimate freshwater and marine survival rates, and assess the impact of restoration efforts and climate change on the abundance of the Chinook Salmon population in Redwood Creek. Continuation of this life cycle monitoring station, and the development of a life-cycle model for this population, will directly support the CDFW/NMFS Coastal Salmonid Monitoring Plan and recovery plans for coastal Chinook Salmon.

**HUMBOLDT BAY COHO MONITORING**

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|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Darren Ward, Fisheries Department, Humboldt State University |
| Duration: | August 2017 – July 2020 |
| Funding: | California Department of Fish and Wildlife/FRGP ($966,547) |

This proposed project will use spawning ground surveys in tributaries of Humboldt Bay to establish the regional status and trends of adult salmonid abundance, and continue to operate a life cycle monitoring station (LCS) in Freshwater Creek. Sampling infrastructure and established sampling programs at Freshwater Creek include a weir that functions as a trap for both juveniles and adults and PIT tag antennas in several locations throughout the watershed. The LCS at Freshwater Creek will continue 15 years of monitoring clearly showing a long-term declining trend in adult Coho Salmon abundance. As habitat restoration and enhancement projects proceed in the Humboldt Bay watershed ongoing monitoring will provide insight into the response of Coho Salmon populations to these conservation efforts.

Monitoring efforts for Coho Salmon at the Freshwater Creek LCS focus on population abundance and survival rates within the basin. However, long-term trends in population dynamics, particularly extinction risk, for Freshwater Creek may depend on interactions with Coho Salmon populations outside the basin. This project will incorporate juvenile tagging and detection efforts in streams adjacent to Freshwater Creek to characterize dispersal among tributaries and use these parameters, in combination with estimates of population synchrony across basins from the time series of escapement data, to evaluate potential metapopulation dynamics of Humboldt Bay tributaries. In addition, the expanded tagging and detection efforts will allow us to compare life history diversity across basins that differ in habitat and restoration status.

**LIFE CYCLE MONITORING OF COHO SALMON IN PRAIRIE CREEK**

| | |
|---|---|
| Investigators: | Dr. Margaret Wilzbach, CACFWRU |
| | Dr. Mark Henderson, CACFWRU |
| Duration: | June 2017 – March 2020 |
| Funding: | California Department of Fish and Wildlife/FRGP ($629,357) |

This proposed project will continue the long-term monitoring of adult and smolt abundances of the Coho Salmon population in Prairie Creek, a northern California watershed which is internationally renowned and managed for its old-growth stands of ancient coast redwoods and

their plant and animal inhabitants. Long-term monitoring in Prairie Creek provides information essential for developing management strategies to ensure population viability of its Coho Salmon, and in providing a benchmark for evaluating salmon recovery in regional streams which have experienced a greater intensity of disturbance. The project is complemented by physical habitat and water quality monitoring by Redwood National and State Parks, facilitating evaluation of habitat-productivity relationships.

The project purpose is to contribute to life cycle monitoring of the Coho Salmon population in Prairie Creek. Specific objectives are to: 1) estimate abundance of returning adults, based on walking surveys during the spawning season to enumerate live fish, carcasses, and redds; 2) estimate abundance of smolts emigrating from Prairie Creek, using mark-recapture methods based on tag detections at stationary antenna arrays and capture in a rotary screw trap; and 3) estimate freshwater and marine survival rates, and evaluate predictive relationships between freshwater survival and growth with habitat attributes. Marine survival will be estimated from adult abundance estimates and detection of tagged fish among the returning adults at antenna stations. Freshwater growth and survival of juvenile fish will be estimated from capture of tagged fish in the smolt trap and from antenna detections. Relationships between habitat attributes and freshwater production will be evaluated through model selection.

***Headwaters stream.***

# UNIT PROGRAM REVIEW

## PROGRAM DIRECTION

### Personnel

The California Unit is pleased to welcome Dr. Mark Henderson, who was hired to serve as Assistant Unit Leader in Fisheries. Mark's research expertise is in quantitative fisheries ecology. Mark began his employment on April 4, 2016.

Post-doctoral associate Christopher Manhard came on board in January 2016. Christopher is working closely with Nick Som, USFWS, to extend the Klamath River Stream Salmonid Simulator Model to incorporate Coho Salmon and to evaluate best practices for assigning flow-to-habitat relationships for the Klamath River.

Leslie continues to contribute to guidance of Unit and CNRS students in addition to providing administrative support to the Unit. Leslie put in many hours working on the submission of three FRGP grants and has been granted permission by the Sponsored Programs Foundation to submit these in their place. She is an active participant in the Institute for Student Success, and in discussion groups focused on understanding student needs. She attended and received trainings for federal travel and other web-based USGS functions.

The Coop Unit extends a fond farewell and best wishes to Steve Smith, who is retiring from his position as Dean of the College of Natural Resources and Sciences this summer. Steve has been a loyal booster of the Coop Unit and was instrumental in securing the green light to hire our new Assistant Unit Leader. We look forward to building a strong relationship with our next Dean.

### Research

Wilzbach and Henderson attended the national Cooperative Research Units (CRU) All Hands meeting in Santa Fe, NM in March 2016. The meeting was themed: "Strengthening the pillars of the CRU program: our roles in research, state partnerships, and education". Particular emphasis was placed on the need to adopt landscape perspectives in the management and conservation of national and international resources, and the importance of combining the collective science, capacity, creativity, and resources of partners and programs to achieve common conservation priorities. Subsequent to the meeting, discussion has been initiated with Larry Rabin, Assistant Regional Director for Science Applications with the FWS Pacific Southwest Region and with responsibility for FWS work related to Landscape Conservation Cooperatives, in the interests of furthering potential science initiatives with our FWS partner. Larry has pledged to attend next year's Cooperator Meeting, as has our national CRU Chief, John Organ.

On the research front, we were disappointed that none of the proposals we submitted to the CDFW Fisheries Restoration Grants program (FRGP) to continue our long-term monitoring of Coho Salmon in Prairie and Redwood Creeks were funded for the next cycle of funding. This will hurt the Coop Unit coffers, as funding from this program has provided the bread and butter support of our research program for the past decade. Wilzbach and Henderson have

submitted proposals to the FRGP program to reinstate monitoring for the following cycle (summer 2017), and are seeking opportunities for diversifying research funding for the fisheries program.

The Unit continues to make progress in expanding our program to address wildlife concerns. HSU researcher Joe Szewczak is working with the Coop to assess that status of the Townsend's big eared bat across its California range. Funds have been awarded to the Coop for a project to monitor the population status of the federally-endangered giant kangaroo rat within the San Joaquin Valley. This work will be conducted by HSU wildlife biologist Tim Bean.

You can access Cooperative Fish and Wildlife Research Units Program – 2015 Year In Review and ESRI Story Map.

**FACILITIES AND EQUIPMENT**

We appreciate the outstanding facilities provided by HSU.

**UNIVERSITY SERVICE AND TEACHING**

**Courses Taught**

| | | |
|---|---|---|
| Ecology of Running Waters (3 units) | Wilzbach | Fall 2015 |

**Graduate Student Major Advisor**

| | |
|---|---|
| Wilzbach | John Deibner-Hanson – MS Fisheries, Humboldt State University<br>Andrea Dockham - MS Fisheries, Humboldt State University<br>Peter Drobny - MS Fisheries, Humboldt State University<br>Jon Hollis – MS Fisheries, Humboldt State University<br>Sam Rizza – MS Fisheries, Humboldt State University<br>Nicholas Van Vleet – MS Fisheries, Humboldt State University |

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

| | |
|---|---|
| Duffy | Rosemary Records – PhD Environmental Engineering, Colorado State University<br>Sam Rizza - MS Fisheries, Humboldt State University<br>Russ Bryant - MS Wildlife, Humboldt State University |
| Som | John Deibner-Hanson – MS Fisheries, Humboldt State University<br>Peter Drobny – MS Fisheries, Humboldt State University<br>Nicholas Van Vleet – MS Fisheries, Humboldt State University<br>Justin Alvarez – MS Fisheries, Humboldt State University |
| Wilzbach | Justin Alvarez – MS Fisheries, Humboldt State University<br>Emily Ferrell – MS Environmental Science & Mgmt, Humboldt State University<br>Molly Gorman, MS Fisheries, Humboldt State University<br>Jeffrey Hayes – MS Forestry, Humboldt State University<br>Michelle Krall – MS Fisheries, Humboldt State University<br>Alexander Wick – MS Forestry, Humboldt State University |

## UNIVERSITY AND OTHER SERVICE

| | |
|---|---|
| Wilzbach | Member, IACUC<br>Member, Elk River Technical Advisory Committee<br>Member, Prairie Creek Technical Advisory Committee<br>Alternate Member, California Advisory Committee on Salmon and Steelhead Trout |
| Farrar | Updates and maintains the Unit's University and USGS web pages; member of Fisheries building evacuation team. |

## THESES OF UNIT-SPONSORED GRADUATE STUDENTS

Bryant, R. 2015. An Assessment of the native invertebrate pollinator community and flora sources in grasslands of eastern North Dakota. M.S. Thesis, Humboldt State University, Arcata, CA.

Schmelzle, M. 2015. Using occupancy modeling to compare Environmental DHA (eDNA) to traditional field methods for regional scale monitoring of an endangered aquatic species. M.S. Thesis, Humboldt State University, Arcata, CA.

Rizza, S. 2015. Asymmetric introgression between Coastal Cutthroat Trout and steelhead: Variable introgression by linkage group. M.S. Thesis, Humboldt State University, Arcata, CA.

## STUDENT AWARDS

Deibner-Hanson, John: State University Grant

Drobny, Peter: Danielle Plumb Zumbrun Memorial Scholarship, Marin Rod and Gun Club, State University Grant

Gottesman, Aaron: State University Grant

Hollis, Jon: Founding Faculty Scholarship, Marin Rod and Gun Club, Travel Award from the California Chapter of the Society for Freshwater Sciences

Van Vleet, Nick: Danielle Plumb Zumbrun Memorial Scholarship

## PRESENTATIONS

Hollis, J. Export of invertebrate drift from fishless headwater streams: Evaluating the use of this subsidy by downstream salmonids (*Oncorhyncus* spp.) and its potential contribution to fish production. Oral presentation, Riparian Summit Conference. Korbel, California. April 2015.

Rizza, S., A. P. Kinziger, J. C. Garza, and M. A. Wilzbach. Asymmetric introgression between Coastal Cutthroat Trout and steelhead in the Smith River Basin, California. Oral presentation at the 145th Annual Meeting of the American Fisheries Society. Portland, Oregon. August 2015.

Schemlze, M. Occupancy models to compare environmental DNA to traditional seining methods for monitoring of endangered species. Oral presentation, 145th Annual Meeting of the American Fisheries Society. Portland, Oregon. August 2015.

Schemlzle, M.C. and A.P. Kinziger. 2016. Using occupancy modeling to compare environmental DNA to traditional field methods for regional-scale monitoring of an endangered aquatic species. Molecular Ecology Resources DOI:10.1111/1755-0998.12501.

Wilzbach, M.A. Role and source of macroinvertebrates in fish growth. Invited oral presentation, Riparian Summit Conference. Korbel, California. April 2015.

Wilzbach, M., B. Hodge, W. D. Duffy, R. M. Quiñones, and J. A. Hobbs. Life history variation in Klamath River steelhead. Invited oral presentation, 145th Annual Meeting of the American Fisheries Society, Portland, Oregon. Aug 2015.

Wilzbach, M.A. Fisheries and Aquatic Resources of Prairie Creek. Invited oral presentation, Prairie Creek Technical Advisory Committee, Redwood National Park, Orick, CA. April 2016.

**SCIENTIFIC PUBLICATIONS**

Danehy, R., M. A. Wilzbach, Young, M. et al. Regional specific interactions of forests and fish. *in* Danehy, R. and A. Dolloff (eds.). Reflections on forest management: can fish and fiber coexist? American Fisheries Society, Bethesda. In review.

Drobny, P. 2016. Influence of intra- and inter-specific salmonid densities and habitat on overwinter survival of juvenile Coho Salmon in Prairie Creek. MS thesis. College of Natural Resources and Sciences, Humboldt State University, Arcata, CA.

Hodge, B., M. A. Wilzbach, and W. G. Duffy. 2014. Potential fitness benefits of the half-pounder life history in Klamath River Steelhead. Transactions of the American Fisheries Society 143:864-875.

Hodge, B., M. A. Wilzbach, W.D. Duffy, R. M. Quiñones, and J. A. Hobbs. Life history diversity in Klamath River steelhead. 2015. Transactions of the American Fisheries Society, 145:2,227-238, DOI: 10.1080/00028487.2015.1111257.

## UNIT STAFF

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Leslie Farrar, Unit Administrative Support: leslie.farrar@humboldt.edu

## GRADUATE STUDENT ASSISTANTS

Russ Bryant, Wildlife

Andrea Dockham, Fisheries

John Deibner-Hanson, Fisheries

Peter Drobny, Fisheries

Jon Hollis, Fisheries

Sam Rizza, Fisheries

Nick Van Vleet, Fisheries

**Student Technicians**

Chris Fabian
Wayne Hicks
Dylan Keel
Spencer Lejins
Lloyd Petrungaro

**Technicians**

Elizabeth Beilke
Charles Boone
Adam Canepa
Elizabeth Entzel
Melissa Gordon
Reed Hamilton
Steven Holt
Audrey Huff
Ariela Kester
Todd Newhouse
Laurel Osborn
Roderick Park
Lena Pine-Campbell
Matthew Settelmayer
Benjamin Sheppard

**RESEARCH ASSOCIATES AND COOPERATORS**

Nick Som, Affiliate Scientist
Christopher Manhard, Research Associate
Matt Metheny, Biologist