

IN COOPERATION WITH:



SJ. & JESSIE E. QUINNEY
COLLEGE OF
NATURAL RESOURCES
UtahStateUniversity



*U.S. Geological Survey - Utah Division of Wildlife Resources - Utah State University
The Ecology Center - U.S. Fish and Wildlife Service - Wildlife Management Institute*

Annual Report 2017

U.S. Geological Survey, Utah Cooperative
Fish & Wildlife Research Unit

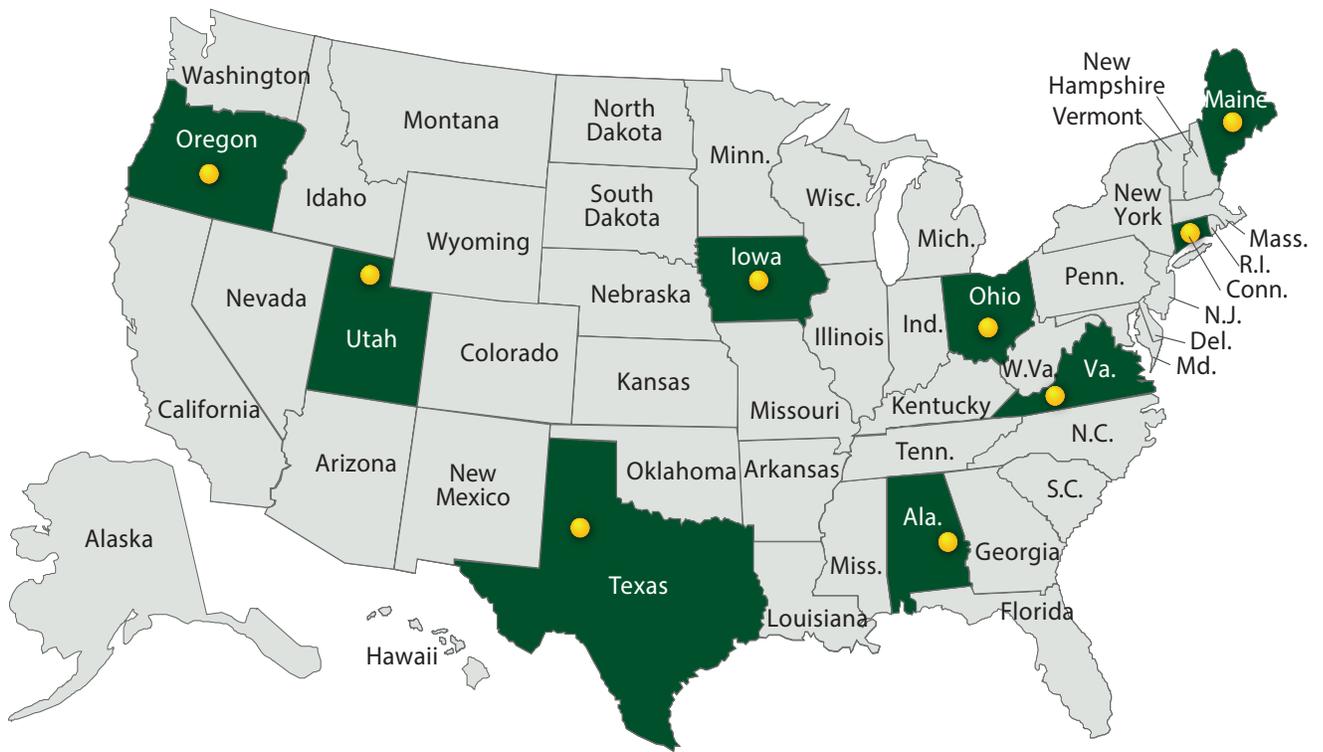
*Brief History
of
U.S. Geological Survey Cooperative Fish
& Wildlife Research Units*

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 United States including Alaska and Hawaii.

Cover Photo by Tom Edwards

Oenothera caespitosa, Common names: Evening primrose, Tufted evening primrose, Fragrant evening primrose.



1935: First 9 Units



2016: 40 Current Units

Research Highlights

South Canyon Sage-Grouse PI: Nicki Frey

At 3:00 a.m. on a frigid winter morning Nicki Frey, an extension associate professor in the Department of Wildland Resources at USU, leads a group of new biologists trapping west of Bryce Canyon. Cold, deep snow is all they see on the valley floor.

The group is looking for the greater sage-grouse whose GPS transmitters are sending Frey signals, indicating they are nearby. For best results, researchers trap sage-grouse on moonless nights. The only light they have comes from the ATVs and headlamps.

Frey explains, “Southern Utah is the farthest southern location where greater sage-grouse live in the U.S. This valley is part of their winter habitat.”

In disbelief, one biologist responds, “It would be impossible for grouse to winter here.” The biologist’s statement is understandable, since research shows the winter habitat for greater sage-grouse is in areas where sagebrush is above the snow, so the grouse can hide underneath and receive protection from the brush and nutrition from its seeds.

Just as Frey begins to respond 20 grouse burst out of the snow in front of them and fly away. “It scared us out of our skin.” Frey said. “Everyone retreat! Everyone off of the snow!” Frey calls out.



She and her colleague Lisa Church, a biologist from Bureau of Land Management then get down on their hands and knees and begin searching for where the grouse had been hiding. They see wing marks in the snow and a hole close by. With the use of a flashlight, they look down the hole and discover the birds had come from a cave under the snow-covered sagebrush. Incredibly, the grouse have been living under the deep snow.

Sagebrush in this area only grow 1.5 to 3 feet, and since the snow can get up to 12 feet it’s not far into winter before the sagebrush is completely covered and the grouse have been able to adapt.

Frey explains, “They make these little snow caves and eat the sagebrush leaves inside the cave until they’re gone, then they pop out and pop back into the next sagebrush cave and eat the leaves in there.” Buried sagebrush isn’t the only obstacle the southern grouse have had to adapt to.

Frey explains, “[In Northern Utah you have ... nice rolling hills with lots of sage brush that seems to go on forever. In Southern Utah, we have little valleys of prime sage-grouse habitat, but they’re

divided by rugged mountains and tree covered hills.”

This environment pushes the grouse to fly longer and further than they normally would. They fly back and forth between the fragmented sagebrush habitats to find what they need to have a healthy population. Having to constantly travel between these habitats takes a toll on the southern grouse. This is an area Utah wildlife managers have helped the greater sage-grouse by removing pinyon-juniper forests which fragment their habitat.

According to Frey, “Anytime we [reconnect] habitat [in the southern region] the grouse use it immediately because they want to expand.”

The impact the Bureau of Land Management and Utah Division of Wildlife Resources projects have had on decreasing the forest barriers is astounding. “The numbers of sage-grouse have steadily increased every year.” Frey’s research highlights this bird’s remarkable ability to adapt to southern Utah’s climate.

By using the research to assist with management planning, Utah can continue removing barriers for grouse survival and ensure their continued presence in our wildlands.

This piece aired on UPR’s Wild About Utah January 22-28, 2018

Research Highlights

Restoring the Bonneville Cutthroat Trout in Logan river's Right-hand Fork PI: Phaedra Budy

In the 1970s, many feared Utah's native fish, the Bonneville Cutthroat Trout, was extinct. Managers were able to report the Bonneville cutthroat trout was still in Utah's rivers and streams, but the sub-species was imperiled.

For over a decade, managers and anglers worked to keep the fish off the Endangered Species list. In 1997, to ensure the long-term conservation of our state fish in Utah, four federal agencies, two state agencies, and the Goshute Tribe came together to create and sign the Utah Conservation Agreement for Bonneville Cutthroat Trout.

The signers of the agreement rely heavily on ongoing, research and monitoring about important populations and the trout's environment, to make good management decisions.

One source of this data is the Fish Ecology Lab of Phaedra Budy, professor in the Watershed Sciences Department and Unit Leader for the U.S. Geological Survey Cooperative Fish & Wildlife Research Unit at USU and her research team. With this data, managers can focus their restoration efforts on areas where they are most likely to succeed, such as the Right-hand fork, a tributary of the Logan River.

Prior to 2013, the Right-hand fork was brimming with exotic and invasive Brown Trout. In 2002, Budy's lab recorded 4,000 brown trout per kilometer in the tributary - denser than any other recorded population on earth. This exotic fish pushed out native trout. Brown Trout thrive in Right-hand fork because of the creek's is spring fed. The spring stabilizes the water temperatures which promotes fish growth and survival.

Budy hypothesized the dense population of Brown Trout were overflowing into the main leg of Logan River, increasing the exotic trout population there. She predicted if managers could replace the Brown Trout with a population of Bonneville Cutthroat trout, these native fish would thrive.

In about 2010, a partnership of the UDWR, USFS, Cache Anglers, and USU began taking steps for recovering the Bonneville Cutthroat trout in the tributary. In 2013, they used a chemical treatment to remove the Browns from the Right-hand fork. To ensure the exotic trout would not re-enter, researchers installed

structures at the mouth of the tributary allowing trout to exit but not return.

The new population of Bonneville Cutthroat trout had to come from the Logan River, so the genetics would remain the same.

Paul Thompson, deputy director of the Recoveries Program in Utah's Department of Natural Resources said, "Because [the Logan River] has whirling disease we couldn't move live fish, so we collected eggs from the spawning fish in Temple fork, another tributary of the Logan River."

The Cache Anglers played a large role in the relocation of these trout. Budy explains, "Removing [the eggs and embryos] then restocking the juveniles was largely the responsibility of the Cache Anglers. They did a wonderful job."

The Bonneville Cutthroat trout are now thriving in the Right-hand fork with all ages.

It has been over 50 years since managers feared the Bonneville Cutthroat trout was extinct. With ongoing conservation efforts, the native trout has now been restored to 40% of its historic range.

This piece aired on UPR's Wild About Utah, March 19-25, 2018



Mission Statement

Utah Cooperative Fish and Wildlife Research UDWR - Utah

In 2017, the Utah Cooperative Fish and Wildlife Research Unit celebrates its 82st 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.

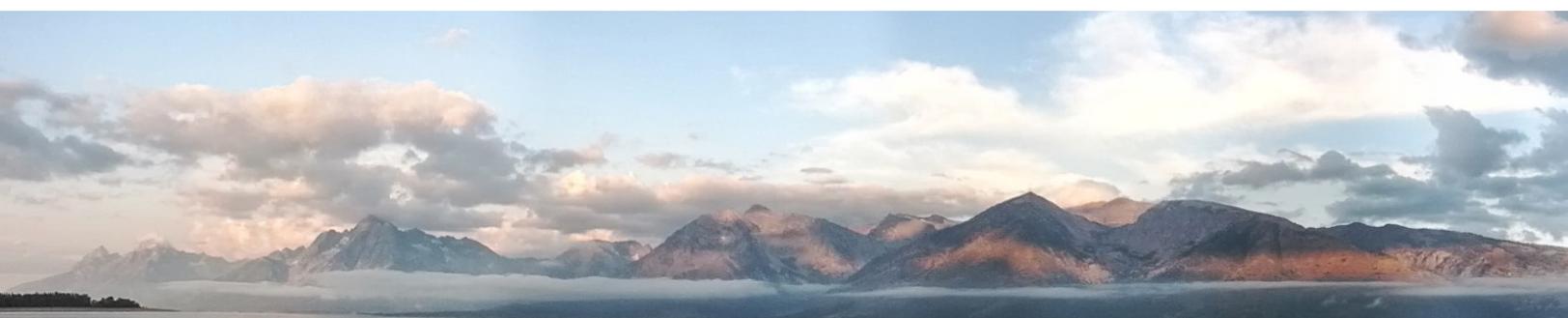
Research expertise of the Unit staff includes landscape ecology, conservation biology, research design and applied statistics, larger scale animal dynamics, geographical information system and habitat restoration methodology, terrestrial and aquatic habitat analysis, population management and assessment, 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.

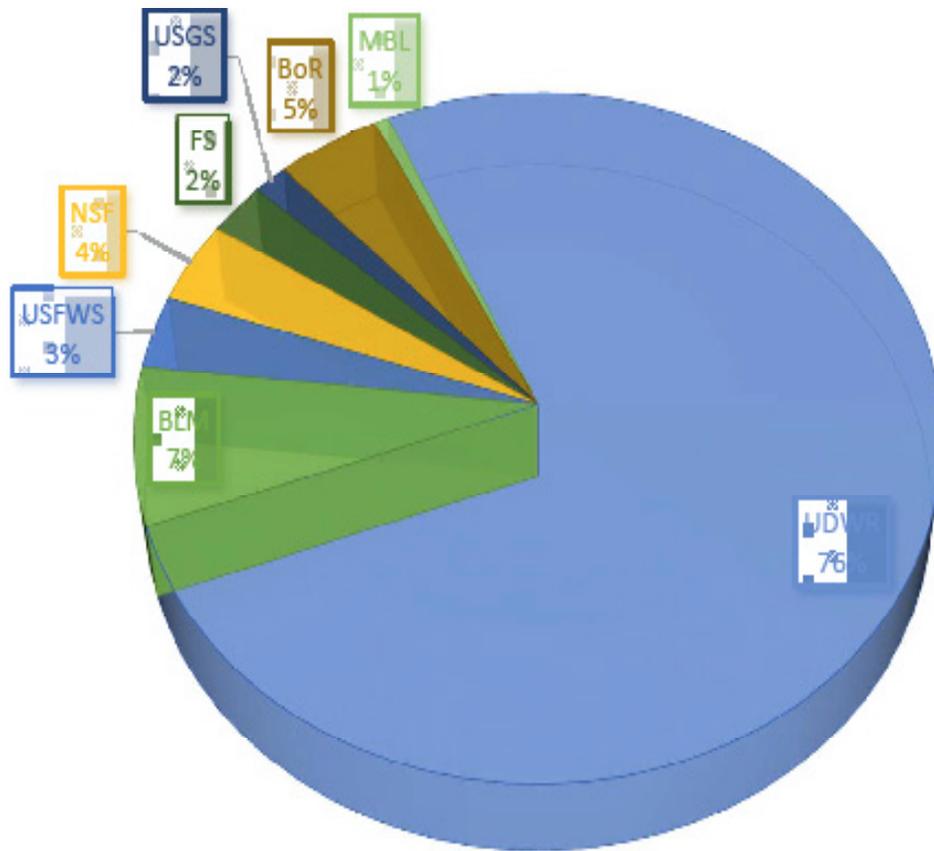
Primary graduate and cross-listed graduate/undergraduate level

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 provided 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.

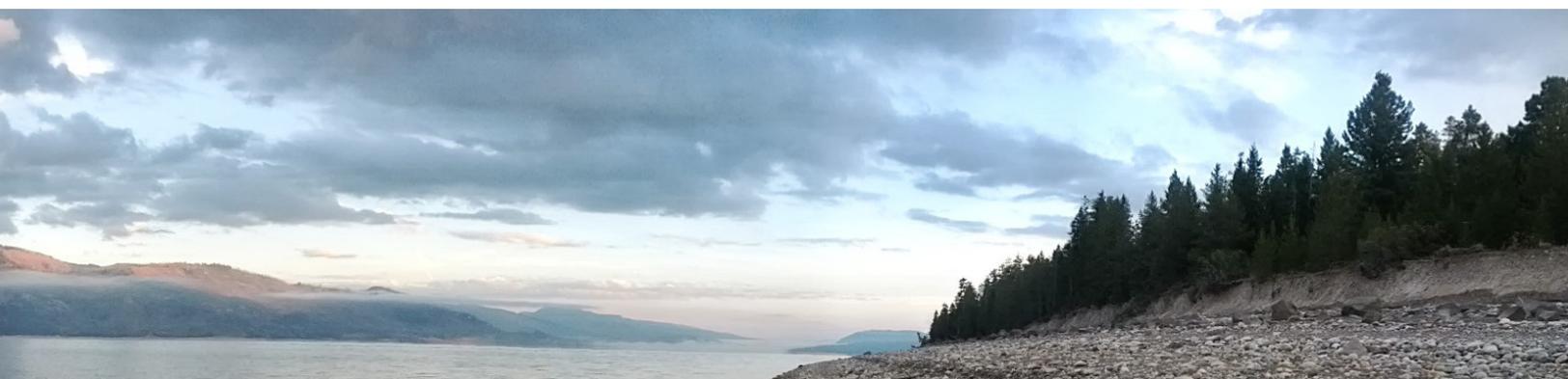
Cooperating faculty in the Quinney College of Natural Resources (QCNR), the Ecology Center, and across the University (USU) are, and will continue to be, integrated into Unit research to apply diverse expertise to all facets of a research problem. The primary goal of the Unit is to provide high quality 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.



2017 Research Contracts & Grants Funding Summary by Source



- BLM** - Bureau of Land Management
- BoR** - Bureau of Reclamation
- FS** - U.S. Forest Service
- MBL** - Marine Biological Laboratory, University of Chicago
- NSF** - National Science Foundation
- UDWR** - Utah Division of Wildlife Resources
- USFWS** - U.S. Fish and Wildlife Service
- USGS** - U.S. Geological Survey



Sampling of USU Alumni Working for UDWR

Name	Job Title	USU College	Major	Degree
J.D. Abbott	Sergeant	NR	Fisheries & Aquatics	BS
Paul Vincent Badame	Wildlife Coordinator	NR	Fisheries & Wildlife	BS
J. William (Bill) Bates	Assistant Director	NR	Fisheries & Wildlife	MS
Thomas W. Becker	Wildlife Biologist	NR	Fisheries & Wildlife	BS
Melinda Bennion	Aquatic Biologist II	NR	Natural Resources	MNR
Heather Hill Bernales	Biometrician	NR	Wildlife Biology	MS
David L. Beveridge	Lieutenant	NR	Fisheries & Wildlife	BS
Gary John Bezzant	Regional Habitat Manager	NR	Human Resources	MS
Garn J. Birchell	Asst Aquatics Program Manager	NR	Fisheries & Wildlife	MS
Calvin M. Black	Asst Aquatics Program Manager	NR	Fisheries & Wildlife	BS
Natalie Boren	Biologist	NR	Natural Resources	BS, MNR
Quentin Bradwisch	Native Aquatics Biologist	NR	Fisheries & Wildlife	BS
Nic Braithwaite	Blue Ribbon Fisheries Biologist	NR	Fisheries Biology	MS
Adam Brewerton	Conservation Wildlife Biologist	NR	Ecology	MS
Matthew G. Briggs	Sergeant	NR	Fisheries & Wildlife	BS
Kevin Bunnell	SRO Regional Supervisor	NR	Ecology	PhD
Michael F. Canning	Assistant Director	NR	Aquatic Ecology	MS
Torrey Christophersen	Lieutenant	NR	Fisheries & Wildlife	BS
Bryan Christensen	Volunteer Services Coordinator	NR	Natural Resources	MNR
James Christensen	Assistant Wildlife Manager	NR	Natural Resources	MNR
Avery Cook	Upland Game Project Leader	NR	Ecology	MS
Gary L. Cook	Wildlife Recreation Prgm Coord	NR	Fisheries & Wildlife	BS
Jason Cox	Range Trend Project Leader	NR	Natural Resources	MNR
Darren L. Debloois	Wildlife Biologist	NR	Fisheries & Wildlife	MS
Justin S. Dolling	NRO Regional Supervisor	NR	Fisheries & Wildlife	BS
Cody Edwards	Native Aquatics Species Biologist	NR	Fisheries & Aquatics	BS
Ja Eggett	Asst Hunter Education Coordinator	AGR	Landscape Architecture	BS
Robert Fitts	Biologist	AGR	Plant Science	MS
Charles L. Greenwood	Wildlife Manager	NR	Fisheries & Wildlife	BS
Wayne Gustavson	Project Leader - Lake Powell	NR	Fisheries & Wildlife	MS
Michael Hadley	Wildlife Biologist	NR	Wildlife Biologist	BS
Troy T. Hammond	Conservation Officer	NR	Fisheries & Wildlife	BS
Richard Dale Hepworth	Aquatics Program Manager	NR	Fisheries & Wildlife	BS
Gary Howes	Assistant FES Hatchery Manager	NR	Natural Resources	MNR
Bradley Hunt	Hardware Ranch Manager	NR	Wildlife Science	BS
Bruce C. Johnson Jr.	Lieutenant	NR	Fisheries & Wildlife	BS



Photo provided by UDWR

Sampling of USU Alumni Working for UDWR

Name	Job Title	USU College	Major	Degree
Edwards Johnson	Fisheries Biologist	NR	Fisheries & Wildlife	BS
Jason D. Jones	Waterfowl Area Manager	NR	Natural Resources	MNR
Daniel Keller	Native Aquatics Biologist	NR	Natural Resources	MNR
Kyle Kettle	Predator Management Specialist	Science	General Studies	Assoc
Kip L. King	Conservation Officer	NR	Fisheries & Wildlife	BS
Shane Kitchen	Conservation Officer	NR	Wildlife Science	BS
Charles Lawrence	Conservation Officer	NR	Forestry	MS
David R. Lee	CUP Project Leader	NR	Fisheries & Wildlife	BS
Dale F. Liechty	Wildlife Biologist	NR	Fisheries & Wildlife	BS
Raymond Lee Loken	Sergeant	NR	Fisheries & Wildlife	BS
John Allen Lytle	Conservation Officer	NR	Fisheries & Wildlife	BS
Dax L. Mangus	Wildlife Program Manager	NR	Wildlife Biology	MS
Roy Marchant	Wildlife Biologist	NR	Fisheries & Wildlife	BS
Tory D. Mathis	Wildlife Biologist	Science	Biology	BS
Douglas Messerly	Regional Supervisor	NR	Fisheries & Wildlife	BS
Dean L. Mitchell	R3 Initiative Coordinator	NR	Fisheries & Wildlife	BS
Dustin Lee Mitchell	Wildlife Biologist	NR	Wildlife Biology	MS
Jonathan K. Moser	Conservation Officer	Science	Biology	BS
Benjamin K. Nadolski	Policy Analyst	NR	Fisheries Biology	MS
Casey Olsen	Wildlife Specialist	NR	Wildlife Specialist	BS
Daniel Olson	Wildlife Migration Coordinator	NR	Wildlife Biology	PhD
Weston P. Pearce	Strawberry Project Biologist	NR	Fisheries & Aquatics	BS
Jason D. Robinson	Upland Game Biologist	NR	Wildlife Biology	MS
Craig J. Schaugaard	Fish Culture Coordinator	NR	Aquatic Ecology	MS
Michael T. Slater	Wildlife Program Manager	NR	Fisheries & Wildlife	MS
Deanna Strohm	Research Biologist	NR	Aquatic Ecology	MS
Philip Kenton Tuttle	Conservation Outreach Manager	NR	Natural Resources	MNR
Xaela Walden	Wildlife Tech II	NR	Wildlife Science	BS
Guy W. Wallace	Wildlife Program Manager	NR	Fisheries & Wildlife	BS
Alan Ward	Strawberry Project Leader	NR	Fisheries & Wildlife	MS
Randy H. Wood	Wildlife Program Manager	NR	Fisheries & Wildlife	BS

SUMMARY:

Natural Resources 92%

Science 5%

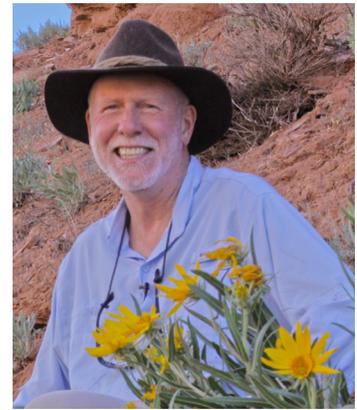
Agriculture 3%



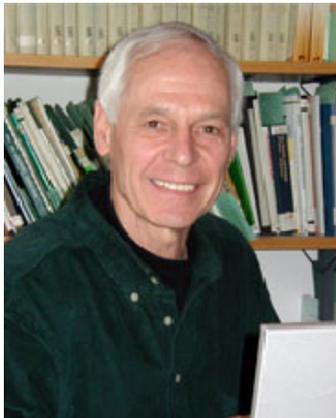
Scientists, Staff & Graduate Students



Phaedra Budy
Aquatic Research Ecologist
Unit Leader



Thomas Edwards
Landscape Research Ecologist
Assistant Unit Leader



John Bissonette
Landscape Research Ecologist
Emeritus



Shauna Leavitt
Administrative Assistant
and Outreach Specialist



Frank Howe
UDWR Research Liaison
USU Adjunct Faculty



Gary Thiede
Research Associate
Watershed Sciences



Mary Conner
Reserach Associate Professor
Wildland Resources



Robert Fitts
Research Associate
UT Natural Heritage Program



Peter MacKinnon
Research Associate
Watershed Sciences



David Stoner
Research Associate
Wildland Resources



Mindy Wheeler
Program Coordinator III
USU & UDWR



Zach Ahrens
Aquatic Ecology
Master's Candidate



Nick Barrett
Aquatic Ecology
Ph.D. Candidate



Demitra Blythe
Fisheries Biology
Master's Candidate



Colton Finch
Aquatic Ecology
Ph.D. Completed

Graduate Students

continued



Stephen Klobucar
Aquatic Ecology
Ph.D. Candidate



Bryan Maloney
Aquatic Ecology
Master's Completed

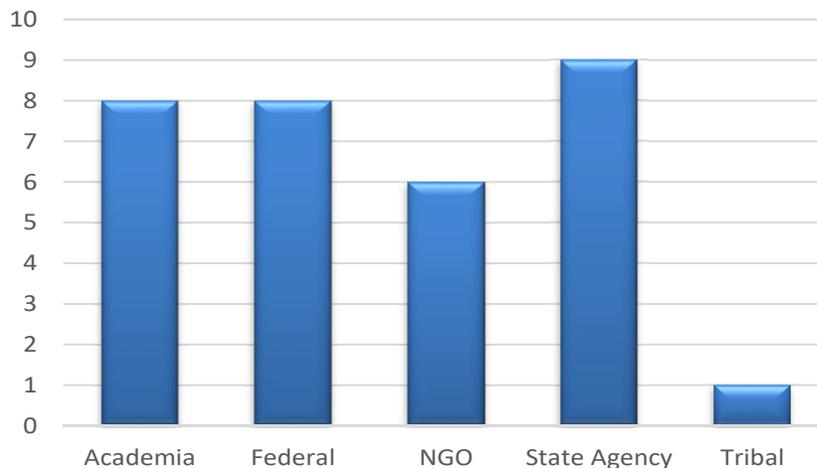


Andrew Sims
Wildlife Ecology
Master's Completed



Ben Stout
Aquatic Ecology
Master's Candidate

Where are they now? Graduates from the past 10 years



Productivity

Publications

BISSONETTE

PUBLISHED

Bissonette, J. A. The observer sampling scale problem: a consilient solution. Invited paper. 2017. *Journal of Wildlife Management* 81(2):192-205, DOI: 10.1002/jwmg.21187.

BUDY

IN REVIEW

LaPlanche, C. A. Elger, F, Santoul, and P. Budy. In re-review. Forecasting the eradication success of an exotic fish from an alpine stream. *Biological Conservation*. Accepted pending major revisions 15 September, 2017. BIOC_2017_626. USGS FSP: IP-XX.

Klobucar, S.L., J.W. Gaeta, and P. Budy. In re-review. A changing menu in a changing climate: Using experimental and long-term data to predict invertebrate prey biomass and availability in arctic lakes. *Freshwater Biology*. Accepted pending minor revisions 24 November, 2017. Manuscript ID FWB-P-Jun-17-0265.R1. USGS FSP: IP-087907.

Meredith, C. P. Budy, and J Schmidt. In review. Investigating scour depths in relation to patterns of spawning brown trout and the changing physical template of a mountain river. Submitted to *River Research and Applications*. 28 December, 2017. USGS FS: IP-01031.

Heredia, N. and P. Budy. In re-review. Trophic ecology of Lahontan Cutthroat Trout *Oncorhynchus Clarkii* Henshawi: historical predator-prey interaction supports native apex predator in unique desert lake. Submitted 26 September 2017 to *Transactions of the American Fisheries Society*. Accepted pending major revisions 4 November, 2017. Manuscript ID Society. TAFS-2017-0123. USGS FSP: IP-066465.

PUBLISHED

Winters, L.K., P. Budy, and G.P. Thiede. 2017. Earning their stripes: the potential of tiger trout and other salmonids as biological controls of forage fishes in a western reservoir. *North American Journal of Fisheries*

Management 37:380-394. USGS IP-074773. DOI:10.1080/02755947.2016.1264509.

Strohm, D. P. Budy, and T.A. Crowl. 2017. Matching watershed and otolith chemistry to establish natal origin of an endangered desert lake sucker. *Transactions of the American Fisheries Society* 146:732-743. DOI: 10.1080/00028487.2017.1301994. USGS IP-069787.

Klobucar, S.L., T.W. Rodgers, and P. Budy. 2017. 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. *Canadian Journal of Fisheries and Aquatic Sciences*. 00: 1–5 (0000) DX.DOI. ORG/10.1139/CJFAS-2017-0114. USGS IP-086031.

Budy, P., T. Bowerman, R. Al-Chokhachy, M.M. Conner, and H. Schaller. 2017. Quantifying long-term population trends of threatened bull trout: challenges, lessons learned, and opportunities. *Canadian Journal of Fisheries and Aquatic Sciences: Rapid Communication* 74 (12): 2030-2034, <https://doi.org/10.1139/cjfas-2017-0114> USGS IP-066765.

Budy, P. and J. Gaeta. 2017. Brown trout as an invader: A synthesis of problems and perspectives in Western North America. Invited Chapter 12.1 in: Javier Lobón-Cerviá & Nuria Sanz Ball. Ilosera, editors. *The Brown Trout *Salmo trutta* L.: A primer on a paradigmatic species*. Wiley. ISBN: 9781119268314. USGS FSP: IP-074692.

Laub, B.G., G.P. Thiede, W.W. MacFarlane, and P. Budy. In press. Evaluating the conservation potential of tributaries for native fish in the Upper Colorado River



Basin. Fisheries, Feature Article. Accepted 26 September, 2017. USGS IP: 081178.

Budy, P., K.B. Rogers, Y. Kanno, B. Penaluna, N.H. Hitt, J. Dunham, C. Mellison, and W.L. Somer., and J. DeRitto. In press. Distribution and Status of Trouts and Chars in North America. *Invited* Chapter 8 in: Diversity and Status of Trouts and Chars of the World. Editors: J.L. Kershner, J. E. Williams, R. E. Gresswell. Transactions of the American Fisheries Society. Symposium Book. USGS FSP: IP-088494.

Hansen, M., P. Budy, C. Guy, and T. McMahon. In press. Trout as Native and Invasive Species: a Management Paradox. *Invited* Chapter 819 in: Diversity and Status of Trouts and Chars of the World. Editors: J.L. Kershner, J. E. Williams, R. E. Gresswell. Transactions of the American Fisheries Society. Symposium Book. USGS FSP: IP-095921.

Dornelas, M and P. Budy (#25) and 182 others. 2018. BioTIME: a database of biodiversity time series for the Anthropocene. *Global Ecology and Biogeography*. Global 2018; 00:1–26. <https://doi.org/10.1111/geb.12729>. USGS FSP: under USGS co-author Rybicki.

EDWARDS

IN REVIEW

Stoner, D. C., J. O. Sexton, D. M. Choate, J. Nagolb, H. H. Bernalesd, S. A. Simsa, K. E. Ironsidee, K. M. Longshoref, and T. C. Edwards, Jr. Climatically driven changes in primary production propagate through trophic levels. In revision, *Global Change Biology*.

Edwards, T.C., Jr., J. Elith, R. Wueest, M.P. Nobis, G.G. Moisen, T.S. Frescino, J. Gibson, F. Schurr, W. Thuiller, S. Normand, Svenning, J-C., D. Gravel, C. Merrow, and N.E. Zimmermann. Identifying environmental and geographic



Photo provided by USFWS

characteristics of leading and trailing zones of tree species distribution tension. In revision, *Ecography*.

Edwards, Jr., T.C., J. Gibson, G.G. Moisen, T.S. Frescino, A. Psomas, and N.E. Zimmermann. Forecasting climate-induced distribution shifts for the piñon- juniper complex of the Western United States. In revision, *Global Change Biology*.

Ironside, K.E, D. Mattson, T. Arundel, T. Theimer, B. Holton, T.C. Edwards, Jr. and J. Hansen. Geomorphometry in Landscape Ecology: Issues of scale, physiography, and application. In revision, *Current Landscape Ecology Reports*.

Goeking, S. A., D. L. Izlar, and T.C. Edwards, Jr. A landscape-level assessment of whitebark pine regeneration in the Rocky Mountains, USA. Accepted, *Forest Science*.

BOOK

Edwards, T. C., Jr., The analysis of ecological data using R. Accepted for 2018 publication date, Chapman/CRC Press, Boca Raton, Florida, USA. 567pp.

Edwards, T. C., Jr. A primer on the management and manipulation of ecological data using R. Accepted for 2018 publication date, Chapman/CRC Press, Boca Raton, Florida, USA. 179pp.

PUBLISHED

Ironside, K.E, D. Mattson, D. Choate, D. Stoner, T. Arundel, J. Hansen, T. Theimer, B. Holton, B. Jansen, J.O. Sexton, K. Longshore, and T.C. Edwards, Jr. 2017. Variable detection rates in terrestrial global positioning system telemetry data deployed on large mammals: probability of missing fixes. *Wildlife Society Bulletin* 41:329-341. DOI: 10.1002/wsb.758.

Nagol, J. R., J. O. Sexton¹, A. Anand, R. Sahajpal, and T. C. Edwards, Jr. 2017. Extraction of end-member phenology by spectral unmixing. *International Journal of Digital Earth* 11:233-245. DOI: <https://doi.org/10.1080/17538947.2017.1319975>.

Stoner, D.C., J.O. Sexton, H.H. Bernales, J.R. Nagol, and T.C. Edwards, Jr. 2016. Productivity of a mountain ungulate tracks phenological variability over a latitudinal gradient. *PLoS One* 11(2): e0148780. DOI: <https://doi.org/10.1371/journal.pone.0148780>.

Presentations

BUDY

Gaeta, J. W., Stout, J. and B., P. Budy., M. Conner, P. MacKinnon, and M. McKinstry. 2017. Reservoir and lake fish dynamics under a climate: Improving our ability to estimate vital rates of change and multi-year drought. Leaders endangered fishes on the San Juan River using novel applications of Invited Symposium, Western Division, PIT tag technology. Joint Meeting of the Colorado-Wyoming and Utah Chapters of the American Fisheries Society. Grand Junction, CO. February 22, 2017.

Maloney, B., P. Budy, and J. Gaeta. 2017. Evaluating optimal rearing habitat for the Bluehead Sucker (*Catostomus discobolus*). Oral presentation. Joint meeting of the Colorado-Wyoming and Utah Chapters of the American Fisheries Society, February 2017, Grand Junction, CO, USA.

Thiede, G.P., P. Budy, and B. Laub. 2017. The effect of lake level on forage and Lahonton Cutthroat Trout in Pyramid Lake, Nevada. Invited Symposium: Resiliency and Vulnerability of Lentic Ecosystems and Communities to Climate Change and Multi-year Drought: What is known and what remains Annual Conference Meeting of the Western Division of the American Fisheries Society, 23 May, 2017, Missoula, MT.

Laplanche, C., G.P. Thiede, and P. Budy. 2017. Modelling the invasion and management of brown trout in the Logan River, Utah. Annual Meeting of the Western Division of the American Fisheries Society, 24 May, 2017, Missoula, MT.

Gaeta, J. and P. Budy. Invited Symposium Leaders: Resiliency and Vulnerability of Lentic Ecosystems and Communities to Climate Change and Multi-year Drought. Western Division, American Fisheries Society Annual Conference, Missoula, MT, May 22-25.

Budy, P., S. Klobucar, L. Winters, D. Strohm, and G.P. Thiede. 2017. Crowded reservoir trophic niche space: likely influences of a warmer, drier climate? May Invited Symposium: Resiliency and Vulnerability of Lentic Ecosystems and Communities to Climate Change and Multi-year Drought: What is known and what remains. Annual Meeting of the Western Division of the American Fisheries Society, 23 May, 2017, Missoula, MT.

Stout, J.B., P. Budy, M. Conner, P. MacKinnon, and M. McKinstry. 2017. Wanted: Dead or Alive. Determining



Photo by Shauna Leavitt

fish status from mobile PIT antenna detection data. 42nd Annual Meeting of the Western Division of the American Fisheries Society. Missoula, MT. May 22, 2017.

Maloney, B., P. Budy, and J. Gaeta. 2017. Do spawning and rearing habitat contribute to the recruitment bottleneck of imperiled Bluehead Sucker (*Catostomus discobolus*)? Oral presentation. Annual Meeting of the Western Division of the American Fisheries Society, May 2017, Missoula, MT, USA.

Laub, B. G., D. Blythe, and P. Budy. 2017. Understanding Multiple Impacts of Hydrologic Alteration on Native Fish Communities in the Rio Grande, Texas and Mexico. American Fisheries Society, Western Division, Annual Meeting, Missoula, Montana, 22-25. May 2017.

Blythe, D.E. and P. Budy. 2017. Has an altered hydrologic regime changed ecosystem function and impacted the native fish biodiversity of the Rio Grande? Presentation. ESA Annual Meeting, Portland, Oregon, August 7-11 2017.

Budy, P. D. Blythe, B. Maloney, J. Schmidt, and T. Blythe. 2017. The ecological context of flow related issues in the Rio Grande/Rio Bravo: Bi-national Rio Grande Forum. 7 November, 2017. El Paso, Texas.

Budy, P. 2017. Towards a better understanding of one of the world's worst invasive fishes. Invited Dept. of Ecology Seminar. Montana State University, Bozeman, Montana. 7 December, 2017.

EDWARDS

Edwards, T. C. Jr., R. D. Fitts, C. Keleher, C. Bailey, J. R. Gibson, and E. Hammill. Can landscape-scale models be applied to resolving rare plants conservation and energy conflicts in the Colorado Plateau region of western North

America? 2017 Meeting of the Association of Landscape Ecology - Europe, Gent, Belgium, 15 September 2017.

Sims, S.A, D. Stoner, D. Koons, H. Bernales, and T.C. Edwards, Jr. Short-term forecasting of mule deer survival: an adaptive modelling process. 2017 Utah Chapter of the Wildlife Society Annual Meeting, Bryce Canyon, Utah, 22 April 2017.

Stoner, D, J. O. Sexton, H. H. Bernales, J. Nagol, D. M. Choate, K. E. Ironside, K. M. Longshore, and T. C. Edwards, Jr. A statewide evaluation of mule deer abundance, cougar home range size, and predator-prey density. 2017 Utah Chapter of the Wildlife Society Annual Meeting, Bryce Canyon, Utah, 22 April 2017.

Edwards, T. C. Jr., R. D. Fitts, C. Keleher, C. Bailey, J. R. Gibson, and E. Hammill. Rare plants conservation and non-renewable energy development in the Colorado Plateau of Western North America: can landscape-scale models actually help? 2017 Annual Meeting U.S. Chapter of the Association of Landscape Ecology, Baltimore, Maryland, 4 October 2017.

Edwards, T. C. Jr., R. D. Fitts, C. Keleher, C. Bailey, J. R. Gibson, and E. Hammill. An optimization approach to assessing landscape-scale energy development effects on rare plant species in the Colorado Plateau of western North America. 82nd North American Wildlife and Natural Resources Conference, Spokane, Washington, 6 March 2017.

Edwards, Jr., T. C., Jr., J. R. Gibson, G. G. Moisen, T. Frescino, A. Psomos, and N. E. Zimmermann. Contraction and expansion zones in western North America piñon-juniper woodlands under projected 21st century climate change. 8th Biennial Conference of the International Biogeography Society, Tucson, Arizona, 10 January 2017.

Gibson, J. R., T. C. Edwards, Jr., G. G. Moisen, T. Frescino, A. Psomos, and N. E. Zimmermann. Contraction and expansion zones in western North America piñon-juniper woodlands under projected 21st century climate change. 8th Biennial Conference of the International Biogeography Society, Tucson, Arizona, 10 January 2017.

Popular Media

LEAVITT (COOP EXTENSION AND OUTREACH)

RADIO:

March 12, 2018. "Recovery of Native Bonneville Cut-



throat Trout in Right-hand Fork." <http://wildaboututah.org/recovery-of-native-bonneville-cutthroat-trout-in-right-hand-fork/>

January 26, 2018. "South Canyon Sage-Grouse." <http://upr.org/post/south-canyon-sage-grouse-wild-about-utah>

December 18, 2017. "Sixty In-stream Habitat Structures in Four Days: Demonstrating Creek Restoration Techniques." <http://wildaboututah.org/sixty-instream-habitat-structures-in-four-days-demonstrating-creek-restoration-techniques/>

November 2, 2017. "Weber Rivers Bluehead Sucker Population." <http://upr.org/post/weber-river-s-bluehead-sucker-population-wild-about-utah>

September 28, 2017. "Trout vs. Chub." <http://wildaboututah.org/trout-vs-chub/>

September 1, 2017. "Bear Lake Sculpin – *Cottus extensus*." <http://upr.org/post/bear-lake-sculpin-cottus-extensus-wild-about-utah>

July 14, 2017. "Securing Utah's Moose Population." <http://upr.org/post/securing-utah-s-moose-population-wild-about-utah>

June 16, 2017. "Greater Sage-Grouse In Utah." <http://upr.org/post/greater-sage-grouse-utah-wild-about-utah>

April 28, 2017. "The Beaver: Heling Keep Waer On Drying Lands on Wild About Utah." <http://upr.org/post/beaver-helping-keep-water-drying-lands-wild-about-utah>

INTERNET:

Winter 2018. Coop Catchup Newsletter, Issue 75, U.S. Geological Survey Fish & Wildlife Cooperative Research Unit Program. (editor)

September 2017. Coop Catchup Newsletter, Issue 74, U.S. Geological Survey Fish & Wildlife Cooperative Research Unit Program. (editor)

March 2017. Coop Catchup Newsletter, Issue 73, U.S. Geological Survey Fish & Wildlife Cooperative Research Unit Program. (editor)

PRINT:

March 2018. Outdoor News Bulletin, Wildlife Management Institute. "Recovery of Native Bonneville Cutthroat Trout in Right-hand Fork." <https://wildlifemanagement.institute/outdoor-news-bulletin/march-2018/recovery-native-bonneville-cutthroat-trout-right-hand-fork>

Summer 2017. Utah State Magazine. "Sage Lessons from Sage-Grouse Conservation." https://issuu.com/usuprm/docs/utah_state_magazine_summer_2017/10

Research Grants (Active)

BUDY

2016- 2021. Collaborative research: An exploration of the direct and indirect effects of climatic warming on arctic lake ecosystems. Principal Investigators: Budy, P., A. Giblin, B. Crump, S. Null, J. Jin. National Science Foundation: Office of Polar Programs. Total award to date \$999,335.

2015- 2018. Assessing the state of river science, water resources management, and water resources planning tools for the Rio Grande / Rio Bravo. Principal Investigators: P. Budy and J. Schmidt. U.S. Geological Survey, Total award to date \$131,725.

2017-2021. Arctic LTER: Climate change and changing disturbance regimes in Arctic landscapes: LAKES. Principal Investigator: Budy. National Science Foundation, Utah Division of Wildlife Resources. 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: Phaedra Budy and Mary Conner. Bureau of Reclamation (DOI), Total award to date \$1.2 M.

2017-present. Adaptive and experimental desert river restoration. Principal Investigators: Budy and Wheaton. Bureau of Land Management and UDWR Watershed Restoration Initiative. Total combined award \$350,000.

2017-present. Logan River Creel, data synthesis, and population viability modeling. Principal Investigator: Phaedra Budy. Utah Division of Wildlife Resources, U.S. Forest Service, and Cache Anglers (Trout Unlimited). Total award to date \$30,000.

2011-present. Evaluating cutthroat trout performance and identifying limiting factors for the native fish community of Pyramid Lake and development of an Adaptive Fishery Management Plan. Phaedra Budy (PI), Utah State University, USFWS, Great Basin Cooperative Ecosystem Unit (CESU). Total award to date \$394,769.

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

2015- 2017. Weber River, Bluehead Sucker recruitment bottleneck study. Utah Division of Wildlife Resources, Total award to date \$128,221.

EDWARDS

2013-2019. Habitat modelling of rare plant species in the Intermountain West. Principal Investigator: Thomas C. Edwards, Jr., Bureau of Land Management, Utah, U.S. Fish and Wildlife Service, U.S. Forest Service, Utah Department of Natural Resources, Total award to date \$900,000.

2015-2020. Technology transfer: development of state-of-art analytical and modelling shortcourses for land managers. Principal Investigator: Thomas C. Edwards, Jr., U.S. Geological Survey, Total award to date \$51,000.

2016-2019. Unifying mathematical and statistical approaches for modeling animal movement and resource



Photo by Colton Finch



Photo by Shauna Leavitt

selection. Principal Investigators: James Powell, Utah State University (on detail to NSF 2017-2019), Thomas C. Edwards, Jr., National Science Foundation, Total award to date \$180,000 to Utah State; \$485,000.

2011-2017. Spatial responses to climate across trophic levels: monitoring and modeling plants, prey, and predators in the Intermountain Western United States. Principal Investigator: Thomas C. Edwards, Jr. (PI from 2013-2017), NASA, \$549,000 directly to scientist; \$1,912,000 project total.

2016-2019. Distribution patterns and vegetation dynamics of forest canopy trees in the Northern Pantanal, Mato Grosso, Brasil. Principal Investigator: Thomas C. Edwards, Jr., República Federativa do Brasil, CNPq & CAPES, \$46,600 (R\$175,000).

2015-2017. Weather and primary productivity mediated effects on mule deer population dynamics across a latitudinal gradient. Principal Investigator: Thomas C. Edwards, Jr., Utah Division of Wildlife Management, Total Funding: \$64,000.

Graduate Students Directed

BUDY

COMPLETED

Mohn, Harrison. 2016. Improving management and conservation practices of Bonneville cutthroat trout (*Onchorhynchus clarkii* Utah) through an evaluation of movement and spatial population structure. Co-advised with Brett Roper. MS Thesis. Ecology. Utah State University.

Maloney, Bryan. 2017. Evaluating habitat-based niche requirements for the imperiled bluehead sucker (*Catostomus discobolus*): can we identify the cause of an identifying potential recruitment bottlenecks?. Co-advised with Jereme Gaeta. MS Thesis. Ecology. Utah State University. Spring 2017.

IN PROGRESS

Chapman, Kevin. 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. Defended. 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. Defended November, 2017. Slated date of completion: June 2018.

Finch, Colton. In progress. Fires, floods, and fish: projecting population recovery in an inland watershed. PhD Dissertation. Ecology. Utah State University. Slated date of completion: Unknown.

Stout, Benjamin. Improving our ability to estimate vital rates of endangered fishes on the San Juan River using novel applications of PIT tag technology. Co-advised with Mary Conner. MS Thesis. Ecology. Utah State University. Slated date of completion: Fall 2018.

Blythe, Demitra. In progress. Assessing the food web structure and ecological function relative to the historical condition of the Rio Grande in the Big Bend region. MS Thesis. Ecology. Utah State University. Defense Scheduled for April 27, 2018. Slated date of completion: Summer 2018.

Newlon, Courtney. In progress. Identifying cues for movement and temporally-dynamic limiting factors in the bull trout movement corridor. Defended. Slated date of completion: Fall 2018.

Ahrens, Zachery. In progress. Ecological effects and fishery conservation implications of a quasi-natural fish barrier on the Lower San Juan River, Utah. Slated date of completion: Fall 2020.

MNR GRADUATE COMMITTEE ADVISEMENT – CURRENT

Cody Edwards, Utah Division of Wildlife Resources, Fisheries

Calvin Black, Utah Division of Wildlife Resources,
Fisheries
Clint Brunson, Utah Division of Wildlife Resources,
Fisheries
Seth Elsen, Hood Canal Salmon Enhancement Group
Michael Fiorelli, Utah Division of Wildlife Resources,
Fisheries

EDWARDS

IN PROGRESS

Hersey, Kent. Adaptive modelling of seasonal mule deer movement patterns. Utah State University. Ph.D. Candidate, 2017.

Haupt, Marley. Distribution modelling of rare plant communities. Utah State University. Ph.D. Candidate, 2017 (co-chair).

McGahan, Ian. Using point-pattern processes to model animal movement across landscapes of varying resistance. Utah State University. Ph.D. Candidate, 2016 (co-chair).

Research Associates Directed

EDWARDS

Robert Fitts, Department of Wildland Resources, Utah State University (2011-current).

Visiting Scholar Collaboration

BUDY

Dr. C. La Planche, Ecole Nationale Supérieure d'Agronomie de Toulouse, Castanet-Tolosan, France, (2016, 2017).



Photo by Kirk Dahle

EDWARDS

Dr. Nadja Machado, Professor, Federal Institute of Mato Grosso, Graduate Program in Environmental Physics, Instituto Federal de Mato Grosso, Campus Cuiabá - Bela Vista., BRASIL. (*Program is Brazilian version of the U.S. Fullbright Program). Collaborative Research: Selection of priority areas for conservation in Mato Grosso state based on ecological niche modeling, potential distribution of species and landscape structure.

Undergraduate Research Projects Advised

BUDY

Hafen, T. 2018. Ecological effects of lake characteristics and arctic char presence on cohabiting native fish assemblage structure and fish size, diet, and growth. Oral presentation at the Utah Chapter of the American Fisheries Society meeting, March 2018. Ogden, UT.

Arnold, T. 2018. Using non-lethal fin ray analysis to determine growth rates of spawning and non-spawning walleye (*Sander vitreus*) in Willard Bay Utah. Oral presentation at the Utah Chapter of the American Fisheries Society meeting, March 2018. Ogden, UT.

Shamo, T. 2018. Examining relationships between barometric pressure and lunar cycle on angler catch rates in the Logan River, Utah. Oral presentation at the Utah Chapter of the American Fisheries Society meeting, March 2018. Ogden, UT.

West, R. 2018. Potential drivers of diet and spatial variation of sculpin in the Logan River, Utah. Poster presentation at the Utah Chapter of the American Fisheries Society meeting, March 2018. Ogden, UT.

Nichols, K. 2018. Evaluating diet overlap between cutthroat trout and brown trout held in experimental enclosures under differing densities: Can native trout at higher densities resist nonnative trout impacts. Poster presentation at the Utah Chapter of the American Fisheries Society meeting, March 2018. Ogden, UT.

EDWARDS

Robinson, Molly. 2018. Advanced Mathematical Approaches for Modeling Animal Movement through Landscapes, Utah State University URCO Award.

Professional & Academic Service

BISSONETTE

PEER REVIEWED FOR:

Biodiversity Conservation 2/28/17, Human Wildlife Interactions 3/8/17, PloS One 3/22/17, Book Chapter Johns Hopkins 7/7/17, Ecosphere 7/8/17, Movement Ecology 7/20/17, Human Wildlife Interactions 7/24/17, Environmental Assessment and Monitoring 8/8/17, Biological Conservation 9/21/17

BUDY

PEER REVIEWER FOR:

Editor, 2017 – present, Ecology of Freshwater Fish.

PROFESSIONAL SERVICE

USU, Quinney College of Natural Resources representative. Chemical Hygiene Committee. 2017.

USU, East Campus. East Gateway District Plan Faculty Committee. 2017.

USU, Honors Application Review Committee, 2015, 2018.

USU, Watershed Sciences, Undergraduate Field and Laboratory Class Skills Committee. 2017-2018.

EDWARDS

PEER REVIEWER FOR:

Ecology Letters, PNAS, Ecology, Landscape Ecology, Environmental Management, Biological Conservation, Journal of Vegetation Science, Trends in Ecology and Evolution, Diversity and Distributions, Ecography, Conservation Biology

PROFESSIONAL SERVICE

General-Secretary, International Association for Landscape Ecology (2009-current)

Bureau of Land Management, State of Utah, Rapid Ecosystem Analysis Implementation Committee (2011-current)

Landscape Ecology Strategic Committee (2017)
The scientist was appointed to serve on a USGS, Ecosystems, committee to provide strategic guidance on

application of landscape ecology to meet DOI and USGS mission responsibilities. Ongoing

Workshops & Training

BUDY

Graduate Fish Ecology (WS 6230/7230). Utah State University, Department of Watershed Sciences. 2002, 2004, 2006, and 2017.

EDWARDS

WILD 6500 Biometry design and analysis of ecological research

WILD 6580 / 4580 baseR Management and manipulation of data using R

Webinar, Species distribution models in conservation #1 - the statistics that underlie them. Twice-yearly presentation to various state and Federal biologists.

Webinar, Species distribution models in conservation #2 – validation as the key to proper application. Twice-yearly presentation to various state and Federal biologists.

Elements of Research Design, annual workshop presented to employees of the Utah Division of Wildlife Resources (2017).

Species Distribution Models Using R, five-day shortcourse on construction of distribution models, Utah State University (2017). 28 attendees.

baseR: Management and Manipulation of Data Using R, three-day shortcourse on data management and manipulation in R. Utah Division of Wildlife Resources (2017), BLM State of Utah (2017). 20-30 students.

Population Viability Analysis (M Connor, Lead), two-day shortcourse on basics of PVA. Utah Division of Wildlife Resources, Utah State University (2017). 23 students.

Honors & Recognition

BUDY

USGS/DOI Star Award. 2017 Superior Performance. (1% of salary + extra hours of annual leave). November 2017.

Terrestrial Research Projects

Flower's beardtongue species distribution model 2016-2017

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
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS:

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

July 2016 – September 2017

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.

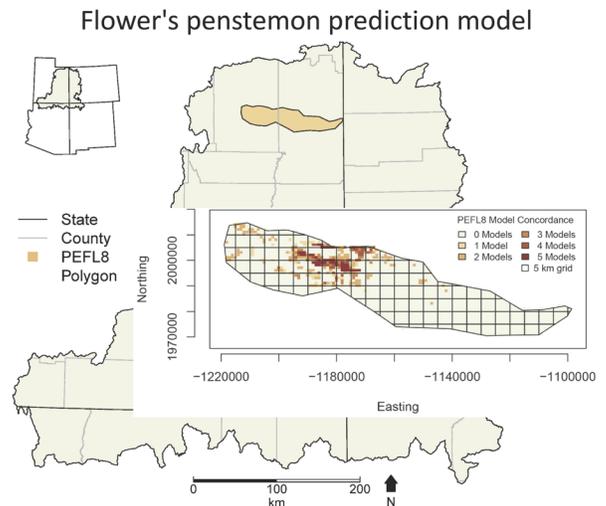


Photo by Tom Edwards

Linking mule deer survival in Utah to body condition and habitat use

The Utah Division of Wildlife Resources (UDWR) began monitoring mule deer survival in 2009 on 7 management units representing the range of environmental conditions found across the state. This study determines how body condition and habitat use impacts mule deer survival in Utah. Specifically, my objectives are to 1) determine the relationship between prewinter body condition and overwinter survival of mule deer and identify the factors that have the greatest influence on condition, 2) examine the relationship between cause-specific mortality and body condition, and 3) assess how mule deer use of habitat treatment areas influences overwinter body condition decline and survival. Results from this study will improve our understanding of factors influencing deer survival in Utah and allow managers to take actions most appropriate for their units.

FUNDING

Utah Division of Wildlife Resources
Sportsmen for Fish and Wildlife
Mule Deer Foundation
Safari Club International
Utah Archery Association
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Hersey, K.R., Ph.D. Candidate

FACULTY SUPPORT

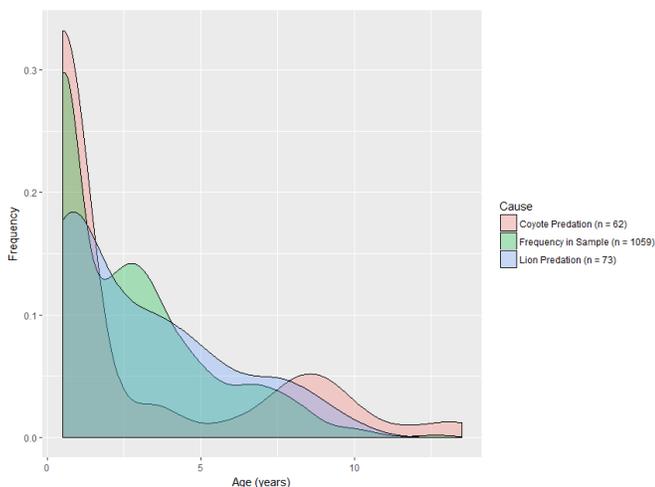
Thomas Edwards, UCFWRU, USU Wildland Resources

PROJECT PERIOD

August 2017 - July 2021

FIGURE CAPTION

Coyote (pink) and mountain lion (blue) predation in relation to age structure of mule deer (green). Coyote predation clearly targets yearlings and ignores older age classes, while mountain lions predate deer in relation to available age classes.



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.

FUNDING

National Aeronautics and Space Administration
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

David Stoner, Research Associate
Andrew Sims, M.S. Candidate

FACULTY SUPPORT

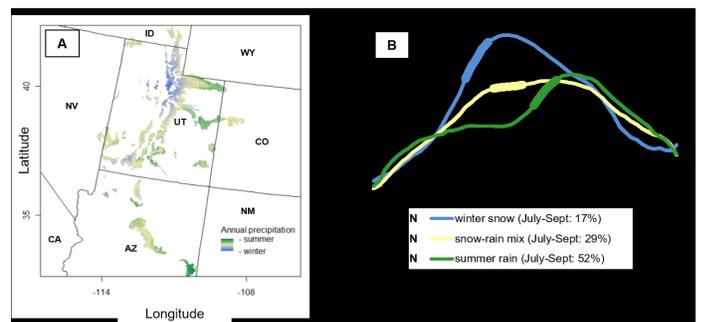
Thomas Edwards, USGS UCFWRU, USU Wildland Resources

PROJECT PERIOD

September 2011 – July 2016 (Completed)

FIGURE CAPTION

High elevation mule deer summer ranges (A) and associated phenological curves (B) in southwestern North America (2004-2011; 33-42° N). Curves represent a transition from ecosystems where plant phenology is driven by spring snowmelt and dry summers (blue), to those timed to summer rains (green). Thick bands approximate mule deer fawning dates at select latitudes.



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 -
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Robert Fitts, Research Associate
Jacob Gibson, 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

Penstemon growing in dry oil shale of the Uinta Mountains.



Weather and primary productivity mediated 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 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 DWR
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Andrew Sims, M.S. Candidate

FACULTY SUPPORT

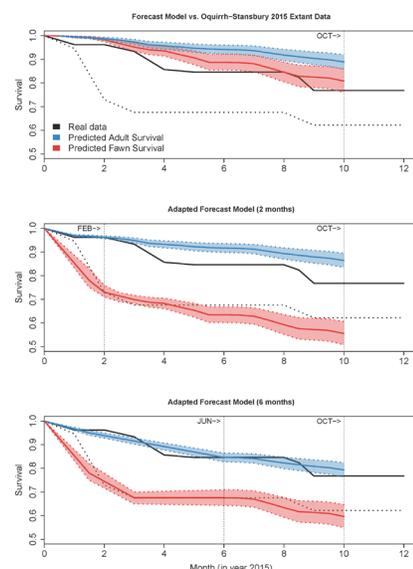
David Koons, USU Wildland Resources

PROJECT PERIOD

August 2014 – May 2017

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.



Aquatic Research Projects

Evaluating how arctic lake ecosystems will respond to a rapidly warming climate

The goal of this project is to better understand how increased temperatures will affect arctic lakes. I plan on using multiple approaches to accomplish this goal. First, I am investigating how warming may affect key ecosystem processes, such as lake metabolism, through changes in the rates of gross primary production and ecosystem respiration. I am also assessing how increased water temperatures and reductions in dissolved oxygen (hypoxia) may severely limit suitable/optimal habitat for fishes within our study lakes. Finally, this year I plan to conduct temperature manipulation experiments which aim at understanding how warming will affect Slimy Sculpin (*Cottus Cognatus*) and its food source, as well as the implications for the entire food web. Future work will aim at developing bioenergetic and ecosystem models to further assess the impacts of warming. Ultimately, this research provide us with valuable knowledge and predictive power that will allow for effective management and conservation of freshwater resources within the Arctic under a changing climate.

FUNDING

National Science Foundation
USU Department of Watershed Sciences
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Nick Barrett, Ph.D. Candidate

FACULTY SUPPORT

Phaedra Budy, USGS UTCFWRU, USU-Watershed Sciences, Ecology Center

PROJECT PERIOD

August 2017-May 2021

FIGURE CAPTION

Graduate student Nick Barrett holding an Arctic char in the field during ice sampling.



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 pikeminnow. 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. We have been able to correctly classify the status of PIT tags detected 93 percent of the time based on movement and location data collected. 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
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Ben Stout, M.S. Candidate

FACULTY SUPPORT

Phaedra Budy, USGS UTCFWRU, USU Watershed Sciences, Ecology Center
Mary Conner, USU WILD, Ecology Center

PROJECT PERIOD

Expected end date September 2018

FIGURE CAPTION

Graduate student Ben (Jesse) Stout operating a PITPASS raft on the San Juan, UT.



Ecological effects and fishery conservation implications of a quasi-natural fish barrier on the Lower San Juan River, Utah

My research is focused on how fish communities and species interactions differ across a longitudinally fragmented section of the San Juan River near its interface with Lake Powell. The Piute Farms Waterfall, a barrier to upstream fish movement resultant of fluctuating reservoir elevation and sediment deposition, currently bisects federally-designated critical habitat of the endangered migratory fishes Colorado Pikeminnow *Ptychocheilus lucius* and Razorback Sucker *Xyrauchen texanus*. Preliminary data suggest that the waterfall may be interrupting seasonal migrations not only of these imperiled species, but also of non-native piscivorous fishes not currently inhabiting the well-studied reaches above. My goal is to elucidate the impact of this barrier on native fish populations and potential species interactions will inform future endangered fish recovery efforts.

FUNDING

Bureau of Reclamation
Utah Division of Wildlife Resources
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Zach Ahrens, UDWR and M.S. Candidate
Mark McKinstry, U.S. Bureau of Reclamation

FACULTY SUPPORT

Phaedra Budy, USGS UTCFWRU, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

March 2018 - October 2019

FIGURE CAPTION

Graduate student Zach Ahrens sampling fish using a raft electrofished on the San Juan River, UT.



Assessing the ecological implications of the altered flow and sediment regimes of the Rio Grande in West Texas, United States

This project overall involves using a food web-based approach to examine how changes to the physical environment alters the aquatic ecological structure and function along a longitudinal gradient with varying levels of channel morphology and simplification along the Rio Grande. From the data collected thus far, Blythe found fish diversity appeared higher in canyon sites than the alluvial valley sites of the river. The fish community also tended to be more diverse at sites the researcher considered more complex in terms of in-channel mesohabitat types. In addition, investigators analyzed stable isotopes to construct the aquatic food web for the Rio Grande. Blythe observed that food webs at sites she considered more complex appeared to be more complex and resilient compared to simplified habitat sites in terms of food web structure. The research contributes to the ecological understanding of the Rio Grande, and contribute to potential management goals aimed at sustaining the aquatic and physical integrity of this desert river.

FUNDING

National Park Service
USGS South Climate Science Center
USU Ecology Center
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

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

FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center
Jack Schmidt, USU Watershed Sciences
Janice Brahney, USU Watershed Sciences

PROJECT PERIOD

January 2016 – May 2018

FIGURE CAPTION

Demitra holding a federally endangered Rio Grande silvery minnow caught at one of the sampling reaches in Big Bend National Park, Texas.



Logan River creel census and Bonneville cutthroat trout status synthesis

The Logan River in northern Utah is home to the largest remaining meta-population of native Bonneville cutthroat trout across their range and supports an extremely important Blue Ribbon trout fishery. The two primary goals of this project are to 1) quantify and understand the importance of the Logan River Blue Ribbon trout fishery recreationally, socially, and economically, and 2) synthesize over 16 years of multi-source fish data into an integrated population model, to allow us to evaluate management options and predict the potential impact of a proposed dam and reservoir on the Temple Fork tributary.

FUNDING

Trout Unlimited-Cache Anglers Chapter
Utah State University
U.S. Geological Survey
Utah Division of Wildlife
U.S. Forest Service
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

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Taylor Shamo, Undergraduate Technician
Allie Huish, Undergraduate Technician
Tyler Arnold, Undergraduate Technician

FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center
Mary Connor, USU Wildland Resources

PROJECT PERIOD

2017 - 2019

FIGURE CAPTION

Bonneville cutthroat trout.



Logan River trout viability: long-term monitoring and evaluation

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 population 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. Abundance of cutthroat trout ranged 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 ranged from 0.77 – 1.02, indicating an apparent overall decline; however, confidence intervals overlapped 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 500 fish/km) and adults are now up to 320 mm long. Our results provide important conservation and recovery benchmarks for cutthroat trout.

FUNDING

Utah State University
U.S. Geological Survey
Utah Division of Wildlife
U.S. Forest Service
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

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FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

2001 – 2018

FIGURE CAPTION

Backpack electrofishing in the Beaver Creek to the Logan River.



The abiotic and biotic controls of arctic lake food webs: a multifaceted approach to quantifying trophic structure and function

Lakes are sensitive to the surrounding climate and can respond rapidly to change. Arctic lakes may be particularly vulnerable to climate change due to overall low productivity and species diversity, and further, the Arctic is warming faster than any other region of the globe. While we can predict how fishes might respond to a warmer climate, we require a better understanding of 1) how their food resources may respond; and, 2) how interannual variability may affect fish growth and condition, especially going into and coming out of harsh arctic winters. Investigators seek to improve the understanding of these areas through a combination of experimentation, observation, and modeling. Additionally, researchers are investigating factors that structure arctic lake food webs. On the North Slope, Alaska, criteria derived from geomorphic constraints of the landscape regulate fish distribution of relatively few species. However, beyond this coarse filter, there is a surprising amount of variation in trophic structure given the low species diversity. Trophic structure is likely a function of complex interactions that are partially determined by surface water connectivity. However, in the face of a changing climate, predictable patterns of lake trophic structure may become unpredictable and new fish community structures may emerge. To better understand these structures and patterns, investigators are using stable isotopes, genetics, and eDNA to extend their predictions. Overall, the results of this project will help guide species conservation and subsistence management in Alaskan Arctic lakes in the face of a changing climate.

FUNDING

National Science Foundation - USU Ecology Center -
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Stephen Klobucar, Ph.D. Candidate

FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

2013 – 2017

FIGURE CAPTION

Recent graduate Stephen Klobucar holding a sampled Arctic char at one of the "Fog" study lakes.



Evaluating habitat-based niche requirements and potential recruitment bottlenecks for imperiled bluehead sucker (*Catostomus discobolus*)

Many desert fishes in the USA are imperiled due to low perceived economic worth and over-allocation of water. Bluehead suckers (*Catostomus discobolus*), endemic to the Intermountain West, are protected by a multi-state conservation agreement. The Weber River (northern Utah) bluehead sucker population is one of few outside of the Colorado River basin and is currently small and likely declining due to a recruitment bottleneck. Over-allocation of water and the subsequent degradation of in-stream habitat have resulted in a lack of slow-velocity habitat within the optimal thermal range for bluehead sucker. Our objectives are to determine whether spawning and rearing habitat (thermal and physical) available in the Weber River may be limiting bluehead sucker recruitment, and identify options for restoration accordingly. We are using reach-based surveys to locate and quantify spawning habitat in the Weber River and Ferron Creek (central Utah), a relatively unaltered reference river. Additionally, the researchers are sampling backwaters near spawning reaches for juvenile sucker and surveying habitat characteristics. For a mechanistic understanding, researchers are conducting laboratory experiments to evaluate juvenile bluehead sucker growth response to different temperature and velocity treatments. By evaluating factors that may limit bluehead sucker recruitment, this study will provide a template for future restoration efforts directed at recovering this imperiled population.

FUNDING

Utah Division of Wildlife Resources - City of Ogden - Davis and Weber Counties Canal Company - PacifiCorp - Provo River Water Users Association - Trout Unlimited - Weber Basin Water Conservancy District - Weber River Water Users Association - USU Ecology Center - Bureau of Reclamation - U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

Bryan Maloney, M.S. Candidate

FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center
Jereme Gaeta, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

2015 – 2017

FIGURE CAPTION

A mature (spawning colors) bluehead sucker sampled in the Weber River, UT.



Trophic ecology and adaptive management of the aquatic ecosystem of Pyramid Lake

Pyramid Lake, Nevada is one of the last remaining strongholds for lacustrine Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). Lahontan cutthroat trout (LCT) support a very popular fishery. The population currently depends almost entirely on stocking programs and efficient management. We have shown LCT consume up to almost 80% of their diet as tui chub, are voracious predators at the top of the food web, and are growing at rates near their maximum possible. Using bioenergetic analyses, we estimate an average individual LCT consumes 65 Tui chub per year. The population of LCT is currently consuming about 60-76% of the Tui chub biomass available each year, and they have not exceeded their carrying capacity. However, there is some evidence the abundance of tui chub, their primary food source, is declining over time. Tui chub declines may be associated with declining lake level. A draft Adaptive Management Plan (prepared by USU) was recently adopted by the Lahontan NFH Complex, U.S. Fish and Wildlife Service, and the Paiute Pyramid Lake Fisheries.

FUNDING:

Lahontan National Fish Hatchery Complex
U.S. Fish and Wildlife Service
Pyramid Lake Fisheries, Paiute Tribe
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS:

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FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center
Jereme Gaeta, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

2011 - 2017

FIGURE CAPTION

Research Associate Gary Thiede sampling larval Tui chub in Pyramid Lake.



Tributary habitat use of endangered and imperiled fishes in the Price River, Utah

The Price River, Utah, provides habitat for three imperiled and three endangered fish species. The goal of this project is to document Price River habitat use and movement by imperiled and endangered fishes, and obtain information on population abundance and distribution. Researchers have been monitoring the extent, magnitude, direction, and timing of use by these species since October 2011. To date, researchers have documented heavy use of the Price River by three endangered fishes and two imperiled fishes; their movements into the Price River generally correspond with increasing temperature and day length. Compared to habitat in some of its neighboring tributaries (such as the San Rafael River), the Price River is less degraded, making it a promising location for conservation and restoration. Tributary use data in combination with the habitat assessment and abiotic data will provide important information to bridge the knowledge gaps that limit effective management of Green River tributaries and allow us to prioritize management actions including flow recommendations and to develop a scientifically-based Price River Restoration Plan.

FUNDING AND PARTNERS

U.S. Bureau of Reclamation
U.S. Bureau of Land Management
Utah Division of Wildlife
U.S. Geological Survey UCFWRU (in-kind)

INVESTIGATORS

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FACULTY SUPPORT

Phaedra Budy, USGS UCFWRU, USU Watershed Sciences, Ecology Center

PROJECT PERIOD

2011 – 2019

FIGURE CAPTION

Research Associate Peter McKinnon working on solar panels powering fish detection equipment on the shores of the Price River.





**Thank you for your
ongoing support for
research and education!**

Notes