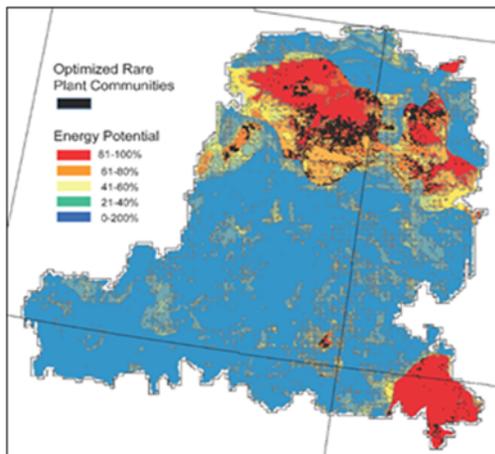

2013 ANNUAL REPORT
U.S. Geological Survey
Utah Cooperative Fish and Wildlife Research Unit
Quinney College of Natural Resources
Utah State University, Logan UT 84322-5290



(Left) This map shows the optimized protection coverage of rare plant communities (black) in relation to high energy extraction potential in the Colorado Plateau. Thomas Edwards' research team is constructing species distribution models for rare plant species under consideration for listing by the FWS. (Right) Kevin Chapman holds a pelican whose eating habits at the Strawberry reservoir are being analyzed. DWR has teamed with Phaedra Budy's research team to study the impact the pelicans are having on the trout and other fish populations in the reservoir.

Presented at the:
2014 Coordinating Meeting
Utah Division of Wildlife Resources
Salt Lake City, UT
7 October 2014



COOPERATORS:
USGS Cooperative Research Units Program
Utah Division of Wildlife Resources
QCNR Utah State University
Wildlife Management Institute
U.S. Fish & Wildlife Service

Mission Statement

Utah Cooperative Fish and Wildlife Research Unit 2013

The major limiting influences upon 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.

**PERSONNEL
COOPERATORS – COORDINATING COMMITTEE**

U.S. GEOLOGICAL SURVEY
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Western Supervisor
U.S.D.I. Cooperative Research Units
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Utah State University
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UTAH DIVISION OF WILDLIFE
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Director
Utah Division of Wildlife Resources
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WILDLIFE MANAGEMENT INSTITUTE
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Chris Smith, Western Rep.
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UTAH COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

UNIT PERSONNEL

Phaedra E. Budy
Leader Fisheries & Professor
Watershed Sciences Department
phaedra.budy@usu.edu

Thomas C. Edwards, Jr.
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Wildland Resources Department
t.edwards@nr.usu.edu

STAFF

Shauna Leavitt
Business Assistant
Utah Cooperative Fish and Wildlife Research
Unit
shauna.leavitt@usu.edu

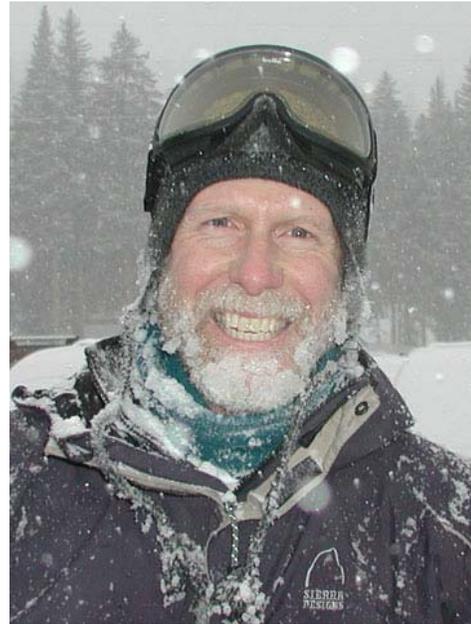
Cecelia Melder
USU Business Service Center
Quinney College of Natural Resources
busctr@cc.usu.edu

Emeritus
John A. Bissonette
Leader & Emeritus Professor
Wildland Resources Department
john.bissonette@usu.edu

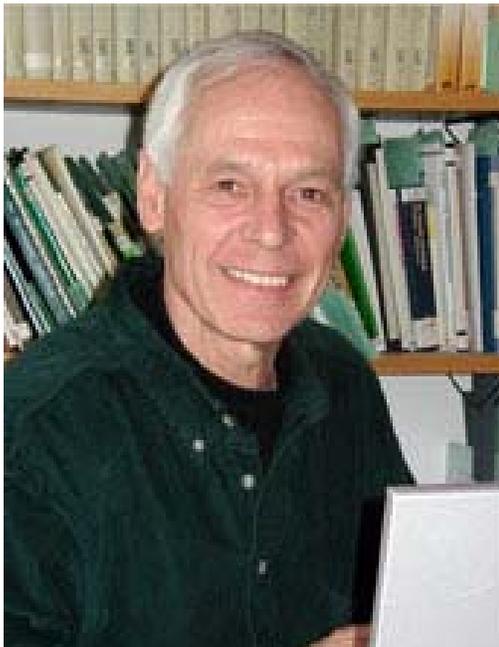
Coop Scientists & Staff



Phaedra Budy
Aquatic Research Ecologist
Unit Leader



Thomas Edwards
Landscape Research Ecologist
Assistant Unit Leader



John Bissonette
Landscape Research Ecologist
Emeritus Unit Leader



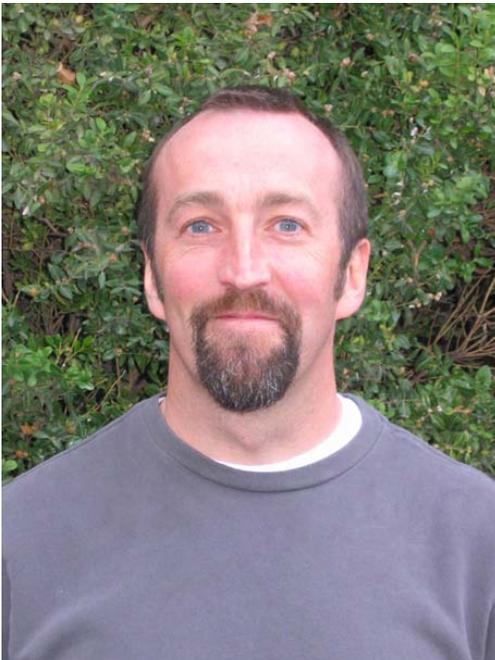
Shauna Leavitt
Business Assistant

UDWR University Liaison



Frank Howe
UDWR Research Liaison
USU Adjunct Associate
Professor of
Wildland Resources

Fish Ecology Lab Manager



Gary Theide
Fisheries Biologist
Department of Watershed
Sciences

USU Scientists with Unit



Robert Fitts
Research Associate
Utah Natural Heritage Program



Jacob Gibson
Research Associate
Wildland Resources



Dr. Nadja Gomes Machado
Visiting Scholar
Instituto Federal de Mato Grosso
Brazil



David Stoner
Post Doctoral Fellow
Wildland Resources

Post Doc Fellows & Grad Students



Tracy Bowerman
Fisheries Biology
Ph.D. Candidate



Kevin Chapman
Aquatic Ecology
Master's Candidate



Kimberly Dibble
Research Biologist
Post Doctoral Fellow



Colton Finch
Wildlife Ecology
Ph.D. Candidate



Michael Guttery
Wildlife Ecology
Post Graduate Researcher



Nick Heredia
Aquatic Ecology
Master's Candidate

Post Doc Fellows & Grad Students



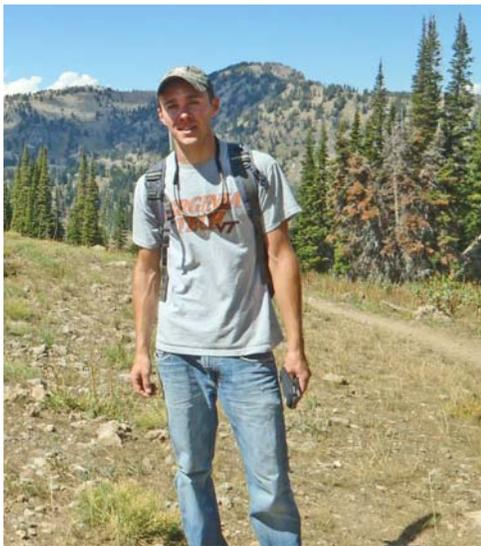
Stephen Klobucar
Aquatic Ecology
Master's Candidate



Brian Laub
Aquatic Scientist
Post Doctoral Fellow



Peter MacKinnon
Aquatic Ecology
Post Graduate Researcher



Harrison Mohn
Fisheries Biology
Master's Candidate



Courtney Newlon
Aquatic Ecology
Master's Candidate



Daniel Olson
Wildlife Biology
Ph.D. Candidate

Post Doc Fellows & Grad Students



Carl Saunders
Aquatic Ecology
Post Doctoral Fellow



Andrew Sims
Wildlife Ecologist
Master's Candidate



Lisa Winters
Watershed Science
Master's Candidate

USU Alumni Working for UDWR

Name	Job Title	USU College	Major	Degree
J.D. Abbott	Wildlife Conservation Officer	Natural Resources	Fisheries & Aquatics	Bachelor's
Anis Aoude	Big Game Coordinator	Natural Resources	Fisheries & Wildlife	Master's
Ronney E. Arndt	Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Richard W. Ashcroft	Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Paul Vincent Badame	Native Aquatics Projects Leader	Natural Resources	Fisheries & Wildlife	Bachelor's
Dan Barnhurst	Engineer/Conservation Officer	Natural Resources	Fisheries & Wildlife	Master's
James William Bates	Wild Life Program Manager	Natural Resources	Fisheries & Wildlife	Master's
Kyle K. Beagley	Energy Biologist	Natural Resources	Forestry	Bachelor's
Thomas W. Becker	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Heather Hill Bernales	Biometrician	Natural Resources	Wildlife Biology	Master's
David L. Beveridge	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Gary John Bezzant	Habitat Program Manager	Business	Human Resources	Master's
Garn J. Birchell	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Master's
Calvin M. Black	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Leon C. Bogedahl	Wildlife Biologist - Big Game Mngmt	Natural Resources	Game Management	Bachelor's
Bruce L. Bonebrake	Habitat Program Manager	Natural Resources	Fisheries & Wildlife	Bachelor's
Quentin Arthur Bradwisch	Native Fish Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Matthew G. Briggs	Sergeant	Natural Resources	Fisheries & Wildlife	Bachelor's
Christopher D. Brown	Assistant Supervisor - Waterfowl	Natural Resources	Range Science	Bachelor's
Michael F. Canning	Conservation Data Coordinator	Natural Resources	Aquatic Ecology	Master's
Charles B. Chamberlain	Aquatics Biologist/Fisheries	Natural Resources	Fisheries & Wildlife	Bachelor's
Kirst Christophersen	Conservation Officer	Education	Family & Human Develop.	Bachelor's
Torrey L. Christophersen	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Kevin D. Christopherson	Northeastern Regional Supervisor	Science	Biology	Master's
Gary L. Cook	Instructor	Natural Resources	Fisheries & Wildlife	Bachelor's
Edwin Thomas Cornia	Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Ellis C. Davis	Lieutenant	Natural Resources	Fisheries Management	Bachelor's
Darren L. Debloois	Biologist	Natural Resources	Fisheries & Wildlife	Master's
Justin S. Dolling	Waterfowl Area Supervisor	Natural Resources	Fisheries & Wildlife	Bachelor's
Kirt A. Enright	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
John A. Fairchild	Habitat Coordinator	Natural Resources	Fisheries & Wildlife	Bachelor's

USU Alumni Working for UDWR

Name	Job Title	USU College	Major	Degree
Carl R. Gramlich	Lieutenant	Natural Resources	Fisheries & Wildlife	Bachelor's
Charles L. Greenwood	Wildlife Manager	Natural Resources	Fisheries and Wildlife	Bachelor's
Ron D. Greer	Habitat Biologist	Natural Resources	Wildlife Biology	Master's
Wayne Gustavson	Project Manager - Lake Powell	Natural Resources	Fisheries & Wildlife	Master's
James G. Guymon	Supervisor/Southern Regional	Natural Resources	Fisheries Management	Bachelor's
Troy T. Hammond	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Miles B. Hanberg	Habitat Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Verl F. Hanchett	Wildlife Officer	Natural Resources	Fisheries Management	Bachelor's
Daniel A. Hansen	WIA Biologist	Science	Biology	Bachelor's
Richard Dale Hepworth	Fisheries Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Mr. JD.	Conservation Officer	Natural Resources	Fisheries & Aquatics	Bachelor's
Richard A. Jensen	State Hatchery Assistant Manager	Agriculture	Agricultural Education	Bachelor's
Bruce C. Johnson Jr.	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Edward K. Johnson	Fisheries Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Daniel Louis Keller	Native Aquatic Biologist	Natural Resources	Natural Resource	Master's
Sean M. Kelly	Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Kip L. King	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
David R. Lee	CUP Project Leader	Natural Resources	Fisheries & Wildlife	Bachelor's
Dale F. Liechty	Hatchery Department	Natural Resources	Fisheries & Wildlife	Bachelor's
Raymond Lee Loken	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
John Allen Lytle	District Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Dax L. Mangus	Wildlife Program Coordinator	Natural Resources	Wildlife Biology	Master's
Roy Marchant	Conservation Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Tory D. Mathis	Wildlife Biologist	Science	Biology	Bachelor's
Gary Alan McKell	District Conservation Officer - Zion	Natural Resources	Game Management	Bachelor's
Douglas G. Messerly	Regional Supervisor	Natural Resources	Fisheries & Wildlife	Bachelor's
Tim Arnold Miles	Fish Culture Coordinator	Natural Resources	Fisheries Management	Bachelor's
Dean L. Mitchell	Conservation Outreach Section Chief	Natural Resources	Fisheries & Wildlife	Bachelor's
Dustin Lee Mitchell	Wildlife Biologist	Natural Resources	Wildlife Biology	Master's
Miles O. Moretti	Interim Director	Natural Resources	Fisheries & Wildlife	Bachelor's
Jonathan K. Moser	Conservation Officer	Science	Biology	Bachelor's

USU Alumni Working for UDWR

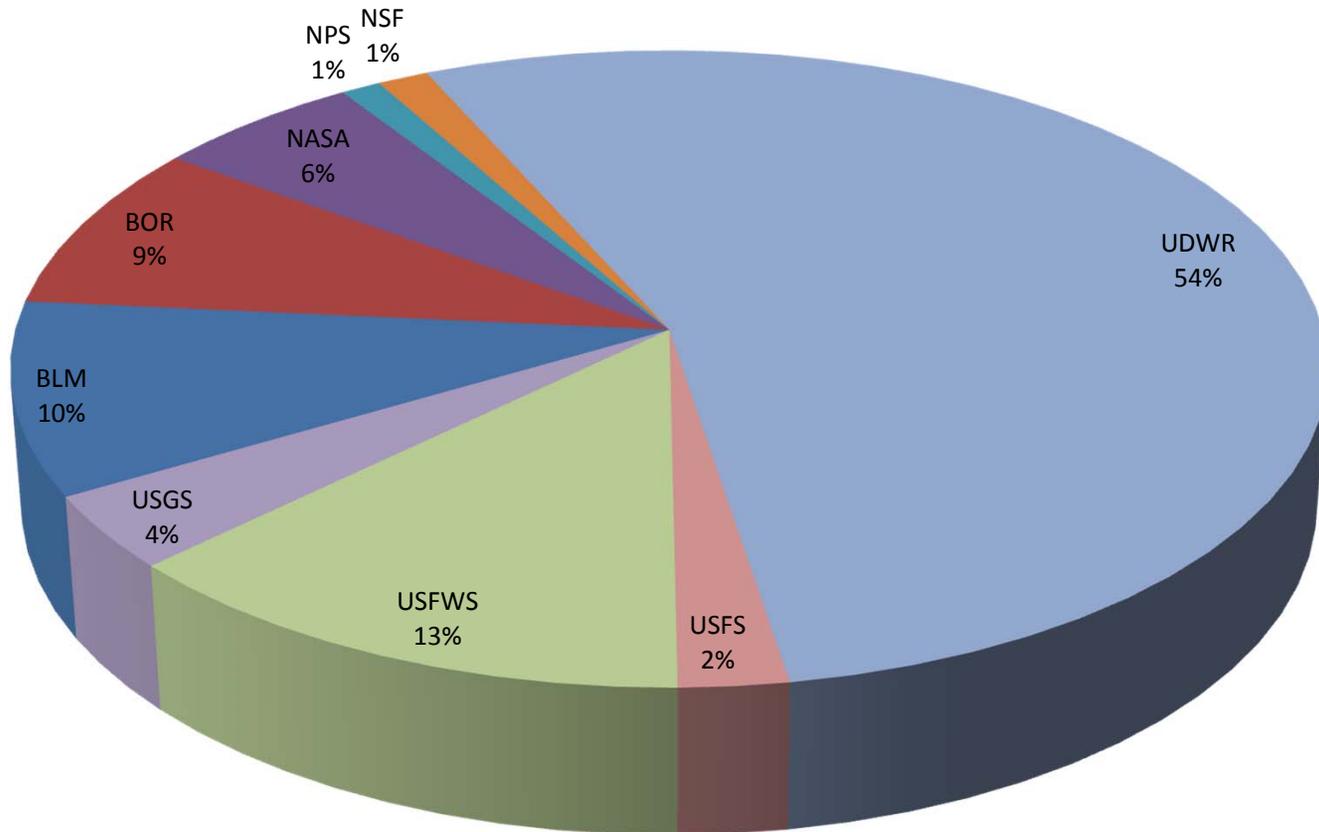
Name	Job Title	USU College	Major	Degree
Debbie Murphy-Inouye	Park Assistant	Agriculture	Agricultural Systms	Bachelor's
Benjamin K. Nadolski	Aquatic Biologist	Natural Resources	Fisheries Biology	Master's
David W. Olsen	Game Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Michael J. Ottenbacher	Aquatics Biologist	Natural Resources	Fisheries and Wildlife	Master's
Weston P. Pearce	Wildlife Specialist-Kamas Fish Hatchery	Natural Resources	Fisheries & Aquatics	Bachelor's
William Clay Perschon	Great Salt Lake Project Coordinator	Natural Resources	Fisheries and Wildlife	Bachelor's
Clare L. Poulsen	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Michael R. Roach	Conservation Officer/Game Warden	Natural Resources	Recreation Resources	Bachelor's
Jason D. Robinson	Upland Game Biologist	Natural Resources	Wildlife Biology	Master's
Craig J. Schauggaard	Project Leader	Natural Resources	Aquatic Ecology	Master's
John C. Schijf	Construction Officer	Natural Resources	Fisheries and Wildlife	Master's
Roger W. Schneidervin	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Michael T. Slater	Fisheries Manager	Natural Resources	Fisheries & Wildlife	Master's
David K. Swenson	Wildlife Officer	Natural Resources	Fisheries & Wildlife	Bachelor's
Robin Ann Toone	Wildlife Technician	Natural Resources	Fisheries & Wildlife	Bachelor's
Philip Kenton Tuttle	Native Aquatics Biologist	Natural Resources	Natural Resource	Master's
Corrie Jo Wallace	Wildlife Specialist	Natural Resources	Wildlife Science	Bachelor's
Guy W. Wallace	Wildlife Biologist	Natural Resources	Fisheries & Wildlife	Bachelor's
Alan Ward	Project Leader- Strawberry Reservoir	Natural Resources	Fisheries & Wildlife	Master's
Roger B. Wilson	Program Chief - Aquatics	Natural Resources	Fisheries & Wildlife	Bachelor's
Randy H. Wood	Assistant Wildlife Manager	Natural Resources	Fisheries & Wildlife	Bachelor's

SUMMARY:

Natural Resources	90%
Science	5%
Agriculture	2%
Education	1%
Business	1%

Financial Summaries for 2013

2013 Research Contracts & Grants Funding Summary by Source

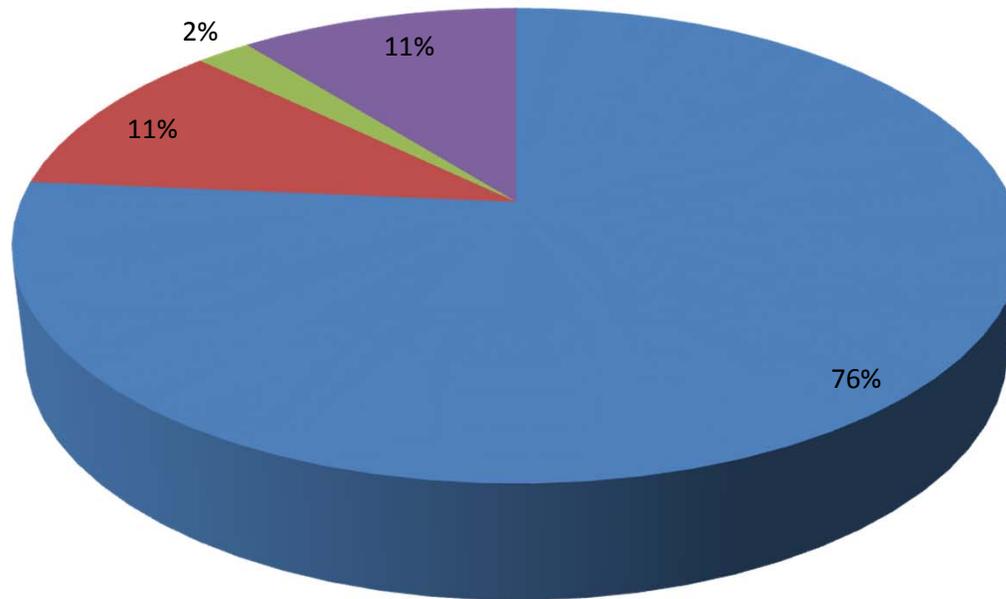


**UTAH COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
FUNDING SUMMARY BY SOURCE
FISCAL YEAR 2013**

	Agency Contributions	
1. Cooperator Base Funds:		
a. U. S. Geological Survey - Cooperative Research Units		
Federal Salaries & Benefits	317,890	
Operating	12,508	
Subtotal		330,397
b. Utah Division of Wildlife Resources Base		
Base Account	46,000	
10% Direct Administrative Costs paid on UDWR Projects	101,516	
Subtotal		147,516
c. Utah State University Contribution		
Staff Support Salary & Benefits	42,200	
Space	32,511	
Indirect Costs Waived on 2013 Projects	723,523	
Subtotal		798,235
2. Indirect Costs Paid on Non-UDWR 2013 Projects		142,689
3. Total 2013 Research Funding Invoiced (Includes IDC Paid + 10% UDWR-DAC)		2,278,465
**IDC and 10% UDWR-DAC (shaded) are listed individually and also included in #3. This figure prevents double entries.		(244,205)
4. TOTAL 2013 Funding Received		3,453,096
		=====

UDWR 10% Administrative Fees January 2014 Allocation

■ Salaries ■ Wages ■ Travel ■ Other



UTAH COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
UDWR Operating Base
Expenditures

	Fiscal Year 2010	Calendar Year 2011	Calendar Year 2012	Calendar Year 2013
Personnel	\$4,323	\$5,571	\$4,149	\$7,705
Fringe	\$1,332	\$1,402	\$1,450	\$3,094
Travel	\$5,098	\$6,860	\$5,568	\$2,079
Gasoline	\$71	\$0	\$180	\$479
Mail	\$1,284	\$830	\$678	\$485
Telecommunications	\$5,513	\$6,013	\$6,502	\$3,682
Supplies	\$9,171	\$4,595	\$6,313	\$5,498
Rentals	\$0	\$0	\$120	\$75
Insurance	\$250	\$1,750	\$2,175	\$2,825
Equipment	\$6,081	\$4,900	\$6,588	\$17,055
Vehicles	\$0	\$0	\$0	\$0
Maintenance (all types)	\$4,888	\$3,246	\$4,914	\$749
Professional Development	\$936	\$606	\$46	\$0
Guests	\$2,291	\$2,568	\$2,906	\$6,786
Tuition	\$0	\$0	\$0	\$0
Miscellaneous	\$0	\$404	\$895	\$25
TOTAL	\$41,238	\$38,745	\$42,485	\$50,538
				<i>YR10/11/12/13</i> \$173,005

**UTAH COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
SUMMARY OF INVOICED RESEARCH FUNDING
FISCAL YEAR 2013**

Utah Division of Wildlife Resources				
	Aquatic Research	288,460		
	Terrestrial Research	828,211		
			<u>1,116,671</u>	49%
Federal				
	RWO	439,849		
	Other	721,945		
			<u>1,161,793</u>	51%
Other Sources				
	Other	-		
			<u>-</u>	0%
			<u>2,278,465</u>	100%
	Grand Total			

ACTIVE RESEARCH: UNIT SCIENTISTS Fiscal Year 2013

Project Duration	Source	Grant Number	Project Title	Principal Investigator	Total Project	FY 2013 Funding
Mar10-Dec14	UDWR	100537	Assessing Vehicle-Related Mortality of Mule Deer in Utah	Bissonette, J	269,610.00	70,957.20
Jul07 - July12	USFWS	070722	RWO 56 Bull Trout Viability II	Budy, P	633,421.25	-
May12-Sep15	USFWS	120973	RWO 63 Bull Trout Viability III	Budy, P	71,757.90	71,757.90
July11-Jun14	UDWR	111202	Weber River Metapopulation and Source Sink Dynamics of Native Trout	Budy, P	32,083.00	32,083.00
July11-Jun14	UDWR	111203	Scofield Reservoir Predator/Prey Interaction	Budy, P	69,550.00	69,550.00
Jul12-Dec13	UDWR	121041	Flaming Gorge Burgot: Diet & Distribution, Early Life History (Sports Fisheries)	Budy, P	118,017.00	118,017.00
July01-Jun13	UDWR	121106	Logan River Trout Viability - Long Term Monitoring and Evaluation (YR 12 - Blue Ribbon)	Budy, P	581,023.00	15,279.00
Apr12-Sep13	UDWR	120649	Three Species Population Monitoring in the White River (UT)	Budy, P	12,446.00	12,446.00
Jul12-Jun13	UDWR	130001	Strawberry Reservoir Fish Distribution Study (Blue Ribbon)	Budy, P	3,000.00	3,000.00
Jan11-Sep15	BOR	110370	CPCESU: Movement & Habitat Studies of Endangered Fishes in the Colorado River Basin	Budy, P	623,182.01	207,727.34
Jul11-Aug16	BOR	110915	CPCESU: Tributary Habitat Use Endangered and Imperiled Fishes in the Price River, UT	Budy, P	166,452.00	42,585.00
Sep12-Jun14	NPS-CESU	130041	NPS CP CESU - Channel Narrowing & Sediment...Big Bend Reach of Rio Grande (Schmidt)	Budy, P	102,139.83	36,069.73
Apr11-Sep14	USFWS	110834	Pyramid Lake Fishery Evaluation	Budy, P	344,769.22	115,998.75
Jun12-Jun17	USFS	121104	Cutthroat Population Conditions within the Logan Watershed	Budy, P	73,902.00	34,451.00
Sep12-Sep17	BLM	130141	BLM CESU - San Rafael Restoration Science	Budy, P	316,000.00	110,000.00
Oct10-Feb17	NSF	100618	Artic LTR: Climate Change	Budy, P	131,000.00	35,000.00
May10-May15	USGS	100806	RWO 59 Sustainable Communities and Landscape Design	Edwards, T	348,557.00	137,072.00
Sep11-Dec14	NASA	111321	RWO 61 Spatial Responses to Climate Across Trophic Levels: Monitoring and Modeling Plants, Prey, and Predators in the Intermountain Western United States	Edwards, T	108,377.35	108,377.35
Aug12-Jul 17	BLM	121026	RWO 64 Step-Down Demo Analysis of Plants and Animals under the BLM Rapid Ecoregional	Edwards, T	122,641.51	122,641.51
Oct09-Apr13	FS	100194	Effects of Projected Climate Change on Distribution Patterns of ...Conifers	Edwards, T	150,000.00	28,106.05
Sep13-Sep16	USFWS	140142	Decision Support for the BLM Colorado Plateau REA and FWS Southern Rockies LCC Grant#121026 Bureau of Land Management \$75,000 (Funded through RWO64) Grant#140142 U.S. Fish and Wildlife Service \$55,700	Edwards, T	55,700.00	-
Jul11-Jun16	BLM	120007	Habitat Modeling of Rare Plant Species on the Colorado Plateau Grant #120007 Utah Natural Heritage Program \$314,000 Grant #121105 Survey of Sensitive Species in UT \$16,536 Grant #130373 Habitat Modeling of Rare Plants Species on the CO Plateau \$21,757	Edwards, T	352,293.00	112,006.64
					4,685,922	1,483,125
					=====	=====

ACTIVE RESEARCH: OTHER PRINCIPAL INVESTIGATORS Fiscal Year 2013

Project Duration	Source Grant Number	Project Title	Principal Investigator	Total Project	FY 2013 Funding
Jul08-Jun13	UDWR 090110	Winter Distribution and Feeding Ecology of Waterfowl on the Great Salt Lake Ecosystem	Conover, M	359,790	53,531
Jul10-Sep13	UDWR 101114	Wildlife Crossing in Utah: Determining What Works and Helping to Create the Best and Most Cost-Effective Structure Designs	Cramer, P	198,100	61,737
Aug12-Jun13	UDWR 130079	UDWR Escalante Fall 2013	Damitz, S	62,000	62,000
Sep09-Jun14	UDWR 100027	Study the Impacts of Artificial Water and Coyotes on Kit Fox in Utah's West Desert	Gese, E	460,017	95,176
Jul08-Jun14	UDWR 090282	Phase III of Cougar Research in Utah (\$85K every May) YR1-4	Gese, E	340,000	85,000
Nov12-Jun15	UDWR 141025	Assessing Approaches to Manage Phragmites in Utah Wetlands	Kettenring, K	30,000	-
Jul10-Jun14	UDWR 101213	Improved Monitoring for Management of the Henry Mountains Bison Herd	Koons, D	360,286	63,177
Mar11-Jun13	UDWR 110451	2011-12 Statewide Utah Angler Survey	Krannich, R	58,965	28,604
Jan13-Dec17	UDWR 130415	Determinants of Population Growth in UT Moose	MacNulty, D	208,499	20,850
Jun11-Jun13	UDWR 120069	Sustaining Utah's Sage-Grouse Local Working Group	Messmer, T	128,880	79,585
Jun12-Jun13	UDWR 120967	Demography, ...and Seasonal Movements of Greater Sage-Grouse in Ruby Pipeline	Messmer, T	216,808	109,090
Sep10-Jun15	UDWR 110152	Genetic Analysis of Utah Bears	Mock, K	118,878	32,115
Nov10-Jun14	UDWR 101029	Evaluate Habitat Quality of Mexican Spotted Owls' Territories in Utah	Schupp, G	125,508	34,644
Oct11-Jun16	UDWR 120335	Evaluating Coyote Predation and Survival of Mule Deer Under Different Predator Management Regimes	Young, J	264,284	59,830
Jun12-Jun13	UDWR 121103	Rehabilitation of Bear Cubs	Young, J	10,000	10,000
				2,942,015	795,339
				=====	=====

UNIT PRODUCTIVITY – CY 2013-2014

Publications

Bissonette

- Bissonette, J. A. 2013. Scale in wildlife management: the difficulty with extrapolation. Chapter 6, Pages 73-83 in P. R. Krausman and J. R. Caine, (eds), *Wildlife Management: contemporary principles and practices*. The Johns Hopkins Press, Baltimore, MD, USA.
- Brodie, J, H. Johnson, M. Mitchell, P. Zager, K. Proffitt, M. Hebblewhite, M. Kauffman, B. Johnson, J. Bissonette, C. Bishop, J. Gude, J. Herbert, K. Hersey, M. Hurley, P. M. Lukacs, S. McCorquodale, E. McIntire, J. Nowak, H. Sawyer, D. Smith, and P.J. White. 2013. Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. *Journal of Applied Ecology* 50:295–305. DOI: 10.1111/1365-2664.12044.
- Biswas, T, R. D. Ramsey, J. A. Bissonette, and J. Symanzik. 2014. Integration of two spectral indices to monitor loss of moist grassland within the Jaldapara Wildlife Sanctuary, India. *International Journal of Remote Sensing* 35(3):1038-1063. <http://dx.doi.org/10.1080/01431161.2013.875631>.
- Ison, D. D. J. A. Bissonette, P. C. Cramer, A. D. Green, S. T. Davis, P. J. Jackson, D. C. Coster. 2014. Monitoring Wildlife-Vehicle Collisions in the Information Age: How Smartphones Can Improve Data Collection. *PLoS ONE* 9(6): e98613. doi:10.1371/journal.pone.0098613.

Budy

- Bottcher, J.L., T.E. Walsworth, G.P. Thiede, P. Budy, and D. Speas. 2013. Frequent Usage of Tributaries by the Endangered Fishes of the Upper Colorado River Basin: Observations from the San Rafael River, Utah. *North American Journal of Fisheries Management, Management Brief* 33:585-594.
- Budy, P., G.P. Thiede, J. Lobon-Cervia, G. Gonzales, P. A McHugh, A. McIntosh, L.A. Vollestad, E. Becares and P. Jellyman. 2013. Limitation and facilitation of one of the world's most invasive fish: an intercontinental comparison. *Ecology* 94:356-367.
- Walsworth, T.E., P. Budy, and G.P. Thiede. 2013. Longer food chains and crowded niche space: effects of multiple invaders on imperiled desert fishes. *Ecology of Freshwater Fish*. Early on line: doi: 10.1111/eff.12038.
- Hough-Snee, N. Roper, B.R., Wheaton, J.M., and P. Budy. 2013. Riparian vegetation communities change rapidly following passive restoration at a northern Utah stream. *Ecological Engineering* 58:371-377.
- Meredith, C., P. Budy, and G.P. Thiede. 2014. Predation on native sculpin by exotic brown trout exceeds that by native cutthroat trout within a mountain watershed (Logan, UT, USA) doi: 10.1111/eff.12134. USGS FSP: IP-042175.
- Bowerman, T., Neilson, B. and P. Budy. 2014. Effects of fine sediment, hyporheic flow, and spawning site selection on survival and development of bull trout embryos. *Canadian Journal of Fisheries and Aquatic Sciences* 71:1–13. USGS FSP: IP-049185.

- Saunders, W.C., P. Budy, and G. Thiede. 2014. Demographic Changes Following Mechanical Removal of Exotic Brown Trout in an Intermountain West (USA), High-Elevation Stream. *Ecology of Freshwater Fish*. doi: 10.1111/eff.12143. USGS FSP: IP-034361.
- Budy, P. and C. Luecke. 2014. Understanding how lake populations of Arctic char are structured and function with special consideration of the potential effects of climate change: a multi-faceted approach. *Oecologia* 176:81–94. USGS FSP: IP-053259.
- Bennet, S., B. Roper, R. Al-Chokhachy, and P. Budy. *In press*. Annual Variation of Spawning Cutthroat Trout in a Small Western USA Stream: A Case Study with Implications for the Conservation of Potamodromous Trout Life History Diversity. *Ecology of Freshwater Fish*. *Accepted 18 June, 2014. Manuscript ID: UJFM-2013-0155*. USGS FSP:IP-050825.
- Laub, B.G., and P. Budy. *In press*. Assessing the likely effectiveness of multi-species management for imperiled desert fishes using niche overlap analysis. *Accepted 11 September, 2014 with minor revisions*. *Conservation Biology*. USGS FSP: IP-058151.

Edwards

- Edwards, Jr., T.C., J. Gibson, G.G. Moisen, T.S. Frescino, R. Wueest, W. Thuillier, J-C Svenning, J. Elith, and N.E. Zimmermann. Differential life stage niche modelling: can we construct species fitness landscapes from SDMs? *In review, 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 review, Global Change Biology*.
- Edwards, Jr., T. C., Jr., F. Kienast, J. Bolliger, and T. Dalang. Maintaining high Alp dry grassland meadows of high conservation priority under short- and long-term ecological change. *In revision, Biological Conservation*.
- Ripplinger, J., J. Franklin, and T.C. Edwards, Jr. Legacies of managed disturbance leave semi-arid plant communities with reduced resilience and altered composition. *In revision, Journal of Vegetation Science*.
- Gross, D.H., J.A. Logan, and T.C. Edwards, Jr. Mountain pine beetle fecundity and offspring size differ among lodgepole pine and whitebark pine hosts. *In revision, Canadian Journal of Forest Research*.
- Brewerton, A., and T.C. Edwards, Jr. Effects of fire restoration treatments on shrubsteppe passerines in the Great Basin. *In revision, Rangeland Ecology and Management*.
- Thuiller, W, T. Münkemüller, K. H. Schiffers¹, S. Dullinger, V.E. Eckhart, T. C. Edwards, Jr., D Gravel, G. Kunstler, C. Merrow, K.M. O’Leary, N. E. Zimmermann, D. Zurell, and F. Schurr. How do demographic parameters relate to probability of occurrences? *In press, Ecography*.
- Merow, C., M J. Smith, W. Thuiller, N. E. Zimmermann, T. C. Edwards, Jr., A. Guisan, S. Normand, R. Wüest, and J. Elith. Back to the basics of Species distribution modeling: what do we learn from complex versus simple response curves? *In press, Ecography*.
- Norevll, R, E., T. C. Edwards, Jr., and F. P. Howe. 2014. Disturbance as restoration in shrubsteppe: mixed effects on non-target bird species. *Journal of Wildlife Management* 78:456-462.

- Svenning, J-C, D. Gravel, R.D. Holt, F. Schurr, W. Thuiller, S. Dullinger, T.C. Edwards, Jr., T. Hickler, S. Higgins, and S. Normand. 2014. Biotic interactions can strongly influence range expansion rates. *Ecography* 37:1-12.
- Gibson, J., G.G. Moisen, T.S. Frescino, and T. C. Edwards, Jr. 2014. Effects of “fuzzing and swapping” forest inventory plot coordinates on species distribution models under projected climate change scenarios: how useful are projection models based on public data. *Ecosystems* 17:43-53.
- Beard, K. H., C. A. Faulhaber, S. L. Durham, F. P. Howe, and T. C. Edwards Jr. 2013. Indirect interactions among rodents and seeds in a shrubsteppe ecosystem. *Western North American Naturalist* 73:426-441.
- Jones, K.B., G. Zurlini, F. Kienast, I. Petrosillo, T.C. Edwards, Jr., T.G. Wade, Bai-lian Li, and N. Zaccarelli. 2013. Informing landscape planning and design for sustaining ecosystem services from existing spatial patterns and knowledge. *Landscape Ecology* 28:1175-1192.
- Edwards, T. C., Jr., D. R. Cutler, and K. H. Beard. 2013. Predicting risk of invasive species occurrence - plot-based approaches. Pages 79-98 in: Welch, B.A., P.H. Geissler, and P. Latham. *Early detection of invasive plant - Principles and practices: U.S. Geological Survey Scientific Investigations Report 2012-5162*, U.S. Geological Survey, Reston, Virginia.
- Edwards, T.C., Jr., D.R. Cutler, and K.H. Beard. 2013. The process of model assessment and evaluation. Pages 119-126 in: Welch, B.A., P.H. Geissler, and P. Latham. *Early detection of invasive plant - Principles and practices: U.S. Geological Survey Scientific Investigations Report 2012-5162*, U.S. Geological Survey, Reston, Virginia.
- Colby W. Brungard, C.W., J.L. Boettinger, M.C. Duniway, S.A. Wills, and T.C. Edwards, Jr. Machine learning for predicting soil classes in three semi-arid landscapes. In review, *Geoderma*.
- 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. Variable detection rates in terrestrial global positioning system telemetry data deployed on large mammals: probability of missing fixes. In review, *Animal Telemetry*.

Presentations

Budy

- Mesner, N., D. Jackson-Smith, D. Stevens, P. Budy. 2013. Assessment of Utah’s Nonpoint Source (319) Program. 2013 Salt Lake Countywide Watershed Symposium, Salt Lake City, October 15, 2013.
- Budy. P. , A. Giblin, G. Kling, and B. Crump. 2013. Arctic Lakes: what have we learned about system response to direct and indirect effects of climate change? Arctic LTER Mid-Term Review, Toolik Field Station, AK. 18 June 2013.
- Fisher, K. and P. Budy. 2013. Comparing Trophic Level Position of Invertebrates in Fish and Fishless Lakes in Arctic Alaska. Poster Presentation. Student Colloquium; Research on Capitol Hill, Salt Lake City, February, 2013.

- Klobucar, S.L., W.C. Saunders, C. Luecke, and P. Budy. 2013. A Lota lota consumption: trophic effects and potential impacts of a novel and voracious predator in Flaming Gorge Reservoir, WY-UT. American Fisheries Society, Utah Chapter, 26-29 March, 2013, Page, Arizona.
- Klobucar, S.L., W.C. Saunders, C. Luecke, and P. Budy. 2013. A Lota lota consumption: trophic effects and potential impacts of a novel and voracious predator in Flaming Gorge Reservoir, WY-UT. American Fisheries Society, Western Division, 15-18 April, 2013, Boise, Idaho.
- Klobucar, S.L., W.C. Saunders, C. Luecke, and P. Budy. 2013. Understanding the invasion success of a novel predator: burbot life history and trophic interactions in Flaming Gorge Reservoir, WY-UT. American Fisheries Society, 8-12 September, 2013, Little Rock, Arkansas.
- Laub, B. G., P. Budy, and J. Jimenez. 2013. Restoration of the San Rafael River and riparian corridor in southern Utah. Society of Wetland Scientists, 2-6 June, 2014, Duluth, Minnesota, USA.
- Laub, B. G., P. Budy, and J. Jimenez. 2013. Synthesizing population dynamics of native fish species and geomorphic analyses of channel change to guide restoration planning on the San Rafael River, Utah. American Fisheries Society, Utah Chapter, 26-29 March, 2013, Lake Powell Resort/Wahweap Marina, Page, Arizona, USA.
- Laub, B. G., P. Budy, and J. Jimenez. 2013. Restoration of the San Rafael River, Utah: An opportunity for assessment of cumulative project impacts on a large scale. River Crossings: Linking River Communities, River Management Society conference and workshop, 11-15 March, 2013, Grand Junction, Colorado, USA.
- Winters, L., P. Budy, and G.P. Thiede. 2013. Exploring the potential for biological control of an explosive prey base by a suite of three predatory fishes in a high elevation, western reservoir. Oral Presentation. American Fisheries Society, 143rd Annual Meeting, 8-12 September, 2013, Little Rock, Arkansas.
- Winters, L., P. Budy, and G.P. Thiede. 2013. Exploring the potential for biological control of an explosive prey base by a suite of three predatory fishes in a high elevation, western reservoir. Oral Presentation. American Fisheries Society, Western Division, 15-18 April, 2013, Boise, Idaho.
- Hafen, K., L. Winters, and P. Budy. 2013. Agnostic behavior between three species of salmonids commonly stocked in Utah reservoirs. Oral Presentation. American Fisheries Society, Western Division, 15-18 April, 2013, Boise, Idaho.
- Winters, L., P. Budy, and G.P. Thiede. 2013. Exploring the potential for biological control of an explosive prey base by a suite of three predatory fishes in a high elevation, western reservoir. Oral Presentation. Spring Runoff Conference, Utah State University, 9-10 April, 2013, Logan, Utah.
- Winters, L., P. Budy, and G.P. Thiede. 2013. Scofield Reservoir: exploring the potential for biological control of an explosive prey base by three top predatory fishes. Oral Presentation. American Fisheries Society, Utah Chapter, 26-28 March, 2013, Wahweap, Utah. *Best Student Presentation Award*.
- Hafen, K., L. Winters, and P. Budy. 2013. Agnostic behavior between three species of salmonids commonly stocked in Utah reservoirs. Oral Presentation. American Fisheries Society, Utah Chapter, 26-28 March, Wahweap, Utah.

- Budy, P. 2014. Arctic Lakes: Spring 2014 update and new direction. Arctic Long Term Ecological Research, 25-28. February, 2014, Woods Hole, Massachusetts.
- Klobucar, S.L. and P. Budy. 2014. In hot(ter) water: predicting zooplankton biomass and arctic char growth and consumption under climate change scenarios on the Alaska North Slope. Poster. Arctic Long Term Ecological Research, 25-28. February, 2014, Woods Hole, Massachusetts.
- Laub, B. G., J. Jimenez, and P. Budy. 2014. Restoration and monitoring plan for native fish and riparian vegetation on the San Rafael River, Utah. Tamarisk Coalition Research and Management Conference, 18-20 February, 2014, Grand Junction, Colorado, USA.
- Budy, P. 2014. Challenges to desert fish conservation and river restoration in the arid West: How can we avert the perfect storm? University of Missouri, Dept. of Fisheries and Wildlife Sciences. Invited Lecture: 5 March, 2014 Michael Dunmire Lecture Series.
- Laub, B. G. and P. Budy. 2014. All as one or one for all? Assessing the likely effectiveness of managing three native species (bluehead sucker, flannelmouth sucker, and roundtail chub) as an ecological complex. American Fisheries Society, Utah Chapter, 11-14 March, 2014, Price, Utah, USA.
- Chapman, K., P. Budy, and F. Howe. 2014. Evaluating the potential impacts of American white pelican predation on Bonneville cutthroat trout in Strawberry Reservoir, UT. Poster. American Fisheries Society, Utah Chapter, 11-14 March, 2014, Price, Utah, USA.
- Breen, M.J., G. P. Thiede, P. Budy, M. D. Fiorelli, S. Klobucar, and P. MacKinnon. 2014. Population demographics and habitat criteria for three sensitive fishes: why is the White River unique? American Fisheries Society, Utah Chapter, 11-14 March, 2014, Price, Utah, USA.
- Mohn, H., B. Roper, P. Budy. 2014. Quantifying Bonneville Cutthroat Trout spawning movement within the Logan River watershed with consideration to potential metapopulation structure and management. American Fisheries Society, Utah Chapter, 11-14 March, 2014, Price, Utah, USA.
- Laub, B. G., J. Jimenez, and P. Budy. 2014. Restoration and monitoring plan for native fish and riparian vegetation on the San Rafael River, Utah. 2014 Spring Runoff Conference, 1-2 April, 2014, Logan, Utah, USA.
- Budy, P., M. M. Conner, N.L. Salant, and W. Macfarlane. 2014. The clock is ticking for desert fishes of the SW USA: An occupancy-based assessment of regional vulnerability. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.
- Klobucar, S.L. and P. Budy. 2014. In hot(ter) water? predictions of arctic char growth and consumption under climate change scenarios on the Alaska North Slope. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.
- Macfarlane, W.W., P. Budy, G. P. Thiede, and B. G. Laub. 2014. Looking beyond the mainstem for conservation of restoration of endangered Colorado River fishes. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.
- Mohn, H., B. Roper, P. Budy. 2014. Investigating Bonneville Cutthroat Trout spawning movement within the Logan River watershed with consideration to potential metapopulation structure and management. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.

- Laub, B. G. and P. Budy. 2014. All as one or one for all? Assessing the likely effectiveness of multi-species management. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.
- Budy, P., M.M. Conner, N.L. Salant, and W.W., Macfarlane. 2014. The Clock is Ticking for Desert Fishes of the SW USA: An Occupancy-based Assessment of Regional Vulnerability. American Fisheries Society, Western Division, 7-11 April, 2014, Mazatlán, Mexico.
- Dibble, K.L., C. B. Yackulic, T. Kennedy, and P. Budy. 2014. Factors influencing the size of salmonids in regulated river systems: a synthesis of data from the Western United States. Joint Aquatic Sciences Meeting; Portland, OR; May 18-23, 2014.
- Finch, C. and P. Budy. 2014. Habitat mediated dispersal and recolonization in stream fish following a severe fire. Poster. Joint Aquatic Sciences Meeting; Portland, OR; May 18-23, 2014.
- Dibble, K.L., C. B. Yackulic, T. Kennedy, and P. Budy. 2014. An examination of the processes that regulate fish size downriver of dams in the Western United States. 144th Annual Meeting of the American Fisheries Society; Quebec City, Canada; August 17-21, 2014.

Edwards

- Edwards, T.C., Jr, J. Gibson, G.G. Moisen, T.S. Frescino, and N.E. Zimmermann. Differential life stage niche modelling: can we construct species fitness landscapes from species distribution models? Offered paper, 2014 Meeting of the U.S. Chapter of the International Association for Landscape Ecology, Anchorage, Alaska, 5/19/2014.
- Gibson, J. R., G. G. Moisen, T.S. Frescino, and T. C. Edwards, Jr. Distribution shifts of coniferous forests in the Colorado plateau under projected 21st century climate change. Offered paper, 2014 Meeting of the U.S. Chapter of the International Association for Landscape Ecology, Anchorage, Alaska, 5/19/2014.
- Sims, S.A., D. Stoner, T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, D.J. Mattson, D.M. Choate, and K. Longshore. Mountain lion (*Puma concolor*) home-range size and the normalized difference vegetation index: using a landscape productivity index as a surrogate for prey density. Offered paper, 2014 Annual Meeting of the Utah Chapter of the Wildlife Society, St. George, Utah, 3/20/14.
- Stoner, D. T. C. Edwards, Jr., J. O. Sexton, J. Nagol, and H. Bernales. Ungulate reproduction and plant phenology on the Colorado Plateau. Offered paper, 2014 Annual Meeting of the Utah Chapter of the Wildlife Society, St. George, Utah, 3/20/14.
- Stoner, D., and T.C. Edwards, Jr. Using remotely sensed indices of primary productivity to evaluate large mammal abundance and movement in the arid Southwestern United States. Invited paper, Forty-sixth Annual Fall Meeting of the American Geophysical Union, San Francisco, California, 12/10/13.
- Edwards, T.C., Jr. Case studies: using the Colorado Plateau Rapid Ecoregional Assessment to set management and research objectives. Invited paper, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/19/2013.
- Gibson, J. R., G. G. Moisen, T.S. Frescino, and T. C. Edwards, Jr. Distribution shifts of coniferous forests in the Colorado plateau under projected 21st century climate

- change. Offered paper, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/18/2013.
- Ironside, K.E., D.J. Mattson, D. Stoner, T.C. Edwards, Jr., J. Nagol, A. Anand, J.O. Sexton, K.E. D.M. Choate, K. Longshore, B. Holton, and B. Jansen. Colorado Plateau trophic interactions: climate, primary productivity, and large mammals. Offered paper, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/18/2013.
- Stoner, D., T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, and D.J. Mattson. Plant phenology and the abundance of three mountain ungulates on the Colorado Plateau. Offered paper, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/18/2013.
- Sims, S.A., D. Stoner, T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, D.J. Mattson, D.M. Choate, and K. Longshore. Mountain lion (puma concolor) home-range size and the normalized difference vegetation index: using a landscape productivity index as a surrogate for prey density. Offered poster, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/17/2013.
- Edwards, T.C., Jr. Forecasting climate-induced distribution shifts for the piñon-juniper complex of the Western United States. Invited paper, SNF Sinergia Project Spatially Explicit Evolution of Diversity, Zurich ETH and Swiss Federal Research Lab WSL, Birmensdorf, Switzerland, 24/4/2013.
- Stoner, D.C., T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, and D.J. Mattson. Ungulate abundance across a latitudinal gradient: primary production, summer precipitation, and habitat fragmentation. Offered paper, NASA 2013 Annual Meeting on Climate Change and Biodiversity, Bethesda, Maryland, 13/4/2013.
- Edwards, T.C., Jr, J. Gibson, G.G. Moisen, T.S. Frescino, and N.E. Zimmermann. Expansion and contraction tension zones in western US piñon-juniper woodlands under projected climate change. Offered paper, 6th Biennial Meeting of the International Biogeography Society, Miami, Florida, 1/10/2013.

Popular Media

- Leavitt, Shauna L. (2014, July 15). *Trout vs. chub*. Retrieved from <http://wildlife.utah.gov/blog/2014/trout-vs-chub/>
- Leavitt, Shauna L. (2014, July 11). *Strawberry Reservoir pelican project*. Retrieved from <https://www.facebook.com/media/set/?set=a.839890476021966.1073741967.136959382981749&type=1>

Active Grants and other Funding

Budy

- 2013-present Quantifying pelican predation potential on the fish community of Strawberry Reservoir and assessing stream habitat use (PI):
-Utah Division of Wildlife Resources, \$130,790.
-US Forest Service, \$29,307.
- 2011-present Pyramid Lake fishery evaluation: evaluating cutthroat trout performance and identifying limiting factors for the native fish community (PI):
-US Fish and Wildlife Service, \$344,769.
- 2013-present Understanding the effects of wildfire on fish populations and stream geomorphology in Twitchell Canyon (PI):
-Utah Division of Wildlife Resources, \$98,374.
- 2012-present San Rafael restoration science: restoration implementation and riparian area delineation (PI):
-US Bureau of Land Management, \$316,000.
- 2014-2015 Matching watershed otolith microchemistry to establish natal origins of endangered June suckers (*Chasmistis lioris*) (PI):
-Central Utah Water Conservancy District, \$20,000.
- 2014-2015 Ecological changes in aquatic communities in the Big Bend reach of the Rio Grande: Synthesis and future monitoring needs (PI):
-National Park Service \$102,140.
-National Park Service \$41,260.
- 2003-present Bull trout viability (PI):
-US Fish and Wildlife Service, \$1,458,514.
- 2011-present Tributary habitat use of endangered and imperiled fishes in the Price River, Utah (PI):
-US Bureau of Reclamation, \$166,452.
- 2010-2016 Arctic LTER: Climate change and changing disturbance regimes in arctic landscapes (PI):
-National Science Foundation, \$192,000.
- 2012-present Cutthroat trout populations within the Logan River watershed (PI):
-US Forest Service, \$73,902.
- 2012-present Movement and habitat studies of endangered fishes in the Colorado River basin utilizing stationary and mobile pit-tag detection systems (PI):
-US Bureau of Reclamation, \$623,182.

Edwards

- 2013-2016 Decision support systems for the BLM Colorado Plateau REA and FWS Southern Rockies LCC (PI):
- Bureau of Land Management, \$75,000.
- U.S. Fish and Wildlife Service, \$55,700.
- 2012-2016 Habitat modelling of rare plant species in the Colorado Plateau (PI):
- Bureau of Land Management, \$352,300.

- 2011-2015 Step-down demonstration analyses of plants and animals under the BLM Rapid Ecoregional Analysis process (PI):
- Bureau of Land Management, \$165,500.
- 2011-2015 Spatial responses to climate across trophic levels: monitoring and modeling plants, prey, and predators in the Intermountain Western United States (PI):
-NASA, \$1,912,000 Total project; \$532,400 USU.
- 2009-2015 Sustainable communities and landscape designs (PI):
-U.S. Geological Survey, \$348,600.

Graduate Students Directed

Bissonette

Dan Olson. 2013. Assessing vehicle-related mortality of mule deer in Utah, , Ph.D. October 2013.

Budy

Bowerman, Tracy. 2013. A multi-scale investigation of factors limiting bull trout viability. PhD. Ecology. Utah State University.

Klobucar, Stephen. 2013. An experimental and modeling approach to understanding predator-prey dynamics: identifying limitations of predator performance in high desert impoundments. MS Thesis. Ecology. Utah State University.

Winters, Lisa. 2014. An evaluation of the food web dynamics and predator prey interactions in Scofield Reservoir. MS Thesis. Ecology. Utah State University.

Dean, Andy. 2014. An evaluation of the relative performance of diploid versus triploid brook trout with consideration of the influence of lake characteristics. MS Thesis. Ecology. Utah State University.

Heredia, Nicholas. 2014. Food web ecology and energetics of Lahontan cutthroat trout in Pyramid Lake, Nevada: Return of the King? MS Thesis. Ecology. Utah State University.

Newlon, Courtney. *MS degree in progress - Ecology*. Identifying cues for movement and temporally-dynamic limiting factors in the bull trout movement corridor. *To be completed in 2014*.

Strohm, Deanna. *MS degree in progress - Ecology*. Matching watershed and otolith microchemistry to establish natal origins of an endangered desert lake sucker. *To be completed in 2014*.

Klobucar, Stephen. *PhD degree in progress - Ecology*. In hot(ter) water: predicting zooplankton biomass and arctic char growth and consumption under climate change scenarios on the Alaska North Slope. *To be completed by 2016*.

Chapman, K. *MS degree in progress - Ecology*. Quantifying the direct and indirect effects of pelican predation on a population of cutthroat trout in Strawberry Reservoir, UT. *To be completed by 2015*.

Finch, Colton. *PhD degree in progress - Ecology*. Fires, floods, and fish: projecting population recovery in an inland watershed. *To be completed by 2016*.

Edwards

Adam Brewerton. M.S. 2012. Avian response to post wildland fire reseeding treatments in Great Basin shrubsteppe. MS Thesis. Avian Ecology. Utah State University.

Andrew (Steven) Sims. *M.S. degree in progress.* Effects of interannual climate and primary productivity on mule deer survival and fecundity. *To be completed by 2017.*

Research Associates Directed

Budy

Saunders, W.C. 2010 - 2013. 1) A test of the theory of biotic resistance: novel options for native fish restoration. 2) Understanding the invasion success of a novel predator: burbot life history and trophic interactions in Flaming Gorge Reservoir.

Laub, B. 2012 - present. Identifying restoration potential for an imperiled, desert tributary stream.

Edwards

Jacob Gibson, Research Associate

Sustainable communities and landscape designs

David Stoner, Post-doctoral Research Associate

Spatial responses to climate across trophic levels: monitoring and modeling plants, prey, and predators in the Intermountain Western United States

Robert Fitts, Research Associate

Habitat modelling rare plant species in the Colorado Plateau

Michael Guttery, Post-doctoral Research Associate

Decision support systems for the BLM Colorado Plateau REA and FWS Southern Rockies LCC

Visiting Scholar Collaboration

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 with T. Edwards: 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

Roholt, B. *In progress.* A morphometric determination of gape limitation of top fish predators in the western US. Watershed Sciences, USU.

- Reynolds, Jamie. *In progress*. Effects of water quality on fish species in cutler reservoir. Undergraduate Honors Thesis. Quinney College of Natural Resources, USU. Presented at Utah American Fisheries Society and The Wildlife Society, March 2014.
- Hafen, K. 2014. Agonistic behavior between rainbow, cutthroat, and tiger trout in a novel Utah reservoir community. *Prepared for submission to Transactions of the American Fisheries Society as a Note*.
- Ausberger, J. 2013. Sculpin diet composition in the Logan River. Quinney College of Natural Resources, USU. Research Experience for Undergraduates Program.
- Fisher, K. 2013. Comparing Trophic Level Position of Invertebrates In Fish And Fishless Lakes In Arctic Alaska. Undergraduate Honors Thesis. USU. 14 pp.

Edwards

- Sims, S.A., D. Stoner, T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, D.J. Mattson, D.M. Choate, and K. Longshore. Primary productivity predicts mountain lion (*Puma concolor*) home-range size. Offered paper, 2014 Annual Meeting of the Utah Chapter of the Wildlife Society, St. George, Utah, 3/20/14.
- Sims, S.A., D. Stoner, T.C. Edwards, Jr., J. Nagol, J.O. Sexton, K.E. Ironside, D.J. Mattson, D.M. Choate, and K. Longshore. Mountain lion (*puma concolor*) home-range size and the normalized difference vegetation index: using a landscape productivity index as a surrogate for prey density. Offered poster, 12th Biennial Conference of Science and Management on the Colorado Plateau, Flagstaff, Arizona, 9/17/2013.

Professional & Academic Service

Budy

- American Fisheries Society & Sea Grant Best Student Paper/Poster Symposium. May 2014.
- American Fisheries Society, Professional Networking Opportunity, Presentation and Roundtable for students etc., Utah Chapter, Price, UT, 12 March, 2014.
- American Fisheries Society, Education Section, Western Division Representative. 2014 – present.
- Associate Editor, 2010 – present, Ecology of Freshwater Fish.
- New Faculty Teaching Academy, Teaching Mentor, USU, Jereme Gaeta, 2014.
- Committee Assignments:
 Bureau of Land Management, State of Utah, Rapid Ecosystem Analysis Implementation Committee (2011-current).
- Reviewer for:
 Transactions of the American Fisheries Society, North American Journal of Fisheries Management, Ecology of Freshwater Fish, Conservation Biology, Canadian Journal of

Fisheries and Aquatic Sciences, Journal of Fish Biology, Journal of Fish and Wildlife Management, Southwest Naturalist.

Edwards

Reviewer for:

The Auk, Journal of Wildlife Management, Florida Field Naturalist, The Murrelet, Wilson Bulletin, Journal of Field Ornithology, Condor, Current Ornithology, Conservation Biology, Wildlife Society Bulletin, Ecology, Ecological Monographs, Remote Sensing and Environment, American Naturalist, Ecological Applications, Landscape Ecology, Ecological Modelling, Environmental Management, Biological Conservation, Journal of Vegetation Science, Trends in Ecology and Evolution, Diversity and Distributions, Ecography.

Professional Service:

General-Secretary, International Association for Landscape Ecology, 2009-current.
Editorial Board, Journal of Applied Vegetation Science, 2007-2013.
Editorial Board, Ecography, 2010-current).
General-Secretary, International Association for Landscape Ecology (2009-current).

Committee Assignments:

Bureau of Land Management, State of Utah, Rapid Ecosystem Analysis Implementation Committee (2011-current).
State of Utah, Department of Natural Resources, Environmental Monitoring Board, Salt Lake City, Utah (2010-current).
High North Research Centre for Climate and the Environment, Fram Centre, University of Tromsø, Tromsø, Norway (2012).

Organized Symposia

Edwards

Co-Organizer, Fourth Workshop on Advances in Predictive Species Distribution Models, 8/27-29/12, Riederalp, Switzerland.
Co-Organizer, Fifth Workshop on Advances in Predictive Species Distribution Models, 5/3-5/13, Peyresq, France (resulted in 7 manuscripts published, in press, or in review).

Courses/Workshops

Bissonette

Visiting Professor at Albert-Ludwigs-Universitaet Freiburg, three week short course in landscape ecology, 11-29 Nov. 2013.

administration and senior biologists, and 2) Utah Division of Natural Resources and Governors Office.

Edwards

Espresso shortcourses developed and taught:

Courses comprise >300 hours of direct instruction, not including student-required time for associated exercises. Over 500 students and managers have participated in the courses, with courses having been taught at locations ranging from FWS Field offices to University settings to NCTC.

baseR – Data Management and Manipulation in R

graphR – Basic Graphing in R

statR-I – Descriptive Statistics in R

statR-II – Analysis of Variance techniques in R

statR-III – Basic Regression Techniques in R

statR-IV – Categorical Methods in R

Species Distribution Modelling Using R

Bioclimatic Forecast Modelling Using R

Advanced Regression and Classification Techniques Using R.

AQUATICS ANALYSIS FOR THE BLM COLORADO PLATEAU RAPID ECOREGIONAL ASSESSMENT: CHALLENGES AND OPPORTUNITIES REPORT

Dates:

2014-2015

Abstract:

The Bureau of Land Management (BLM), in partnership with the Southern Rockies Landscape Conservation Cooperative, prepared a rapid ecoregional assessment (REA) document for the Colorado Plateau in 2012. The purpose of the rapid ecoregional assessment is to integrate scientific data across the different management boundaries in the Colorado Plateau in support of regional conservation and



management planning. Although a number of data sources have been compiled and integrated, uncertainty remains regarding how to use the resulting map products to guide identification of priority areas for conservation, restoration, and development on the ground.

We are contributing expertise on native fish and other aquatic resources to a team whose purpose is to review the REA, identify data gaps and overlooked information sources, identify threats to conservation of key species based on compiled data in the REA, and provide recommendations for using the information in the REA to direct conservation and restoration planning. The development of the “Challenges and Opportunities Report” is intended to help managers develop local-scale projects that are consistent with high-priority conservation and restoration targets identified at the level of the Colorado Plateau ecoregion. In other words, the analysis will provide a step-down from the scale of the Colorado Plateau to the field-office level where management decisions are ultimately made and implemented. Overall, the goal is to develop management and conservation efforts for aquatic resources within a regional-scale focus on priorities and threats.

Funding:

Primary: Bureau of Land Management
U.S. Geological Survey – UCFWRU (in-kind)

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Brian Laub, Research Scientist, USU- Dept. of Watershed Sciences
Justin Jimenez, Fisheries/Riparian Program Lead, BLM Utah State Office
Scott Miller, Director, National Aquatic Monitoring Center, USU – Dept. of Watershed Sciences

PROGRAM REVIEW OF UTAH'S STATE CONSERVATION AGREEMENTS AND STRATEGIES

Dates:

2014-2015

Abstract:

The state of Utah is signatory to a number of conservation agreements that are intended to guide management and research of sensitive aquatic species and prevent listing of the species under the Endangered Species Act. The species that are managed under these agreements include:

- Northern Leatherside chub
- Southern Leatherside chub
- Boreal Toad
- Bonneville Cutthroat Trout
- Columbia Spotted Frog
- Virgin River Spinedace
- Least Chub
- Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker



Each conservation agreement has a unique history and was prepared separately for each species. Although there has been important progress in managing sensitive species under these conservation agreements, the Utah Department of Natural Resources (UDNR) has raised concerns that limited funding for implementing the agreements could be used more efficiently, particularly with respect to whether monitoring is appropriate to assess progress toward accomplishment of goals, is being repeated by other agencies, and whether efforts could be combined for multiple species.

The goal of this project is thus to conduct an external review of the conservation agreements and provide recommendations to the UDNR for improvement of goals, objectives, and monitoring plans for each agreement. Reviews will be conducted through ongoing dialogue between reviewers and key management personnel who are familiar with work being conducted under each conservation agreement. We will be providing a series of workshops for natural resource personnel that will highlight key approaches and strategies that could be useful in improving the agreements, based on the review findings and based on investigations of similar conservation agreements implemented by other agencies that were proven to be successful.



Funding:

Primary: Utah Department of Natural Resources
U.S. Geological Survey – UCFWRU (in-kind)

Investigators:

Holly Strand – Principle Investigator, USU-Quinney College of Natural Resources
Phaedra Budy, Professor and Director, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Brian Laub, Research Scientist, USU- Dept. of Watershed Sciences
Charles Hawkins, Professor, USU-Dept. of Watershed Sciences

ECOLOGICAL CHANGES IN AQUATIC COMMUNITIES IN THE BIG BEND REACH OF THE RIO GRANDE: SYNTHESIS AND FUTURE MONITORING NEEDS

Dates:

2014-2015

Abstract:

Similar to many desert river systems, the Rio Grande has been impacted by dams and water withdrawals over the last century. The altered physical processes and resultant changes in geomorphology and riparian vegetation communities along the river have been well studied, and basic monitoring of riparian vegetation communities and other biological resources has also been conducted on the river. However, a synthesis of knowledge and models linking the biological data to knowledge of altered physical processes that can be used to understand how physical processes support aquatic habitat and biota and how these aquatic resources can be better managed under future changes is lacking.



We will be collecting and synthesizing available data on aquatic communities in the Big Bend region and combining this available data with a review of relevant literature to develop models that link biotic dynamics with physical processes. In particular, we will work closely with local scientists and managers to develop time series of abundance and population trends of aquatic species in order to gauge current status of species and identify how altered physical processes and other environmental changes have impacted aquatic biota over time.



In addition, we will summarize habitat requirements and life history of target species to better predict future response of these organisms to further hydrologic and geomorphic changes and to inform potential management activities. We will synthesize available data on abundance trends, habitat requirements, and life history parameters in conceptual models, and through this process identify data gaps and research needs. This project will thus result in recommendations for future monitoring and scientific research to improve understanding of aquatic resources and their interaction with physical processes operating in the Big Bend region.

Funding:

Primary: Desert Landscape Conservation Cooperative
U.S. Geological Survey – UCFWRU (in-kind)

Investigators:

Phaedra Budy, Professor and Director, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Brian Laub, Research Scientist, USU- Dept. of Watershed Sciences
Jack Schmidt, Professor, USU-Dept. of Watershed Sciences
Dave Dean, Researcher, Grand Canyon Monitoring and Research Center

IMPLEMENTATION AND MONITORING OF A SCIENCE BASED RESTORATION AND MANAGEMENT PLAN FOR NATIVE FISH AND RIPARIAN VEGETATION ON THE SAN RAFAEL RIVER, UT

Dates:

2014-2015

Abstract:

Like many rivers in the southwestern US, the San Rafael River in southeast Utah has been impacted by hydrologic alterations, habitat fragmentation, and non-native fish and vegetation establishment. In low-water years, the lower San Rafael River often becomes dewatered due to irrigation withdrawals. In addition, spring snowmelt floods have declined in magnitude and duration due to water capture in the upper portion of the basin. However, summer monsoon floods still occur regularly and transport large quantities of sediment into the lower river. This sediment is no longer exported from the river channel due to the loss of spring snowmelt floods. As a result, the channel has narrowed and deepened, the floodplain has aggraded, and backwaters and other off-channel habitats have filled with sediment. Saltcedar (*Tamarix* sp.) has colonized the river banks in high densities and exacerbated floodplain aggradation and channel narrowing by stabilizing bank and floodplain sediments. The combination of reduced spring snowmelt flows and saltcedar colonization has led to a narrowing and simplification of the river channel. Non-native fish species have also colonized the San Rafael River below Hatt Ranch dam (pictured below), which is a complete barrier to upstream fish movement. Despite these threats, three native species of conservation concern are found in the San Rafael River, the bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and roundtail chub (*Gila robusta*). However, these species occur in low abundances in the San Rafael River and thus restoration has the potential to help ensure the persistence of these native fish.



We used analyses of channel change, current maps of vegetation distribution, and modeling of potential response of native fish to restoration measures to develop a watershed-scale restoration plan that prioritizes reaches for conservation and restoration measures. We are applying an experimental and phased approach to the restoration design, so that we can understand the cumulative impacts of different restoration projects over a large scale. Through monitoring of fish, channel morphology, and vegetation response, we envision that the outcomes of the San Rafael River restoration project will help inform restoration efforts throughout the southwestern US.



Funding:

Primary: Bureau of Land Management
Bureau of Reclamation & U.S. Geological Survey – UCFWRU (in-kind)

Investigators:

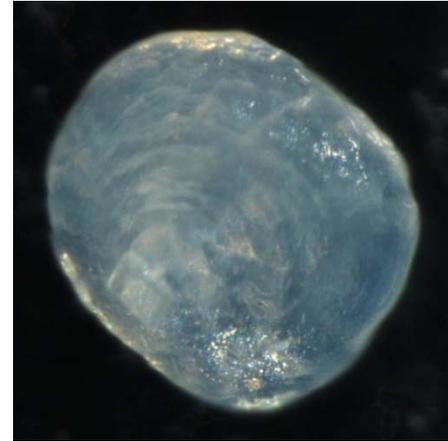
Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Brian Laub, Research Scientist, USU- Dept. of Watershed Sciences
Justin Jimenez, Fisheries/Riparian Program Lead, BLM Utah State Office
David Dean, Researcher, Grand Canyon Monitoring and Research Center

MATCHING WATERSHED AND OTOLITH MICROCHEMISTRY TO ESTABLISH NATAL ORIGINS OF AN ENDANGERED LAKE SUCKER

Dates: 2013-2014

Abstract:

Anthropogenic changes to the landscape, such as stream fragmentation, revised flow regimes, channelization, sediment loading, and introduced non-native species, have resulted in high rates of decline in freshwater species. Many desert species, such as the June sucker (*Chasmistes liorus*), are currently listed as endangered. Managers have increasingly turned to habitat restoration as a key component to recovery plans. For endangered species, one of the primary outcomes of habitat restoration is an outcome of successful reproduction and recruitment of individuals into the adult population. The June sucker is potamodromous, demonstrating migrations from a lake habitat, Utah Lake, UT, into degraded tributary habitats to spawn. Confirmation of natural recruitment as a function of habitat restoration can only be achieved by establishing natal origins.



Recent research has proven the validity of otolith microchemistry, a technique that analyzes small quantities of elements, to trace potamodromous fish to their natal tributaries. Previous studies have documented that localized habitats in terms of microchemistry are reflected in otolith composition, thereby potentially making this a valuable way of determining fish origins. The primary goal of this study is to use otolith microchemistry to establish natal origins of June sucker. To accomplish this we will first quantify the chemical signatures among tributary spawning habitats. Second, we will determine if the otolith microchemistry signatures from June sucker otoliths can be used to determine natal origins. Lastly, we will develop a statistical model that is capable of classifying fish to their respective tributary based the element:calcium ratios in the otolith microchemistry.

The data obtained from this study will advance the current understanding of the June sucker recruitment dynamics and result in a fundamental improvement in our ability to determine where natural recruitment into the adult spawning population is occurring. In addition, this knowledge may help evaluate factors limiting recruitment in Utah Lake tributaries, identify future restoration localities, and assist effectiveness monitoring of spawning habitat restoration efforts.

Funding:

June Sucker Recovery Program

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU-Dept. of Watershed Sciences

Deanna Strohm, Graduate Research Assistant, USU-Dept. of Watershed Sciences



HABITAT QUALITY, SELECTION, AND CONNECTIVITY IN STREAM DWELLING SALMONIDS AFTER WILDFIRE DISTURBANCE

Dates: 2014-2016

Abstract:

The 2010 Twitchell Canyon wildfire burned approximately 18,000 hectares of Fishlake National Forest, Utah, including significant proportions of the Clear Creek watershed. Clear Creek is an extensive coldwater stream network that is an important conservation area for native Bonneville cutthroat trout, *Oncorhynchus clarkii utah* (see right). Most of the fishes, including non-native fishes, were extirpated from the drainage as a result of fire-induced habitat impairment such as temporary anoxia and extensive debris flows. Restoration of the native fish community, including Bonneville cutthroat trout, is ongoing, but is hampered by the instability of post-fire habitat and the persistence of stochastic flood events. Pre-fire land management practices such as fire suppression and the introduction of non-native fish species amplified the impacts of the Twitchell Fire on the aquatic community. While there has been a fundamental shift toward restoring natural wildfire to forests throughout the west, there is still significant uncertainty of how native fish populations should be managed to increase resilience to perturbations such as wildfire.



We are using a combination of remote sensing, direct surveys, and habitat-metapopulation modeling to address three primary research questions related to restoration of the native fish community affected by the Twitchell Fire. First, we are using bathymetric lidar coupled with direct, discrete measurement to determine the degree and extent of habitat impairment and to quantify the amount and distribution of habitat features such as pools, preferred substrate, large woody debris, and cover that are important to Bonneville cutthroat trout. Second, we are surveying both burned and unburned streams to assess prey availability and determine if significant differences prevail, and evaluate if fish select different habitat or food based on fire history. Third, we are building a metapopulation viability model based on extant distribution of quality habitat patches and migration barriers

to determine the probability of population persistence/extinction and to prioritize habitat restoration efforts for this important native fishery.

Funding:

Primary: Utah Division of Wildlife Resources
Quinney Fellowship to Colton Finch (PhD)
U.S. Geological Survey -UCFWRU (in-kind)

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Patrick Belmont, Co-Principle Investigator, USU – Department of Watershed Sciences
Colton Finch, PhD student, USU- Dept. of Watershed Sciences
Keelin Schaffrath, PhD student, USU – Department of Watershed Sciences

EVALUATING THE POTENTIAL IMPACTS OF AMERICAN WHITE PELICAN PREDATION ON BONNEVILLE CUTTHROAT TROUT IN STRAWBERRY RESERVOIR, UTAH

Dates:

2014-2015

Abstract:

The development of the western United States caused wide-spread changes to natural ecosystems. Remaining populations of fish and wildlife also went through changes in size and distribution as a result of changes to habitat, resource availability, pollutants, invasive species and human exploitation. As current conservation efforts contribute to the restoration of predators, questions arise as to how these predators will exploit altered habitat and affect population potential prey populations that developed in their absence. Strawberry Reservoir, Utah, is one of many examples of a highly altered ecosystem, with dynamics that differ substantially from historic conditions. The present fish assemblage of the reservoir consists of both native species such as the Utah chub (*Gila atraria*) and Utah sucker (*Catostomus ardens*), as well as stocked and naturally-reproducing cutthroat trout (*Oncorhynchus clarki utah*), an extremely popular sport fish. Since the early 2000's, American white pelicans (*Pelecanus erythrorhynchos*) spend the months of April-August on the reservoir. Behavioral observations of pelicans and retrieval of PIT tags from stocked cutthroat trout indicated the pelicans may prey upon and/or intimidate cutthroat trout during the spawning run from late May to mid June. This study is intended to contribute to the understanding of developing predator-prey relationships in novel ecosystems, by determining the relative contribution of mortality to cutthroat trout by pelican predation, preferred prey species of pelican (e.g., trout versus suckers), and behavioral effects of pelican flocks on potential cutthroat spawners.



To accomplish this, we are experimentally manipulating the distribution of pelicans, near cutthroat spawning tributaries, via selective hazing techniques. We are monitoring the behavioral response of cutthroat trout to the presence of pelicans through fish counts, as well as tracking cutthroat movement into and out of the spawning tributaries via PIT-tag detection arrays. We are also determining the diet composition of the pelicans by collecting stomach content samples from captured birds, and blood samples for isotopic analysis. We will use data from our field collections to develop a population model, to estimate the mortality experienced by cutthroat trout due to pelican predation relative to other sources of mortality.

Funding:

Primary finding source: Utah Division of Wildlife Resources
U.S. Geological Survey – UCFWRU
Utah State University Ecology Center



Investigators:

Kevin Chapman, Principle Investigator , USU- Dept. of Watershed Sciences
Phaedra Budy, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Frank Howe, USU- Dept. of Wildland Resources, UDWR

LOGAN RIVER TROUT VIABILITY AND LONG-TERM MONITORING: FACTORS AFFECTING TROUT POPULATION DYNAMICS, ABUNDANCE, AND DISTRIBUTION IN THE LOGAN RIVER, UTAH

Dates:

2001-2014 (on-going)

Abstract:

Most subspecies of cutthroat trout *Oncorhynchus clarkii* are imperiled or extinct due to the combined effects of habitat degradation and interactions with exotic species. To quantify abundance and vital rates and evaluate trends, we selected a large population of cutthroat trout *O. c. utah* from the Logan River of northern Utah, a river characterized by high-quality and connected habitat. Over a 13-year period, we completed a comprehensive population assessment, including depletion-based abundance estimates and a mark-recapture study of site fidelity, growth, and survival. Abundance of cutthroat trout (> 100 mm TL) varied greatly by sample site, ranging from 38 fish/km at the Third Dam site (the lowermost end of their distribution in the river) up to 822 fish/km at Franklin Basin. Population trend (λ) of cutthroat trout estimated for the entire Logan River population based on pooled site abundance estimates was 0.89 (0.77 – 1.02), indicating an apparent overall decline; however, site-specific population trends are highly variable. Clinical signs of whirling disease were observed in less than 1% of fish handled ($n > 14,000$ fish), while prevalence of *Myxobolus cerebralis* in cutthroat trout was 50 – 100%. The distribution of cutthroat trout and brown trout show a distinct species-zonation pattern (Figure 1). Our results provide important conservation and recovery benchmarks for identifying range-wide limiting factors of Bonneville cutthroat trout. We continue to recommend a precautionary approach to the management of this endemic and important population.

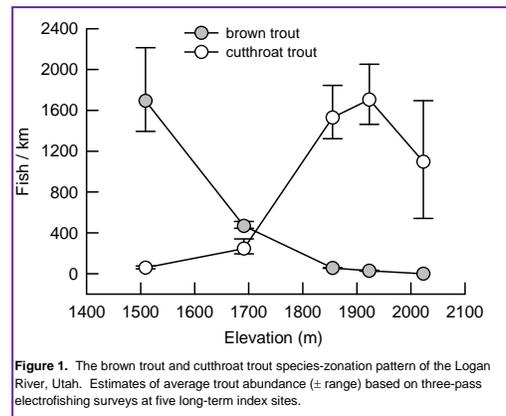


Figure 1. The brown trout and cutthroat trout species-zonation pattern of the Logan River, Utah. Estimates of average trout abundance (\pm range) based on three-pass electrofishing surveys at five long-term index sites.



Funding:

US Forest Service, Fish and Aquatic Ecology Unit, Logan, Utah; US Geological Survey–UCFWRU (*in-kind*); Utah Division of Wildlife Resources, Numerous partners.

Investigators:

Phaedra Budy, Principle Investigator, USGS-UTCFWRU, USU-Watershed Sciences, Ecology Center
Gary P. Thiede, Fisheries Biologist, USU-WATS; Harrison Moen, MS student, USU-WATS

Selected Publications:

Budy, P., G.P. Thiede, J. Lobón-Cerviá, G.G. Fernandez, P. McHugh, A. McIntosh, L.A. Vøllestad, E. Becares, and P. Jellyman. 2013. Limitation and facilitation of one of the world's most invasive fish: an intercontinental comparison. *Ecology* 94(2)

Meredith, C.S., P. Budy, and G.P. Thiede. 2014. Predation on native sculpin by exotic brown trout exceeds that by native cutthroat trout within a mountain watershed (Logan, UT, USA). *Ecology of Freshwater Fish*. doi: 10.1111/eff.12134

Saunders, W.C., P. Budy, and G.P. Thiede. 2014. Demographic changes following mechanical removal of exotic brown trout in an Intermountain West (USA), high-elevation stream. *Ecology of Freshwater Fish*. doi: 10.1111/eff.12143

TRIBUTARY HABITAT USE OF ENDANGERED AND IMPERILED FISHES IN THE PRICE RIVER, UTAH

Dates:

2011 – 2013 (to present)

Abstract:

The Price River, Utah, is currently the focus of considerable conservation debate. Endangered Colorado pikeminnow have been previously but rarely documented using the Price River, and recently documented using a similar neighbor tributary, the San Rafael River. They were found as far as 60 km from the confluence with the Green River. The overall goal of this research project is to document Price River habitat use and movement by Colorado pikeminnow and other imperiled fishes, and obtain information on population abundance and distribution. We are also combining hydrological and geomorphic analyses of channel change with data on current fish distributions and habitat needs to guide restoration efforts on the lower San Rafael River, to learn and guide the restoration of other similar tributaries including the Price. We are applying an experimental approach to the restoration design, so that we can understand the cumulative impacts of different restoration projects over a large scale.

To date, we have documented heavy use of the Price River by 3 of the 4 endangered fishes and all three imperiled fishes, and their movements into the Price River generally correspond with peaks in the hydrograph (Figure 1). Although impacted by many factors, the Price R. still appears to provide adequate and important fish habitat to imperiled native fishes.

Funding:

US Bureau of Reclamation, US Geological Survey – UCFWRU (in-kind), and Utah Division of Wildlife Resources

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU - Dept. of Watershed Sciences, Ecology Center
Gary P. Thiede, Research Associate, USU- Dept. of Watershed Sciences
Peter MacKinnon, Research Associate, USU- Dept. of Watershed Sciences

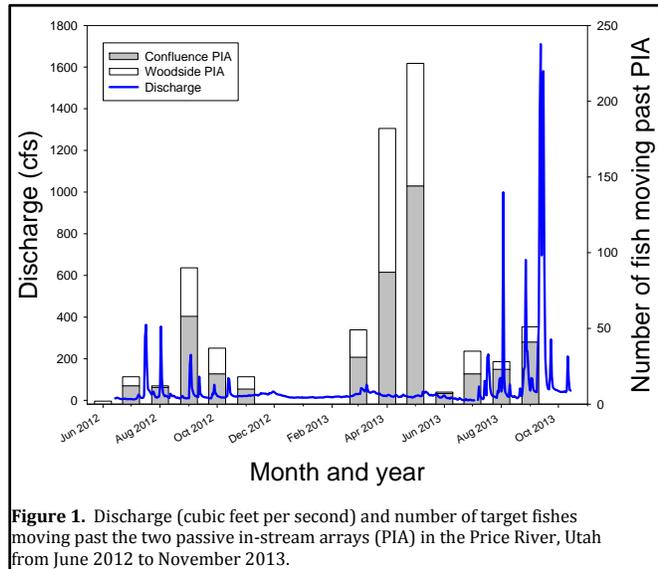


Figure 1. Discharge (cubic feet per second) and number of target fishes moving past the two passive in-stream arrays (PIA) in the Price River, Utah from June 2012 to November 2013.



INNOVATIVE USES OF PIT-TAG TECHNOLOGY: EXAMPLES FROM THE COLORADO RIVER BASIN

Dates:

2009-2014

Abstract:

Radio Frequency Identification or RFID was introduced into the realm of fisheries science in the Pacific Northwest in the mid-1980's with the introduction of the Passive Integrated Transponder (PIT) tag. PIT tags were first used to evaluate survival of anadromous salmonids through the hydroelectric projects in the Columbia and Snake rivers. Innovations such as multiplexing antenna readers, smaller high-performance tags, and larger more robust antennas have resulted in the widespread application of PIT-tag technology as a fisheries data collection tool. PIT-tag detection antennas have traditionally been used in the form of fixed antenna arrays detecting PIT-tagged fish as they move through specific areas of a river. As the use of PIT-tag technology becomes more geographically widespread, the need for alternative detection techniques and methods has become apparent.



The Colorado River Basin presents some unique challenges in fish detection whether using more traditional sampling techniques (e.g., electrofishing, seining, trammel netting, hoop netting) or when using PIT-tag technology. In this basin we are working with long-lived fishes that do not predictably migrate annually to the exact same spawning grounds and have very diverse habitat use over their life span. Innovative new styles and types of fish detection antennas have been developed and tested, driven by the needs and ideas of biologists working in the field. These new methods allow biologists to detect fish "actively" instead of "passively" waiting for the fish to move past a fixed point. These innovative methods open up the possibilities to expand the use of PIT-tag data from traditional mark-recapture studies to habitat use studies. We have completed a number of these projects where smaller, temporary, mobile, and floating antennas have been successfully used to detect PIT-tagged fish where traditional



sampling methods have been less effective. In 2014 we floated a 120 mile section of the San Juan River with a floating PIT-Tag detection system and detected over 550 unique tags. We effectively deployed fully submersible detection antennas on spawning bars and other habitat sites have been impossible to sample using traditional sampling methods, giving us extra resight data as well as habitat use information. By the

end of 2014 we will have 17, stream-wide, stationary PIT-tag detection stations in place in the upper Colorado River Basin, passively providing continuous data to support the data collected by active sampling.

Funding and collaborators:

US Bureau of Reclamation
US Geological Survey – UCFWRU (in-kind)

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU – Watershed Sciences
Peter Mackinnon, Research Associate, USU – Watershed Sciences
Gary P. Thiede, Fisheries Biologist, USU – Watershed Sciences

QUANTIFYING THE DIRECT EFFECTS OF CLIMATIC WARMING ON ARCTIC FISHES AND LAKE ECOSYSTEMS USING WHOLE-LAKE MANIPULATIONS ON THE ALASKA NORTH SLOPE

Dates: 2014 – 2017

Abstract:

Lakes are effective sentinels for climate change because of their sensitivity to the surrounding climate and potential for rapid response to change. Arctic lakes have extremely low productivity and are typically closed systems. Fish species diversity is usually depauperate, and lakes are ice-covered, with water temperature less than 3 °C degrees for 8-9 months of the year. All these factors suggest arctic ecosystems may be extremely sensitive to climate change.

The overall goals of this project are to: (A) experimentally measure the effects of extended growing seasons on system production and community composition (e.g., primary, secondary, fish), and (B) apply empirical data from the whole-lake manipulation to modeled climate change scenarios of fish growth, consumption, and abundance, in order to develop a regional fisheries climate response. We are addressing pressing questions of lake ecosystem response to climate change and advance climate change and ecological sciences with a multi-year, late summer whole-lake warming manipulation to quantify the effects of future climate change on lake ecosystems in the Arctic. Collectively these efforts will allow us to further predict the effects of climatic warming at a broader spatiotemporal scale and improve conservation prioritization and decision-making (e.g., subsistence fishing). This research has the potential to significantly improve understanding of climate change effects on arctic lake ecosystems and improve our ability to more precisely predict lake ecosystem responses to different climate change scenarios.

To perform the whole-lake warming manipulation, we will deploy an anchored epilimnetic warming and mixing raft containing slowly-rotating submerged propellers ($n = 2 - 4$) in the center of each experimental lake. Rafts will be deployed after ice-off and just before the lakes reach average maximum surface temperature (mid-July). The warming system will be operated until the average date of lake turnover (mid-September) to experimentally warm and increase the depth of the epilimnion and extend the growing season, thus simulating climate change effects.



This study will provide some of the first empirical data for experimentally measured impacts of climate change via whole-lake manipulations. Realistic quantification of these changes will improve on the body of knowledge with regard to ecosystem services across arctic landscapes. Arctic ecosystems are most susceptible to rapid change due to polar amplification, and the results of this research could provide the basis for more advanced predictions of change in less extreme climates where change will happen more slowly.

Funding:

National Science Foundation, Long-Term Ecological Research
U.S. Geological Survey – UCFWRU (in-kind)

Investigators:

Phaedra Budy, Principle Investigator, USGS – UCFWRU, USU- Dept. of Watershed Sciences
Stephen Klobucar, Graduate Research Assistant, USU- Dept. of Watershed Sciences

IMPROVING MANAGEMENT AND CONSERVATION PRACTICES OF BONNEVILLE CUTTHROAT TROUT *ONCORHYNCHUS CLARKII UTAH* THROUGH AN EVALUATION OF MOVEMENT CHARACTERISTICS AND SPATIAL POPULATION STRUCTURE IN THE LOGAN RIVER, UTAH

Dates:

2009-2014 (on-going)

Abstract:

We are studying movement distances and destinations of spawning native Bonneville Cutthroat Trout *Oncorhynchus clarkii utah* within the Logan River watershed in northern Utah in order to inform the suitability of current fishing regulations. Given that spawning is the time at which genetic interchange occurs, knowing which areas to protect within the high-quality watershed could benefit this important population. The goals of this research are to, (1) compare movement distances and destinations among tributary and main-stem residing Cutthroat Trout to determine the likelihood of a metapopulation structure, (2) determine the percentage of mobile individuals in different areas of the watershed along with a watershed scale population estimate to identify quantities of fish that are affected by current regulations, and to (3) use acquired data to compare historical reasoning behind Logan River fishing regulations with present day uses and concerns, to better inform management within this important watershed. To achieve these goals, we tagged a total of 2,456 cutthroat trout with Passive Integrative Transponders (PIT) tags during the summers of 2008-2013 within seven, 100-200 meter reaches of the Logan River using standard electrofishing, three-pass depletion techniques. Re-sight date and location data from cutthroat trout are detected continuously via stationary antennas, and regularly with mobile antennas in specific river sections. Using date and location observations from PIT tag readings, it is apparent that very few fish move long distances (>5 km) in order to spawn and over half move less than 500 meters. Because of this, it is unlikely any metapopulation structure exists within the Logan River. During spawning times, we estimate that 61% of the total population of cutthroat trout are protected from angler harvest. The findings of this research provide fisheries managers with more detailed information on how cutthroat trout utilize the Logan River, as a whole so that management decisions better protect Bonneville cutthroat trout populations during crucial times of the year and in critical areas.



Funding:

Utah Division of Wildlife Resources, US Geological Survey, USDA Forest Service, Utah State University, Numerous partners!

Investigators:

Phaedra Budy, Principal Investigator, US Geological Survey–UCFWRU, USU Dept. of Watershed Sciences
Brett Roper, Principal Investigator, USDA Forest Service, USU Dept. of Watershed Sciences
Gary P. Thiede, Fishery Biologist, USU Dept. of Watershed Sciences
Harrison Mohn, Graduate Research Assistant (M.S.), USU Dept. of Watershed Sciences (expected graduation, fall 2014)

SPATIAL RESPONSES TO CLIMATE ACROSS TROPHIC LEVELS: MONITORING AND MODELING PLANTS, PREY, AND PREDATORS IN THE INTERMOUNTAIN WESTERN UNITED STATES

Dates:

2011-2015 (Ongoing)

Abstract:

We will investigate the impact of climate on trophic linkages between primary productivity, herbivores, and top predators across landscapes in the Intermountain western United States. We will deploy GPS collars on 30 mule deer and use the data collected to model spatial patterns of ungulate density on a 16-day interval based on remotely sensed vegetation phenology. The resulting dynamic ungulate habitat models will be used to extrapolate predictions of prey density across the study area, which we will then use as the main predictor for modeling cougar movement using a decade of records collected from 70 intensely monitored individuals across the region. Resulting occupancy surfaces will be modified by spatially-explicit estimates of survival from known fates of >200 cougars to derive analogs of density. With the cost and occupancy surfaces from this analysis, we will then analyze the habitat and movement of cougars as a network to assess the sustainability of the regional cougar metapopulation.

Funding:

National Aeronautics and Space Administration

Investigators:

Joe Sexton, University of Maryland (PI)

David Mattson, U.S. Geological Survey and Northern Arizona University (Co-PI)

Thomas C. Edwards, U.S. Geological Survey UTCFWRU and Utah State University (Co-PI)

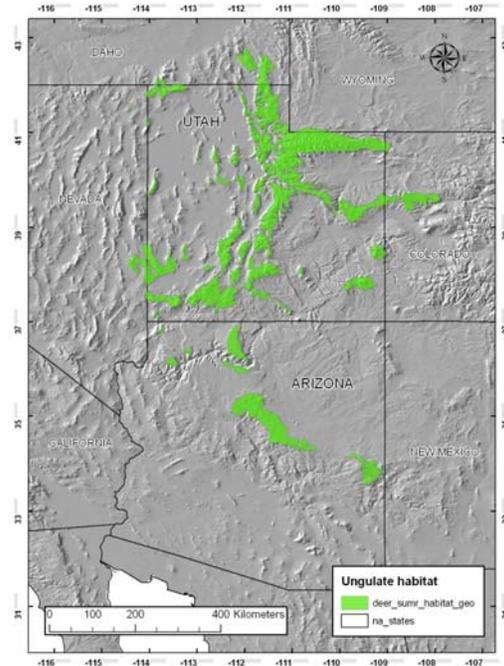
David Stoner, Post-doctoral Research Associate, Utah State University

Reports:

Annual reports 2012, 2013

Publications:

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. Variable detection rates in terrestrial global positioning system telemetry data deployed on large mammals: probability of missing fixes. In review, Animal Telemetry.



Regional study sites

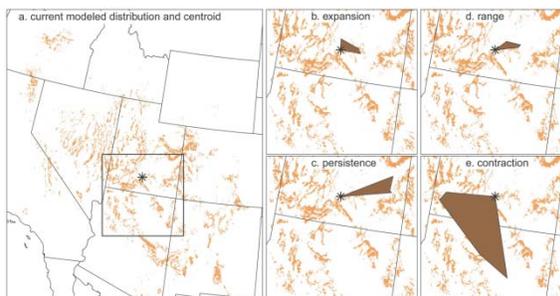
MODELLING CLIMATE CHANGE EFFECTS ON NORTH AMERICAN DRY MID-LATITUDE CONIFERS

Dates:

2009-2014 (Completed)

Abstract:

We evaluated projected climate change effects on ~30 conifer species occupying the mid-dry latitudes of Western North America. The project involves three interrelated components. First, climate projections (e.g., NCAR PM1) were downscaled to 1km resolution for Western North America. Ensemble classifiers were next used to model species distributions as functions of the downscaled climate variables. Last, we defined the leading and trailing edges of tree distributions given projected climate changes.



Modeled expansion, persistence, and contraction of piñon juniper woodlands as a result of projected climate change over the next 80 years.

Funding:

USDA Forest Service, Rocky Mountain Research Station, FIA Program

Investigators:

Thomas C. Edwards, U.S. Geological Survey UTCFWRU and Utah State University (PI)

Gretchen G. Moisen, USDA Forest Service Rocky Mountain Research Station

Niklaus Zimmermann, Swiss Federal Research Lab WSL

Jacob Gibson, Graduate Research Assistant (MS Ecology 2011)

Reports:

None

Publications:

Gibson, J.R., G. G. Moisen, T.S. Frescino, N.K. Zimmermann, and T. C. Edwards, Jr. 2014. Effects of location “fuzz-swap” on species distribution models under projected climate change scenarios: how useful are projection models based on public data? *Ecosystems* 17:43-53.

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 review, *Global Change Biology*.

Thuiller, W, T. Münkemüller, K. H. Schifffers¹, S. Dullinger, V.E. Eckhart, T. C. Edwards, Jr., D Gravel, G. Kunstler, C. Merrow, K.M. O’Leary, N. E. Zimmermann, D. Zurell, and F. Schurr. How do demographic parameters relate to probability of occurrences? In press, *Ecography*.

Edwards, Jr., T.C., J. Gibson, G.G. Moisen, T.S. Frescino, R. Wueest, W. Thuillier, J-C Svenning, J. Elith, and N.E. Zimmermann. Differential life stage niche modelling: can we construct species fitness landscapes from SDMs? In review, *Ecography*.

Merow, C., M J. Smith, W. Thuiller, N. E. Zimmermann, T. C. Edwards, Jr., A. Guisan, S. Normand, R. Wüest, and J. Elith. Back to the basics of Species distribution modeling: what do we learn from complex versus simple response curves? In press, *Ecography*.

SUSTAINABLE COMMUNITIES AND LANDSCAPE DESIGNS

Dates:

2010-2015 (Ongoing)

Abstract:

Environmental sustainability is important to the well-being of people and communities. Land cover and land use are known to affect the quality of a wide range of ecosystem processes and services. The distribution and pattern of land-use activities within a landscape or watershed can dramatically affect the quality of ecosystem services and well-being of societies. However, few studies have documented how community and city designs might affect the sustainability of ecosystem services. Most applications of ecosystem services in community and city planning have either been entirely conceptual, or are very early on in the process. However, rapid environmental change (e.g., climate change) requires a more immediate understanding of the ability of landscape designs to support and sustain a range of ecosystem. This project will develop a set of landscape metrics and models to capture differences in landscape designs and will compare those indicator and model results to conditions of ecological attributes and ecosystem services. An outcome of the project will be new methodologies to evaluate sustainability of ecosystem services.

Funding:

U.S. Geological Survey

Investigators:

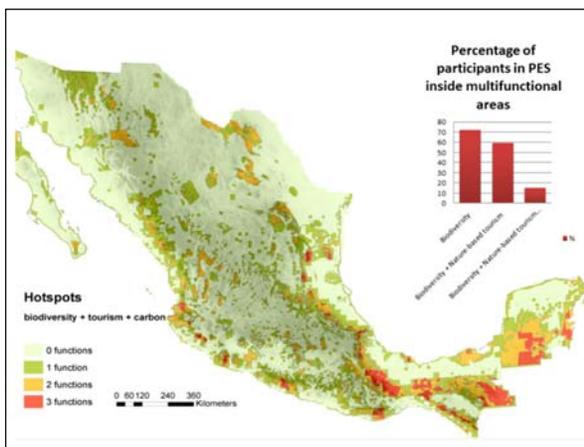
Thomas C. Edwards, U.S. Geological Survey UTCFWRU and Utah State University (PI)
Bruce Jones, U.S. Geological Survey (Co-PI)
Felix Kienast, Swiss Federal Research Lab WSL (Co-PI)
Lorena Segura Morán, Universidad Nacional Autónoma de México, Mexico

Reports:

None. Analyses still ongoing

Publications:

None. Analyses still ongoing.



Large-scale depiction of the capacity of Mexico lands to deliver specific ecosystem services. Three three functions evaluated here include gross biodiversity, nature tourism, and carbon sequestration.

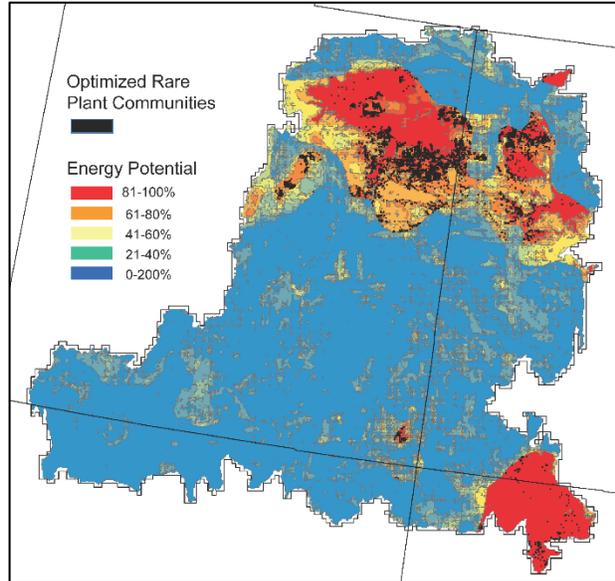
HABITAT MODELLING OF RARE PLANT SPECIES ON THE COLORADO PLATEAU: SUPPORT OF BLM'S ECOREGIONAL ASSESSMENT

Dates:

2012-2016

Abstract:

Utah is home to 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 BLM lands. We are constructing species distribution models for rare plant species under consideration for listing by the FWS, and as species of concern for BLM and the state of Utah. We are evaluating model capabilities to predict likely locations of the species. Additional analyses evaluate distributions in light of proposed energy development in the Colorado Plateau.



Optimized protection coverage of rare plant communities (black) in relation to high energy extraction potential in the Colorado Plateau.

Funding:

Bureau of Land Management, State of Utah

Investigators:

Thomas C. Edwards, U.S. Geological Survey UTCFWRU and Utah State University (PI)
Robert Fitts, Research II, Utah State University (Co-PI)
Rico Hergert, Intern, Swiss Federal Research Institute WSL

Reports:

None. Analyses still ongoing.

Publications:

None. Analyses still ongoing.

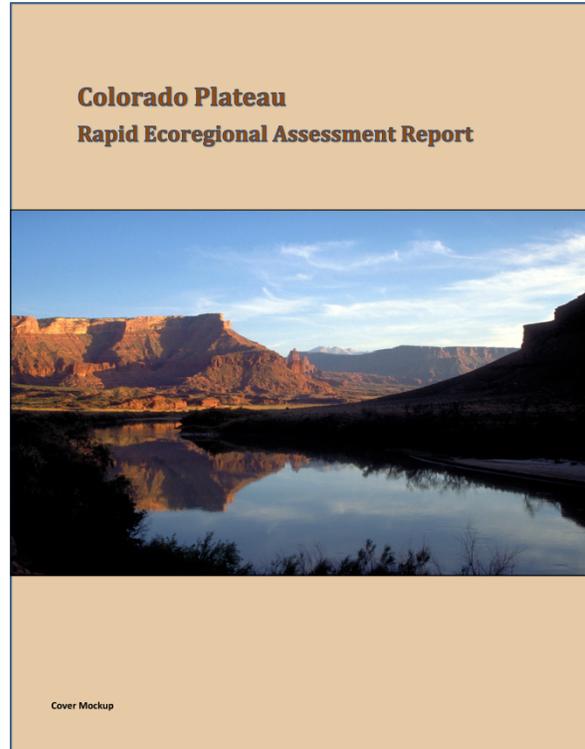
DECISION SUPPORT SYSTEMS FOR THE BLM COLORADO PLATEAU REA AND FWS SOUTHERN ROCKIES LCC

Dates:

2013-2016 New

Abstract:

Rapid Ecological Assessments (REAs) are a product of the Bureau of Land Management’s evolution toward a landscape approach to land and resource management. In conjunction with the FWS Southern Rockies LCC, we will provide scientific, technical and training capabilities to land managers to understand, apply, and adapt models and tools for specific landscapes, resources, and management strategies as requested and needed by decision makers. This will be accomplished through delivery and utilization of a variety of data sets, models and decision support tools in multiple formats as requested and needed by decision makers. These activities will ensure the utility of the REA/LCC data and models in meeting current resource management needs. Specific research foci include emphasis on optimization strategies for identifying high watershed amenable to restoration, and incorporation of climate change effects into existing BLM REA/LCC data structure.



Funding:

Bureau of Land Management, U.S. Fish and Wildlife Service

Investigators:

Thomas C. Edwards, U.S. Geological Survey UTCFWRU and Utah State University (PI)
Michael Guttery, Post-doctoral Research Associate

Reports:

None; new research start

Publications:

None; new research start