Brief History

of

U.S. Geological Survey Cooperative Fish & Wildlife Research Units

The Cooperative Fish and Wildlife Research Units date back to 1932 when J.N. “Ding” Darling invested $3,000 to establish the first Unit in Iowa. This investment was in response to reading a report prepared by Aldo Leopold and 14 other prominent conservationists. This influential report boldly stated that, “wildlife demand was stripping supply,” and there was a need to educate personnel to solve the wildlife conservation problems and to conduct research for wildlife management.

Three years later the first nine Units were established at land-grant universities. Utah was chosen to be one of the original nine established and was to represent the Intermountain West. Now 80 years later there are 40 Coop Units housed in land-grant universities across the Unit States including Alaska and Hawaii.
1935: First 9 Units

2016: 40 Current Units
Research Highlights

The Beaver: Helping Keep Water on Drying Lands

Beginning as early as the 17th century, beavers have struggled to find safe places to build their homes.

Initially, hunters trapped beaver extensively to keep up with the popular beaver fashions in Europe. Then as settlers began moving west, they considered the beavers annoying because of their tendency to cause flooding and damage trees - so the trapping continued.

However, today in many parts of the American West the beaver’s 400-year-old struggle is fading because of their ability to keep water on dry land in an efficient manner.

While beavers may not be welcome in most city limits, ranchers and wildlife managers are re-introducing them to rural areas where the benefits of their dams far outweigh the inconveniences.

One such place is the Della Ranches in west Box Elder County, where the Tanner family has been ranching for six generations. The ranch is located in a remote part of the state and has some of the best intact sagebrush habitat in Utah with strong populations of sage grouse and mule deer.

Most of the precipitation on the ranch, which averages less than 12 inches a year, comes as snow during winter and rain in April and May. By the end of the summer, the majority of the streams have dried up.

Having a sustainable water supply is an ongoing concern for the Tanners. They are searching for ways to keep water on the land throughout the summer.

Jay Tanner explains, “I considered building a reservoir or pond but it would be expensive, require quite a bit of maintenance, and permits. Beaver dams on the other hand are inexpensive, sustainable, and self-maintained.”

Kent Sorenson, habitat biologist from the Utah Division of Wildlife Resources described the financial benefit of the beavers, “[When beaver manage the dams] our operation and maintenance costs go to zero — they do all the work. They are 24/7 - 365-day maintenance crews that do not require a Corps of Engineers 404 permit.

When Jay Tanner learned of the potential benefit of beavers, he drove to Utah State University and met with scientists and researchers who had experienced success in restoring beavers in the west.

Eric Thacker, Rangeland Management Extension Specialist at USU said, “A beaver dam provides a buffer or mitigation for drought.” Once the dams are established, they keep the water on the land. This is beneficial to fish, wildlife and livestock.

Sage-grouse hens like to gather with their chicks in the wet meadows by beaver dams, where they can find plenty of insects and vegetation for their chicks.

After further discussions with USU, the Tanners entered into a multi-year partnership with the Quinney College of Natural Resources and Utah Division of Wildlife Resources to reintroduce beaver to their ranch. Currently, all involved are working to make the streams and surrounding area appropriate for new beaver families. Once the areas are ready and the correct permits are in place, UDWR will capture a beaver pair, keep them in quarantine for the appropriate amount of time then introduce the beavers to a stream on the Tanner Ranch.

Reintroducing a beaver couple instead of a single beaver is essential for the success of the project. They are social critters. Beaver will leave the location and go searching for a partner if they are not re-introduced with one.

In an established beaver dam, you will likely find monogamous parents with their babies called “kits”, their yearlings, and extended families.

Joseph Wheaton, Associate Professor in the department of Watershed Sciences and Principal Investigator on the project said, “If [this] project is successful, the implications are huge for instream and riparian restoration throughout the state of Utah as beaver are potentially an extremely cost-effective form of restoration…”

This piece aired on UPR’s Wild About Utah the week of April 17-21, 2017

Photo provided by USFWS
Some 20 years ago, I attended a meeting in Montana sponsored by the Rocky Mountain Elk Foundation under the initiative “Seeking Common Ground.” The initiative revolved around the impact increasing elk populations where having on ranching. The meeting was well attended with over 200 people present including a lot of local ranchers. The meeting facilitator opened the meeting with a call for increased collaboration among all in attendance. Suddenly, the large meeting hall was filled with a loud pounding noise that resonated throughout the hall, interrupting the facilitator and drawing attention to the source of the outburst. I happened to be sitting next to the source. The source of the noise was a local rancher, a WWII veteran, who had pounded his fist into the table when he heard the word “collaboration.”

He broke the uncomfortable silence he had created with his pounding fist with this statement. “Do you know what we did with collaborators in WWII,” he paused for effect then added, “We shot them”! Needless to say, his comments changed the entire dynamics of the room and meeting.

Depending on what dictionary or source you use, you can find multiple definitions of the word “collaboration.” One of them is “working with the enemy.” Since WWII and more recently the word collaboration has been applied to processes initiated over the last 20 years to being individuals and groups together to work on difficult natural resource or social issues to resolve deep conflicts. In almost all of these cases, the individuals and the groups they may represent have no history of working together because they have different interests, values, and perceptions and thus their perspectives differ greatly on what is the best approach to resolve the issue. They may have been, or are now, actual litigants seeking some remedy through the courts.

In 1996, Utah State University and the Utah Division of Wildlife Resources made a bold decision to “collaborate” with those most affected by conservation policy to develop a community-based conservation (CBCP) adaptive resources management local...

Story continues on page 32.
In 2016, the Utah Cooperative Fish and Wildlife Research Unit celebrates its 81st year of educating future wildlife and fisheries managers and conducting fish and wildlife research – all in an effort to preserve the natural resources of the Intermountain West. This is all possible due to the Agreement among its cooperators, Utah Division of Wildlife Resources (UDWR), the U.S. Geological Survey (USGS), and Utah State University. The Wildlife Management Institute and U.S. Fish and Wildlife Service also participate.

The major limiting influences on fish and wildlife resources in the Intermountain West are terrestrial habitat degradation and loss, and watershed and water development issues. Rapid population growth in the state, coupled with societal desires to access the wide range of natural resources available in the state, has exacerbated the pressures on both terrestrial and aquatic resources. These pressures require novel approaches to the study of, and transfer of research results to, those tasked with the responsibility to blend research information on the status and health of the state’s terrestrial and aquatic ecosystems with other societal values. The Unit’s principal role is to serve as nexus for the collection of this important information. We achieve this through excellence in research, instruction, and interaction with cooperators.

Research expertise of the Unit staff includes: landscape ecology, conservation biology, research design and applied statistics, larger scale animal dynamics, geographical information system and habitat restoration methodology, terrestrial and aquatic habitat analysis, population management and assessment, fish population dynamics, and aquatic food web dynamics. Current research activities focus on landscape-level habitat studies, ecological modeling of lake, reservoir, and riverine systems, avian and terrestrial ecology, and the effects of climate change on habitat and biota throughout the Intermountain West. Future research directions of the Unit will continue to involve endangered fish and wildlife species, sustainable game and sport fish management, and landscape-level studies involving modeling for future climate scenarios.

Primary graduate and cross-listed graduate/undergraduate level courses taught by unit personnel include Design and Analysis of Ecological Research (WILD 6500, emphasizes the research process), Graduate Fish Ecology (WATS 6230), and Fish Diversity and Conservation. Unit personnel have also developed and provide instruction in continuing education and professional advancement short courses for agency personnel, with a current emphasis on analytical tools used by DWR biologists. The Unit also facilitates instruction in a diverse array of workshops developed by cooperating Faculty at QCNR to a wide range of agency cooperators as well.

Cooperating faculty in the Quinney College of Natural Resources (QCNR), the Ecology Center, and across the University (USU) are, and will continue to be, integrated into Unit research to apply diverse expertise to all facets of a research problem. The primary goal of the Unit is to provide high quality information necessary to help resolve pressing natural resource problems. The Unit strives to do this by bringing to bear expertise found not only in the Unit staff, but also in the diversity of cooperating faculty found at USU.
2016 Research Contracts & Grants
Funding Summary by Source

- UDWR - Utah Division of Wildlife Resources
- USGS - U.S. Geological Survey
- BLM - Bureau of Land Management
- BOR - Bureau of Reclamation
- USFWS - U.S. Fish and Wildlife Service
- DOI CSC - South Central Climate Science Center
- NASA - National Aeronautics and Space Administration
- NSF - National Science Foundation
- USFS - U.S. Forest Service
# Sampling of USU Alumni Working for UDWR

<table>
<thead>
<tr>
<th>Name</th>
<th>Job Title</th>
<th>USU College</th>
<th>Major</th>
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<td>J.D. Abbott</td>
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<td>Paul Vincent Badame</td>
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<td>Bryan Christensen</td>
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Photo by Colton Finch
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<td>Jason D. Jones</td>
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**SUMMARY:**

- Natural Resources 93%
- Science 5%
- Agriculture 2%
**Publications**

**BISSONETTE**

**PUBLISHED**


**Budy**

**IN REVIEW**


Klobucar, S., T.W. Rodgers, and **P. Budy**. In review. At the forefront: evidence of the applicability of using environmental DNA to quantify the abundance of fish populations in natural lentic waters with additional sampling considerations. Submitted 26 March 2017. Canadian Journal of Fisheries and Aquatic Sciences: Rapid Communication.

**BOOK CHAPTERS**


**PUBLISHED**


EDWARDS

IN REVIEW


BOOK (IN REVIEW BY PUBLISHER, FSP)


PUBLISHED


Presentations

BUDY

CONFERENCES


Stout, J.B., M. Conner, P. Budy, P. MacKinnon, and M. McKinstry. 2016. Improving our ability to estimate vital rates of endangered fishes
on the San Juan River using novel applications of PIT tag technology. American Fisheries Society, Utah Chapter, March 17, 2016, Altamont, UT.

Maloney, B., J. Gaeta, and **P. Budy.** 2016. Evaluating habitat-based niche requirements for the bluehead sucker (*Catostomus discobolus*): Can we identify the cause of a recruitment bottleneck? American Fisheries Society, Utah Chapter, March 17, 2016, Altamont, UT.


**INVITED PRESENTATIONS**

**Budy, P.** 2016. Arctic Lakes: Where are we in the current project? Where are we going? Arctic LTER Annual Meeting 2016, Woods Hole Marine Biological Station, April 6, 2016, Woods Hole, MA.

**Budy, P.** 2016. Towards a better understanding of factors that limit and facilitate one of the world’s most invasive fishes. Invited Department Seminar, University of Wyoming, February 19, 2016, Laramie, WY.

**Budy, P.** 2016. Understanding the effects of increased drying on desert rivers and fishes: how can we avert the “perfect storm”? Honorary Speaker for 2016: Portneuf Subunit of the Idaho Chapter of the American Fisheries Society. Idaho State University, April 28, 2016, Pocatello, ID.


**EDWARDS**

**CONFERENCES**


INVITED PRESENTATIONS


Edwards, T.C., Jr. How useful is hindcasting as a modelling approach to enhance forecast projections of species distribution models? Invited paper, Université Grenoble Alpes,
Popular Media

BUDY

MULTI-MEDIA
Bonneville cutthroat trout conservation video. Produced by the Quinney College of Natural Resources and also showed on UDWR Facebook page, where it reached >20,000 people on May 9: https://www.facebook.com/UtahDWR/videos/1257954494215560/. 2016.

PRINT

EDWARDS

RADIO


PRINT


February 8, 2016. Interview with Utah State Today (MaryAnn Muffoletto). “NASA Satellites help ecologist to map seasons, mule deer reproduction.”

August 20, 2015. Interview with Ogden Standard Examiners (Leia Larsen). “Cougar plan causes uproar among conservationists.”

November 11, 2014. Interview with Ogden Standard Examiners (Leia Larsen). “Understanding mountain lion behavior helps reduce human conflicts.”

INTERNET


2 April 2016. Researchers tap into space satellites to predict when does are due. http://www.oregonlive.com/today/index.ssf/2016/04/nasa_taps_into_space_satellite.html?


LEAVITT (COOP EXTENSION AND OUTREACH)

RADIO

INTERNET


PRINT


Summer 2016. Coop Catchup Newsletter, Issue 72, U.S. Geological Survey Fish & Wildlife Cooperative Research Unit Program. (Editor)

Research Grants (Active)

**BUDY**


2010-present. Arctic LTER: Climate Change and Changing Disturbance Regimes in Arctic Landscapes: LAKES. Principal Investigator: **P. Budy.** National Science Foundation (NSF), UDWR, Total Award to date $192,000.

2015-present. Adaptive management with and installation and development of methods and analyses for PIT tag technology and data. Principal Investigators: **P. Budy and M. Conner.** Bureau of Reclamation (DOI), Total Award $650,000.

2013-present. Understanding the effects of wildfire on fish populations and stream geomorphology in Twitchell Canyon. Principal Investigator: **P. Budy.** Utah Division of Wildlife Resources (UDWR) Total Award to date $209,556.

2012-present. San Rafael River Restoration Science: Restoration Implementation & Monitoring. Principal Investigator: **P. Budy.** Bureau of Land Management $684,588, Utah Division of Wildlife Resources $26,304, Total Award to date $710,892.


2013-2016. Quantifying pelican predation potential on the fish community of Strawberry Reservoir, Utah (UDWR) and Cutthroat trout restoration (USFS-RMRS). Principal Investigator: **P. Budy.** UDWR, USFS, Total Award to date $190,345.

2011-present. Evaluating cutthroat trout performance and identifying limiting factors for the native fish community of Pyramid Lake, Nevada. Principal Investigator: **P. Budy.** Utah State University, USFWS, Great Basin Cooperative Ecosystem Unit (CESU), Total Award $394,769.

2011-present. Tributary habitat use of endangered and imperiled fishes in the Price River, Utah. Principal Investigator: **P. Budy.** Bureau of Reclamation (BOR), Activities to Avoid Jeopardy Program, Total Award $166,452.

2011-2015. Movement and habitat studies of endangered fishes in the Colorado River Basin. Principal Investigator: **P. Budy.** Bureau of Reclamation (BOR), Activities to Avoid Jeopardy Program, Total Award to date $233,769.

2002-present. Limiting factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah: population dynamics, disease, and synergistic effects. Principal Investigator: **P. Budy.** Utah Division of Wildlife Resources, Total Award to date $714,454.

EDWARDS


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**Photo by Colton Finch**

National Science Foundation, Total award $180,000.


2015-2017. Distribution patterns and vegetation dynamics of forest canopy trees in the Northern Pantanal, Mato Gross, Brasil. Principal Investigator: **T.C. Edwards, Jr.** República Federativa do Brasil, CNPq & CAPES, Total award $46,600 (R$175,000).

2015-2016. Weather and primary productivity mediated effects on mule deer population dynamics across a latitudinal gradient. Principal Investigator: **T.C. Edwards, Jr.** Utah Division of Wildlife Resources, Total award $37,400.

2014-2017. An inventory and modelling system for rare plants in the Intermountain West. Principal Investigator: **T.C. Edwards, Jr.** Bureau of Land Management, $225,000, Utah Department of Natural Resources (ESMF funds), $137,400, U.S. Fish and Wildlife Service, $26,600, Total Award to date $389,000.


Graduate Students Directed

**BUDY**

**COMPLETED**


Chapman, Kevin. In progress. Evaluating the potential direct and indirect impacts of American white pelican predation on Bonneville cutthroat trout in Strawberry Reservoir, Utah. MS Thesis. Ecology. Utah State University. **Slated date of completion: Unknown.**

Klobucar, Stephen. In progress. Understanding how arctic lake fish populations and communities are structured and function with special consideration of the potential effects of climate change. PhD Dissertation. Ecology. Utah State University. **Slated date of completion: Fall 2017.**


Maloney, Bryan. In progress. Evaluating habitat-based niche requirements for the bluehead sucker (*Catostomus discobolus*): can we identify the cause of a recruitment bottleneck? Co-advised with Jereme

**IN PROGRESS**

Graduate Students Directed

**BUDY**

**IN PROGRESS**

Chapman, Kevin. In progress. Evaluating the potential direct and indirect impacts of American white pelican predation on Bonneville cutthroat trout in Strawberry Reservoir, Utah. MS Thesis. Ecology. Utah State University. **Slated date of completion: Unknown.**

Klobucar, Stephen. In progress. Understanding how arctic lake fish populations and communities are structured and function with special consideration of the potential effects of climate change. PhD Dissertation. Ecology. Utah State University. **Slated date of completion: Fall 2017.**


Maloney, Bryan. In progress. Evaluating habitat-based niche requirements for the bluehead sucker (*Catostomus discobolus*): can we identify the cause of a recruitment bottleneck? Co-advised with Jereme


Newlon, Courtney. In progress. Identifying cues for movement and temporally-dynamic limiting factors in the bull trout movement corridor. Slated date of completion: Spring 2017

MNR GRADUATE COMMITTEE ADVISEMENT – CURRENT

Calvin Black, Utah Division of Wildlife Resources, Fisheries Reed Chaston, Utah Division of Wildlife Resources, Fisheries Michael Fiorelli, Utah Division of Wildlife Resources, Fisheries Seth Elsen, Hood Canal Enhancement Group, Fisheries

EDWARDS

IN PROGRESS

Sims, Andrew (Steven). In progress. Effects of interannual climate and primary productivity on mule deer survival and fecundity. MS Candidate.

Utah State University. Slated date of completion: Spring 2017

MNR GRADUATE COMMITTEE ADVISEMENT – CURRENT

Kari Coy, Management of Phragmites, Western Enviro Resources
Lindsey Washkowiak, Rare plant distribution models, U of Wyoming Nature Conservancy

Research Associates Directed

BUDY

Thiede, Gary P. 2002 - present. Lab manager. Oversees all Fish Ecology Lab research project logistics including report writing, permitting, field and lab work, and technician supervision, and contributes intellectually to science.


Gibson, Jacob. 2012 - present. Step-Down Analysis of Plants and Animals under the BLM Rapid Ecoregional Analysis. Research Associate.


EDWARDS

Dr. E. Becares, Dept. of Ecology, University of Leon, Spain, (2014, 2015). Limitation and facilitation of one of the world’s most invasive fish: an intercontinental comparison.


EDWARDS

Dr. Nadja Machado, Professor, Federal Institute of Mato Grosso, Graduate Program in Environmental
Undergraduate Research Projects Advised

**BUDY**


Simmons, L. 2016. Big fish in a small pond or small fish in a small pond? Investigating arctic char dimorphism with consideration of predator-prey interactions. Oral presentation at the Utah Chapter, American Fisheries Society Meeting, March 2016, Altamont, UT.


BUDY

**Bissonette**

*INVITED EXTERNAL THESIS/DISSERTATION EXAMINER*

Reviewed Ph.D. dissertation for University of Freiburg

*REVIEWER*


**BUDY**

*PEER REVIEWER FOR:*


Physics, Instituto Federal de Mato Grosso, Campus Cuiabá - Bela Vista, BRASIL. (*Program is Brazilian version of the U.S. Fulbright Program). Collaborative Research with T.C. Edwards: Selection of priority areas for conservation in Mato Grosso state based on ecological niche modeling, potential distribution of species and landscape structure.

PROFESSIONAL SERVICE
Ecology of Freshwater Fish, Editor, 2015-present

EDWARDS

PEER REVIEWER FOR:

PROFESSIONAL SERVICE
General-Secretary, International Association for Landscape Ecology, 2009-current.

Workshops & Training

BUDY

Fish Diversity and Conservation (WATS 3100 lecture, 3110 laboratory). Utah State University, College of Natural Resources, Watershed Sciences Department (Co-taught with J. Gaeta).

EDWARDS

WILD 6900 baseR: Management and Manipulation of Ecological Data Using R, Spring 2016, 13 students (graduate)

WILD 6500 Biometry: Design and Analysis of Ecological Research Using R, Fall 2016, 24 students (graduate)

WILD 6900 baseR: Management and Manipulation of Ecological Data Using R, Fall 2016, 27 students (4 undergraduate, 23 graduate)


Honors & Recognition

BUDY

USU S.J. and Jessie E. Quinney, College of Natural Resources, Large and Notable Grant Recipient Award. Research Week Awards Gala. April 2016.

Selected Outreach Activities

BUDY

The Native American Summer Mentorship Program- 25 Undergraduates from the Navajo Tribe. Field Trip to USU. Lab visit to Budy Fish Ecology Lab: 1) explained the lab and structure: what do we do, fish and ecology research studies, 2) described some projects in Utah: some hands on items (pelican puke, PIT tags), and 3) described undergrad opportunities in detail: technician work, undergraduate research. 9 May 2016.
Flower’s beardtongue species distribution model 2015-2016

Flower’s beardtongue (Penstemon flowersii) is a species of concern in the Uinta Basin. Its range is limited, found in only a small area near Myton, Utah. Energy development projects surround the habitat and are now planned to commence in the known habitat area. The species grows mostly on private and tribal lands, with one small parcel on Bureau of Reclamation lands and another small plot owned by The Nature Conservancy. A petition to list Flower’s beardtongue under the Endangered Species Act was rejected, but with new development, pressure to classify Flower’s beardtongue as Endangered or Threatened is mounting. To aid in evaluating the proposed endangered species listing we created a species distribution model using existing location and habitat information. The model was used to explore likely locations for new occupied sites. Final model prediction accuracies were >93%.

FUNDING
Utah DNR Endangered Species Mitigation Funds

INVESTIGATORS and STUDENT RESEARCHERS
Robert Fitts, Research Associate
Mindy Wheeler, Research Associate
Benjamin Gibbons, Undergraduate Researcher Technician
Kristian Valles, Undergraduate Researcher Technician

FACULTY SUPPORT
Thomas Edwards USGS, UTCFWRU, USU Wildland Resources

PROJECT PERIOD

FIGURE CAPTION:
Spatially explicit prediction model for Flower’s penstemon. Darker browns indicate high model concordance and hence greater reliability in the likelihood of plant presence.
learnR: Data management, manipulation, and analysis of ecological data using R

The nature of analytical tools employed by University, Federal, State, Tribal and NGO researchers and scientists for analyzing ecological data has changed dramatically from commercial packages (e.g., SAS, SYSTAT) to an open source (“freeware”) environment. Central to this new approach towards analysis of ecological data is R. As a self-described statistical computing package, R rests on a core set of analytical base “packages” augmented by an extensive library of contributed analytical packages. While end-users can learn R by themselves through trial and error, experience indicates some level of base training is required to jump-start end-users. Much of this training can occur in traditional classroom settings, but the nature of R makes it amenable to distance delivery methods. This proposal will generate a set of courses in R amenable for online delivery, including through DOI Learn.

FUNDING
U.S. Geological Survey, Office of Employee Development

INVESTIGATORS
N/A

FACULTY SUPPORT
Thomas Edwards USGS, UTCFWRU, USU Wildland Resources

PROJECT PERIOD
April 2016 – April 2018

FIGURE CAPTION:
Web interface to learnR.

Spatial Responses to Climate across Trophic Levels: Monitoring and Modeling Plants, Prey, and Predators in the Intermountain Western United States

We investigated the impact of climate on trophic linkages between primary productivity, herbivores, and top predators across western United States landscapes. Using the 2011 NLCD land-cover map and 14 years of MODIS NDVI composites of vegetation, we modeled land surface phenology based on geospatial climate datasets, including interpolated, remotely sensed, and topo-climatic variables derived from digital elevation models. The research fits niche-based distribution and animal movement models to remotely sensed data in order to describe the linkages between climate and ecosystems across the primary producer, herbivore, and predator trophic levels. The research has gathered time series of satellite images and coincident direct measurements of predator-prey communities over nearly a decade, as well as static soil, topography, and other geospatial data layers into a model ecosystem to inform natural resource management across the region. A total of 10 publications resulted from my project oversight. As a research group, we made 25 research presentations at professional meetings over the course of the project. In addition, we made seven presentations we describe as outreach, including portrayal of some of our collected movement information on the NASA Hyperwall.

FUNDING
National Aeronautics and Space Administration (NASA)

INVESTIGATORS & COOPERATORS
David Stoner, Research Associate
Andrew Sims, Graduate Student
USGS Southwest Biological Science Center, Flagstaff
USGS Western Science Center, Las Vegas
University of Maryland, Global Land Cover Facility

FACULTY SUPPORT
Thomas Edwards, USGS, UTCFWRU, USU Wildland Resources

PROJECT PERIOD
September 2011 – July 2016

Step-down demo analysis of plants and animals under the BLM Rapid Ecoregional Analysis Process

Three combined efforts serve as a step-down demonstration analysis of the Bureau of Land Management’s (BLM) Rapid Ecoregional Assessment (REA) process which is currently being implemented across BLM-owned and managed lands. These include (i) quantitative assessments of a Gunnison sage-grouse bioclimatic model, and map products of projected grouse distributions and habitat under climate and land-use change scenarios; (ii) optimization models for identifying watersheds of highest restoration potential, targeting aspen habitat as an example; (iii) use of REA-based datasets on an independent project funded from other sources (i.e., rare plants and energy development); and (iv) development of a set of workshops on how REA data can be used by field managers. The workshops are designed to inform BLM land managers on how the REA databases can be used for current management issues of concern to BLM, and what additional site-specific data may need to be gathered and where.

FUNDING
Bureau of Land Management

INVESTIGATORS
Jacob Gibson, Research Associate

FACULTY SUPPORT
Thomas Edwards, USGS, UTCFWRU, USU Wildland Resources
David Koons, USU Wildland Resources
Edd Hammill, USU Watershed Sciences

PROJECT PERIOD
August 2012 – July 2017

FIGURE CAPTION: Spatially explicit depiction of change in selected climate variable. “More red” indicates higher rate of change in an area. Note Gunnison Basin (white). Indicates a rate of change outside the norms of the region.

Utah threatened and endangered plant inventory: Modelling rare plant species distributions in the context of multiple-use land management

Utah is the home of approximately 340 endemic plant taxa. Many of these are considered species of concern at both State and Federal levels, with the U.S. Fish and Wildlife Service having responsibility for reviewing the species of concern for possible listing under the Endangered Species Act. Of special interest are identifying, mapping, and modelling known and possible locations of the species on public lands. The botany element of the Utah Natural Heritage Program, now housed in the Quinney College of Natural Resources, Utah State University, will survey for plants considered for review by the Fish and Wildlife Service, along with other species where little information is available. Species distribution models will be built for each species and analyzed in the context of ongoing management issues on public lands, especially energy development.

FUNDING
Bureau of Land Management
Utah DNR

INVESTIGATORS
Robert Fitts, Research Associate
Mindy Wheeler, Research Associate
Benjamin Gibbons, Undergraduate Research Technician
Kristian Valles, Undergraduate Research Technician

FACULTY SUPPORT
Thomas Edwards, USGS, UTCFWRU, USU Wildland Resources
Edd Hammill, USU Watershed Sciences

PROJECT PERIOD
October 2012 – September 2017

FIGURE CAPTION: Predicted distribution of the hookless cactus (darker brown, higher presence likelihood) in relation to known presence (green) and absence (red). Blue are random field sample test locations.
Weather and primary productivity medicated effects on mule deer population dynamics across a latitude

This research increases understanding of how climate influences deer demographic rates in Utah, and how these rates may change in the future. The objectives of this study are to: (i) model and project deer survival and fecundity for a range of environmental conditions at the wildlife management unit (WMU) level; (ii) identify WMU’s where deer productivity and survival is most likely to change due to variation in weather and NDVI; and (iii) examine current deer survival rates and determine if they are truly representative of the surrounding units. By combining NDVI and climatic variable data, we will be able to determine how WMU’s differ and be able to evaluate if Utah Division of Wildlife Resources (DWR) is monitoring survival on the appropriate units. Additionally, the results will inform DWR as to which deer units are over or underperforming and how this will likely change with changing climate.

FUNDING
Utah Division of Wildlife Resources (match to NASA funding)

INVESTIGATORS
Andrew Sims, M.S. Graduate Student

FACULTY SUPPORT
Thomas Edwards, USGS, UTCFWRU, USU Wildland Resources
David Koons, USU Wildland Resources

PROJECT PERIOD
August 2014 – December 2016

FIGURE CAPTION: Adaptive forecasting example. Top figure is initial forecast: note it over predicts. Data from two months into the year (middle figure) improves forecast of juveniles, but it requires six months into year to improve forecast for adults.

Habitat modeling of rare plant species in the Intermountain West

This project increases knowledge on rare plants in the Intermountain West by continuing to (i) implement sampling, data organization, and modelling protocols developed previously, with an expansion outside of the extent of the Colorado Plateau; (ii) expand modelling efforts to now include abundance estimates, and species-specific occupancy estimates, where data density is sufficient; and (iii) begin development of a more encompassing data structure amenable to BLM REA Data Portal. The Utah Natural Heritage Program will continue to provide detailed GPS based locations of sensitive species, along with abundance measures of individual plants at sample locations. This information will update older reports of the species using hand drawn maps of plant clusters and rough estimates of numbers of individuals. The information gathered at negative (i.e., true absence) points will be used to better define the habitat of the sensitive species, and help in future surveys for rare plants. Collection of these data is part of a longer-term strategy to survey these species and obtain sufficient data for spatial modelling efforts.

FUNDING
Bureau of Land Management

INVESTIGATORS
Robert Fitts, Research Associate
Mindy Wheeler, Research Associate
Benjamin Gibbons, Undergraduate Research Technician
Kristian Valles, Undergraduate Research Technician

FACULTY SUPPORT
Thomas Edwards, USGS, UTCFWRU, USU Wildland Resources
David Koons, USU Wildland Resources

PROJECT PERIOD
October 2012 – September 2017

FIGURE CAPTION: Spatially explicit prediction model for Elizabeth’s milkvetch.
Improving our ability to estimate vital rates of endangered fishes on the San Juan River using novel applications of PIT tag technology

Accurate estimates of vital rates are essential for tracking and understanding the successful recovery of endangered species such as the razorback sucker and the Colorado pike-minnow. Mobile Passive Integrated Transponder (PIT) tag antenna systems (e.g., on a floating raft) have recently been developed to increase resight rates; however, mobile systems present new challenges. Tags, not fish, are detected thus increasing the chance that shed tags or dead fish with tags are being detected which could lead to over-estimation of survival. Our goal is to address this limitation and determine if the addition of mobile detections can improve vital rate estimates. Our field work concentrates on 273 kilometers of San Juan River designated critical habitat. PIT tags were seeded in the river to quantify dead/shed tag movement. Live fish movements were identified by matching tag detections with live capture data. Preliminary results suggest that even dead tags move much greater distances than initially thought. This method may be useful in censoring data and increasing fish resighting numbers, which will improve the accuracy and precision of estimates of vital rates, while also providing new information about post stocking location and habitat associations.

FUNDING
U.S. Bureau of Reclamation

INVESTIGATOR
Ben Stout, M.S. Candidate

FACULTY SUPPORT
Phaedra Budy, USGS UTCFWRU, USU Watershed Sciences, Ecology Center
Mary Conner, USU Wildland Resources, Ecology Center

PROJECT PERIOD
June 2015 – December 2017
Evidence of the applicability of using environmental DNA to quantify the abundance of fish populations in natural lentic waters with additional sampling considerations

In the Arctic, we are using a multifaceted approach combining field observations, experiments, and modeling techniques to improve our understanding of lake ecosystems in a changing climate. In one component, we investigated the relationship between eDNA concentration and arctic char (Salvelinus alpinus) abundance in five natural lakes, and additionally, we examined the effects of different temporal (e.g., season) and spatial (e.g., site, depth) scales on eDNA concentration. Concentrations of eDNA were linearly correlated with fish abundance ($R^2 = 0.82$) and exponentially correlated with density ($R^2 = 0.97$ by area; 0.85 by volume). Across lakes, eDNA concentrations were greater and more homogeneous in the water column during mixis; however, when stratified, eDNA concentrations were greater in the hypolimnion. Overall, our findings demonstrate that eDNA techniques can produce effective estimates of relative fish abundance in natural lakes. These findings can guide future research and management of important fish populations (e.g., conservation, subsistence resources) in a changing climate using rapid and minimally invasive sampling.

**FUNDING**
National Science Foundation
Ecology Center, Utah State University
U.S. Geological Survey - UCFWRU (in-kind)

**INVESTIGATORS**
Stephen Kloobcar, PhD Candidate
Tyler Arnold, Undergraduate Researcher

**FACULTY SUPPORT**
Phaedra Budy, USGS-UCFWRU, USU Watershed Sciences, Ecology Center

**PROJECT PERIOD**
October 2010–February 2022

Twitchell Fire Research: Habitat-based predictions of cutthroat trout biomass in burned streams

Post-fire debris flows and channel reorganization often create visually dramatic habitat alterations. However, habitat quality for salmonids is an aggregate of physical conditions and the limiting factor in burned watersheds may not be visually apparent. Our objective was to identify habitat characteristics that predict trout biomass between burned and unburned watersheds. We measured numerous habitat attributes and used a linear mixed-effects model to determine the best predictor of Bonneville cutthroat trout biomass. Percent canopy cover is the best predictor of cutthroat biomass, with water depth as the second best predictor and year and stream as random effects. Our quantitative descriptions of the relationship between habitat and biomass can improve the efficiency of habitat restoration and improve our understanding of the population viability and ecology of these culturally and economically important fishes.

**FUNDING**
Quinney College of NR, PhD Fellowship
U.S. Forest Service
Utah Division of Wildlife Resources
USU Ecology Center
Utah U.S. Geological Survey-UCFWRU (in-kind)

**INVESTIGATORS**
Colton Finch, PhD Candidate

**FACULTY SUPPORT**
Phaedra Budy, USGS-UCFWRU, USU Watershed Sciences, Ecology Center
Patrick Belmont, USU Watershed Sciences
Brett Roper, FS & USU Watershed Sciences
Sarah Null, USU Watershed Resources
Nancy Huntly, USU Ecology Center

**PROJECT PERIOD**
August 2013 - August 2017
Evaluating habitat-based niche requirements for imperiled bluehead sucker (*Catostomus discobolus*); identifying potential recruitment bottlenecks

Bluehead sucker (BHS; *Catostomus discobolus*) now occupy only 47% of their historic range, and the genetically-distinct Weber River (N. UT) population is experiencing a likely recruitment bottleneck. The many dams and diversions altering fish habitat and flow and thermal regimes in the Weber River may contribute to the recruitment bottleneck. Our objectives were to determine whether spawning and rearing habitat available in the river is limiting BHS recruitment. We used reach-based surveys to locate and quantify spawning habitat and we sampled backwaters near spawning reaches to evaluate rearing habitat. We conducted laboratory experiments to determine optimal temperatures and velocities for juvenile growth. Availability of pools, gravels, and cobbles were important components of spawning habitat. Juvenile sucker abundance increased significantly with depth of backwaters, and juvenile growth was greatest in cooler temperature and slower velocity treatments. Collectively, these results suggest BHS recruitment may be limited by availability of small, rocky substrate and pools for spawning and deep, slow backwaters at the optimal temperature for rearing. By evaluating factors that may limit BHS recruitment, this study will provide a template for future restoration efforts directed at recovering this imperiled population.

**FUNDING**

**INVESTIGATORS**
Bryan Maloney, M.S. Candidate

**FACULTY SUPPORT**
Phaedra Budy, USGS, UTCFWRU, USU Watershed Sciences
Jerome Gaeta, USU Watershed Sciences, Ecology Center

**PROJECT PERIOD**
April 2015 – April 2017

Factors affecting fish population dynamics, abundance, and distribution: Logan River trout viability and long-term monitoring

A majority of cutthroat trout populations are imperiled or extinct due to habitat degradation and exotic species. To quantify abundance and vital rates and evaluate trends, we selected a large population of Bonneville cutthroat trout from the Logan River, Utah, a river consisting of high-quality, connected habitat. Over the past 16 years, we have completed a comprehensive population assessment, including abundance estimates and a mark-recapture study of site fidelity, growth, and survival. Abundance of cutthroat trout varied greatly by sample site, ranging from 38 fish/km at lower elevations up to 822 fish/m at higher elevations. Population trend (λ) of cutthroat trout estimated for this entire population based on pooled site abundance estimates was 0.89 (0.77 – 1.02), indicating an apparent overall decline; however, confidence intervals overlapped λ = 1 and site-specific population trends are highly variable. The new population of cutthroat trout restored to the Right Hand Fork tributary continues to increase (now 420 fish/km) and adults are now up to 320 mm long. Our results provide important conservation and recovery benchmarks for identifying rangewide limiting factors of native cutthroat trout.

**FUNDING**
U.S. Forest Service
U.S. Geological Survey–UCFWRU (in-kind), Utah Division of Wildlife Resources (UDWR)
UDWR Dedicated Hunter Program
Trout Unlimited and others.

**INVESTIGATORS**
Gary P. Thiede, Research Associate
Thomas Hafen, Undergraduate Technician
Justin Dorathy, Undergraduate Technician
Kendra Nichols, Undergraduate Technician
Ethan Reynolds, Undergraduate Technician
Brad Winger, Undergraduate Technician

**FACULTY SUPPORT**
Phaedra Budy, USGS, UTCFWRU, USU-Watershed Sciences, Ecology Center

**PROJECT PERIOD**
2001- 2016 (on-going)
Assessment of the ecological structure and function of the Rio Grande River in Big Bend N.P., Texas

My project involves understanding how the aquatic ecology, with an emphasis on the native fish community, has been impacted by the modern flow and sediment regimes of the Rio Grande River. From the data I have collected thus far, I found fish diversity was higher in canyon sites than the alluvial valley sites of the river. The fish community also tended to be more diverse at sites I considered more complex in terms of in-channel mesohabitat types. For the upcoming year, I plan to complete my field sampling in Big Bend NP, and begin stable isotope analyses to reconstruct the aquatic food web of the Rio Grande. Reconstructing the food web will allow me to identify any critical limiting factors associated with the native fish diversity of the Rio Grande. My work will contribute to the ecological understanding of the Rio Grande River, and contribute to potential management goals aimed at sustaining the aquatic and physical integrity of this desert river.

FUNDING
National Park Service
USGS Climate Science Center

INVESTIGATORS
Demitra Blythe, M.S. Candidate
Todd Blythe, M.S. Candidate
Brian Laub, Assistant Professor

FACULTY SUPPORT
Phaedra Budy, USGS, UTCFWRU, USU-Watershed Sciences, Ecology Center
Jack Schmidt, USU Watershed Sciences
Janice Brahney, USU Watershed Sciences

PROJECT PERIOD
January 2016 - May 2018
working group (LWG) process throughout Utah to begin addressing localized threats to sage-grouse (*Centrocercus* spp.) and sagebrush obligate species that inhabit Utah. Over time, this process has enhanced communications and collaboration among private stakeholders, local, regional and state governments, and state and federal management agencies and mitigated regional and statewide conservation threats to sage-grouse and other sagebrush obligate species. The first LWGs met 8 years before environmental organizations petitioned the U.S. Fish and Wildlife Service (USFWS) to list the sage-grouse as endangered under the federal Endangered Species Act (ESA).

In March 2010, the USFWS designated greater sage-grouse (*C. urophasianus*) as a candidate species for ESA protection. Their decision was based on continued habitat fragmentation and inadequate regulatory mechanisms at the local, state, and federal levels to curtail the impacts. Because sage-grouse are landscape species that inhabit lands owned and managed by multiple jurisdictions, the preservation of large tracts of suitable habitat and the management of these areas to maintain connectivity between populations will be paramount to their conservation. Listing of the sage-grouse for protection under the ESA would limit state management authority and impact local, state and regional economies.

Within Utah, Governor Gary H. Herbert chartered a Task Force to develop recommendations for a statewide plan for the conservation of sage-grouse and provide for the continued economic health of the state. In 2013, the Conservation of Greater Sage-grouse in Utah (Plan) was published. The Plan would not have been possible without the two decades of research and community involvement accomplished by CBCP. In February 2015, Governor Herbert signed an Executive Order (EO) to fully implement the Plan. The EO recognized and credited the CBCP and the LWGs for conducting the baseline research and community involvement essential to building the Plan. Because the LWGs’ efforts, the state of Utah possessed unparalleled knowledge about the factors essential to the species conservation. The LWG Plans were aggregated into a statewide plan for sage-grouse. The collective result provided an organized approach for addressing the factors used by the USFWS to measure the success of conservation actions.

Utah’s LWGs clearly demonstrated the importance of the knowledge and values of local communities, those communities often most affected by conservation policies, in developing sound conservation policies. This local knowledge is increasingly being sought and acknowledged by federal and state agencies and non-governmental organizations because of their valuable contributions to natural resources conservation and management. The success of these relationships has been linked to reciprocity and transparency in information exchange, common goals, enhanced understanding of rules of law and social processes, and shared scientific discovery, which collectively created a foundation for mutual trust. These social engagement processes, often referred to as local working groups, are enhancing the connectedness of communities to government and shaping individual and group action leading to increased ownership and positive outcomes. Through these processes, innovation, new ideas, and risk taking are encouraged. However, even given innovative successes, there remain practical and policy challenges and unresolved questions regarding how governments view and respond to communities empowered to make their own decisions.

To shed some light on these unresolved questions, Utah State University Extension, Utah Public Lands Policy Coordination Office, Utah Department of Natural Resources, and Utah Division of Wildlife Resources are hosting a symposium from 8-12 AM Wednesday, February 1, 2017, at the 70th Annual Meeting of the Society for Range Management. The symposium will be held in St. George, Utah (Ballroom F of the Dixie Conference Center, 1835 S Convention Center Dr.; there is a registration fee). The symposium will feature case studies that explore the range of community involvement in natural resources conservation decision-making.

For more information about the program go visit the CBCP website at www.utahcbcp.org.
We wish you all safe and successful research this coming year!