2018 RIPARIAN RESTORATION CONFERENCE

Tamarisk Coalition
RESTORE + CONNECT + INNOVATE

GRAND JUNCTION, CO
FEBRUARY 6–8, 2018

Colorado Mesa University
Ruth Powell Hutchins Water Center

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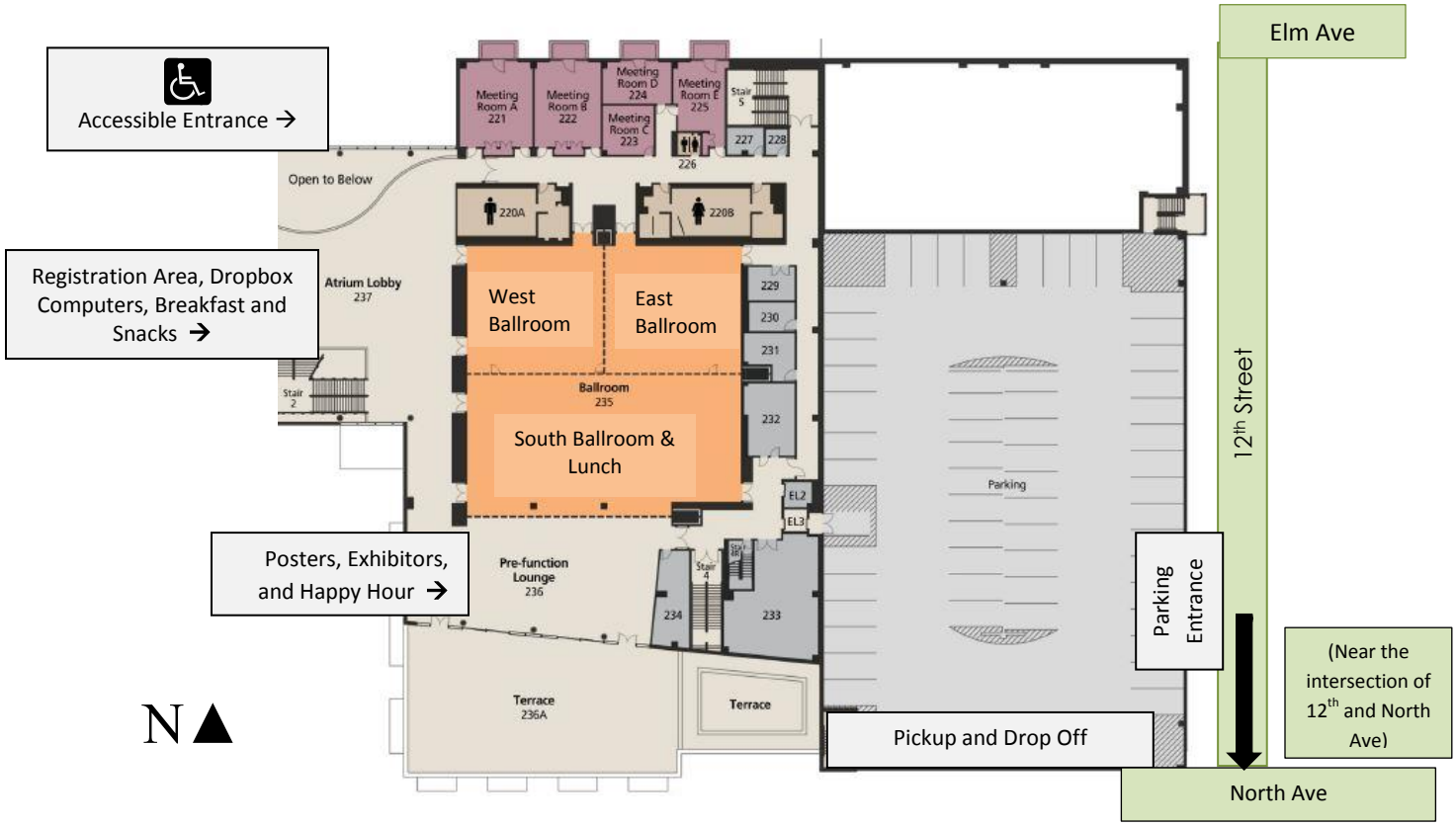
Map of University Center, 2nd Floor



GRAND JUNCTION, COLORADO | FEBRUARY 6-8, 2018

16TH ANNUAL TAMARISK COALITION RIPARIAN RESTORATION CONFERENCE

OVERVIEW

REGISTRATION

The Registration Table, which is located in the Atrium of Colorado Mesa University's University Center, will open at 7:30 am before the start of each day's sessions on February 6th and February 7th. Check the Registration Table for updated information regarding presentations, workshops, field trips, lost and found, etc.

PARKING

Parking at the University Center is available in the garage adjacent to the University Center. Please display the pass that was emailed to you on your vehicle dashboard. Additional parking passes are available at the Registration Table. As noted on the pass, please park on the 2nd level of the parking garage and do not park in Reserved, Pay, or Handicap spaces.

SPEAKER PRESENTATIONS

Presenters will be speaking from 8:15 am – 5:05 pm on Tuesday, February 6th and from 8:30 am – 4:55 pm on Wednesday, February 7th in the Ballrooms at Colorado Mesa University's University Center. Abstracts are included in this program.

POSTER PRESENTERS AND EXHIBITORS

Be sure to visit with our poster presenters and exhibitors in the Lounge from 8:00 am – 5:00 pm on both days!

PRESENTATION DROP-OFF

Presentations will be uploaded via the designated Dropbox computers located at the Registration Table. NOTE TO PRESENTERS: Presentations must be uploaded no later than *one full session* prior to the session that contains your presentation.

FOOD AND DRINKS

Continental breakfast as well as morning and afternoon snacks will be served in the Atrium near the registration table on February 6th and 7th. Lunches will be served in the South Ballroom on February 6th and 7th. See below for more details:

Tuesday, February 6th	Light breakfast, morning/afternoon snacks, and buffet lunch will be provided. Hors d'oeuvres will also be served at the Poster Session/Happy Hour along with one complimentary beer or wine from 5:00 pm ~ 7:00 pm in the Lounge. A cash/credit bar will also be available.

Wednesday, February 7th	Light breakfast, morning/afternoon snacks, buffet lunch provided.
Thursday, February 8th	Meals are not provided. Light snacks (e.g. granola bars, apples) will be available for the two workshops being held at CMU.

WIRELESS INTERNET

Access to Wireless Internet is available in the University Center Building. The passcode is provided at the Registration Table.

CONTINUING EDUCATION UNITS (CEUs)

Continuing Education Units are available with the Society of American Foresters and the Colorado Department of Agriculture.

- The Society of American Foresters (SAF) has approved the conference for up to 17 continuing education credits. Please pick up the SAF's continuing education form at the registration table.
- Licensed Colorado qualified supervisors, certified operators, and private applicators are eligible to receive 1 Credit for Category 107 Rangeland Pest Control from the Colorado Department of Agriculture (CDA) by attending the following sessions:
  - 2/6/2018 11:05 AM - 4:55 PM 5.83 hours
    - One 107 credit for attending any three talks (speaker): Volke, Mahoney, McLeod, Bixby, Shafroth, Gonzalez, Bean, York
  - 2/7/2018 10:35 AM - 2:45 PM 4.17 hours
    - One 107 credit for attending any three talks (speaker): Lewis, Ryder, Patterson, Engel
  - 2/8/2018 9:00 AM - 11:00 AM 2.00 hours
    - Palisade Insectary Field Trip
  - A Tamarisk Coalition staff member will need to sign off on the CDA's form for credit. Completed forms may be turned in at the Registration Table. Tamarisk Coalition will keep the yellow and white copies and give you the pink copy for your records. You will be required to put your Pesticide Applicator License number in the QS/CO Identification box. CDA no longer uses social security numbers to identify pesticide applicators.

NAME BADGES

Please wear your name badge when you are on site as an introduction to new colleagues, a reminder for those you have met before, and as your ticket to the field trip or workshop for which you have registered. Please return your name badge to the Registration Table after the conclusion of the conference.

FUNDRAISING CONSULTATIONS:

Schedule a time with Illene Roggensack of Third Sector Innovations, consultant to the TC Restore Our Rivers Initiative, for a one-on-one session to discuss your organization's specific challenges, needs, and next steps. Sign up at the Registration Desk or email Illene Roggensack at thirdsec@earthlink.net to set up a time.

PROCEEDINGS

Unless otherwise noted by the presenter, all presentations will be posted on our conference website (www.tamariskcoalition.org) in the months following the conference.

EVALUATION

Help us make next year even better! We encourage you to fill out the survey included in your conference packet regarding your conference experience. Please take a few minutes to respond; your feedback will provide critical input as we plan future events that serve your needs as river restoration professionals. You can also fill out an evaluation online at: www.surveymonkey.com/r/REW2018Conference.

FEATURED EVENTS

TUESDAY, FEBRUARY 6TH

SILENT ART AUCTION

Stop by the silent art auction featuring one-of-a-kind pieces inspired by rivers that you can bid on and take home. This year's proceeds from the auction are in honor of Edward Glenn and will be donated to support the Tamarisk Coalition. The auction will close at 3:15 pm on February 7th.

POSTER SESSION & HAPPY HOUR

This is a great opportunity to meet and network with like-minded people! The evening's reception on February 6th, from 5:05 pm ~ 7:00 pm, will include hors d'oeuvres, a free beer or glass of wine, and the opportunity to talk with poster presenters and vendors. Abstracts for poster presentations are included in this program. Bring your coupon (located in the back of your name badge) for a complimentary beer or wine. A cash/credit bar is also available. Thanks to Palisade Brewing Company and Talon Wine Brands for donating the beer and wine.

WEDNESDAY, FEBRUARY 7TH

FIRST PRESIDENT'S AWARD CEREMONY

Join us at lunch on February 7th for our First President's Award Ceremony! The First President's Award is given in memory of Pete Larson, Tamarisk Coalition's first board president, to honor his dedication to restoring natural resources through education, science, and volunteerism. The winner of this award will receive a $500 cash prize to be applied to their restoration efforts.

PLEASE NOTE: Nomination forms are available at the Registration Table and are due by the afternoon break (2:45 pm – 3:15 pm) on February 6th. The individual or organizational representative you nominate must be present at the conference to be qualified for the award.

SOCIAL HOUR AT BARON'S

Wind down from two full conference days at Baron's, located within walking distance of Downtown hotels at 539 Colorado Ave. Baron's offers a great local beer selection, gourmet sandwiches, plus, billiards and a shuffle board. You are on your own for meals and drinks.

WORKSHOPS & FIELD TRIP– FEBRUARY 8TH

EDDMapS WORKSHOP

Presented by Rebekah D. Wallace, EDDMapS Data Coordinator

- 8:00 am ~ 12:30 pm
- Located in the East Ballroom of the University Center at CMU
- Coffee and light snacks will be provided

This interactive workshop will be a hands-on demonstration of EDDMapS, a useful system for reporting and mapping invasive species, biocontrol agents, and more. Participants will walk through bulk data submission, record verification process, data querying, and more. This will also include an EDDMapS Pro demonstration, a system for land managers and professionals to download maps and data, view records off line and in the field, create revisits and new records, and sync data back at the office. Weather permitting; it may also include adventuring outside to explore reporting through the EDDMapS West smartphone app.

MASTERING COMMON CHALLENGES OF PRIVATE FUNDRAISING WORKSHOP

Led by Kristen Jespersen, Tamarisk Coalition; Lindsay Murdoch, Cross-Watershed Network; and Illene Roggensack, Third Sector Innovations

- 8:30 am – 11:00 am
- Located in the West Ballroom of the University Center at CMU
- Coffee and light snacks will be provided

This fundraising training, let by Third Sector Innovations, Tamarisk Coalition, and Cross-Watershed Network, will hone in on the top five challenges that watershed groups face in fundraising (e.g. board development, capacity building, donor communications, foundation relations, making the ask) and provide some concrete best management practices and lessons learned.

PALISADE INSECTARY TOUR

Hosted by Insectary Staff at the Colorado Department of Agriculture

- 9:00 am – 11:00 am, Colorado Department of Agriculture
- Located at 750 37 8/10 Rd, Palisade, CO 81526
- Transportation and snacks are not provided. Tour will begin at 9:00 am, please allow 20-25 minutes for drive time from the downtown/University area.

You've heard about the tamarisk beetle and other insects wandering around in the riparian corridors of the West, but have you seen them up close? Have you admired the backside of a *Coniatus splendidulus* lately? This will be a short indoor walking tour of the Colorado Department of Agriculture, Palisade Insectary. The Insectary has long been a promoter of the use of biological control in weed and insect pest management and is home to about 20 different species of biological control agents. Join us for a closer look at these insects and the unique rearing processes, as well general information on past and future efforts by the CDA's Biological Pest Control Program.

Tamarisk Coalition
RESTORE + CONNECT + INNOVATE

Tamarisk Coalition's 16th Annual

RIPARIAN RESTORATION CONFERENCE

February 6-8, 2018 | Grand Junction, CO

Colorado Mesa University
Ruth Powell Hutchins Water Center

AGENDA | TUESDAY, FEBRUARY 6, 2018

7:30-8:15 AM	Registration and Light Breakfast in Atrium		
Time	**Speaker**	**Presentation Title**	
Plenary Session			
Welcome | South Ballroom			
8:15-8:35	Stacy Beaugh, Tamarisk Coalition	Opening Remarks	
Where We've Been and Where We're Going | South Ballroom			
8:35-8:50	Kai Caraher, USDA-APHIS-PPQ-PHP-Permitting and Compliance Coordination	USDA-APHIS Southwestern Willow Flycatcher Conservation Program	
8:50-9:20	Peter Skidmore, The Walton Family Foundation	Planning for Healthy River Systems	
9:20-9:50	Steve Carothers, SWCA Environmental Consultants	Riparian Research and Management: Past, Present, Future	
9:50-10:20	Bruce Orr, Stillwater Sciences	Emerging Approaches for Managing and Restoring Resilient River-Riparian Ecosystems	
10:20-10:45	**BREAK | Atrium**		
Concurrent Session			
	Restoring for Wildlife | West Ballroom		**Funding Panel | East Ballroom**
10:45-11:05	Lotem Taylor, National Audubon Society	Water and Birds in the Arid West: Habitats in Decline	**Lessons Learned in the Pursuit of Private Funding** This panel, moderated by Illene Roggensack with Third Sector Innovations, will feature speakers from numerous restoration partnerships, and Tamarisk Coalition staff, who all participated in the Restore Our Rivers fundraising campaign. Panelists include Miranda Kersten, Save Our Bosque Task Force; Anna Schrenk, Friends of the Verde River Greenway, Shelly Simmons, Purgatoire Watershed Weed Management Collaborative, and; Stephanie Minneart, Grand Staircase Escalante Partners. Each panelist will talk about their experiences, successes, and challenges in expanding their resource development to include more private funding.
11:05-11:25	Malia Volke, New Mexico Department of Game and Fish	Restoration and Management of Non-native Riparian Wildlife Habitat in the Southwest	
11:25-11:45	Sean Mahoney, Northern Arizona University	Biological Control of Tamarisk *(Tamarix* spp.) Reduces Bird Abundance, Density and Richness: Implications for Southwestern Riparian Habitat and Management	
11:45-12:05	Mary Anne McLeod, SWCA Environmental Consultants	Effects of Tamarisk Defoliation on Southwestern Willow Flycatchers	
12:05-1:05	**LUNCH | SOUTH BALLROOM**		

Concurrent Session				
	Emerging Tamarisk Research | West Ballroom		**Community and Partnerships | East Ballroom**	
1:05-1:25	Randy Long, University of California	Trait Variation Across *Tamarix* Populations	Miranda Kersten, Save Our Bosque Task Force	Save Our Bosque Task Force: Connecting Our River to Our Community
1:25-1:45	Kevin Hultine, Desert Botanical Garden	Local Adaptation to Frost Improves Drought Tolerance in *Tamarix*	Kara Dohrenwend, Rim to Rim Restoration	"Urban" Stream Transitions: Mill Creek in Moab Utah
1:45-2:05	Keara Bixby, Bosque Ecosystem Monitoring Program	Changes in Tamarisk Leaf Beetle Distribution and Abundance, and the Effects on Saltcedar Health in the Middle Rio Grande Bosque	Bill Brandau, University of Arizona	Gila Watershed Partnership 1992-2017: A Story of Sustainability
2:05-2:25	Pat Shafroth, U.S. Geological Survey	Riparian Vegetation Response to Biological Control Of *Tamarix* And Fluvial Processes Along The Virgin River: 2009-2017	Ryan McConnell, Colorado Canyons Association	Community Driven River Stewardship and Student Education along The Gunnison and Colorado Rivers
2:25-2:45	Pam Nagler, U.S. Geological Survey	Measuring Changes in Tamarisk Evapotranspiration in a Riparian Ecosystem near Shiprock, NM	Sarah Johnson, Wild Rose Education	Community Engagement: Guidelines for Excellence from the North American Association for Environmental Education
2:45-3:15	**BREAK | Atrium | 1st President Award Nominations are Due**			
Concurrent Session				
	Emerging Riparian Vegetation Research | West Ballroom		**Panels | East Ballroom**	
3:15-3:35	Eduardo González, EcoLab, University of Denver, Colorado State University	Vegetation Response to *Tamarix* Control in the Colorado and Middle Rio Grande: A Collaborative Study Including 416 Sites	**3:15-4:05 Grazing Panel** Moderated by Shelly Simmons with Tamarisk Coalition. Panelists will explore grazing policy on public lands and riparian management practices on private lands, with an emphasis on conservation and restoration practices beneficial to riparian ecosystems and landowners/land managers alike. Parameters that indicate an upward trend in riparian condition following the implementation of best management practices will be discussed as well as private land management examples from local and regional producers. Panelists will include range management specialists, researchers, and private landowners who are also livestock producers.	
3:35-3:55	Dan Bean, Colorado Department of Agriculture	How Two Generations Per Season Became Six: Evolving Photoperiod Cues And Shifting Temperature Regimes Alter The Life History And Phenology Of *Diorhabda carinulata* , A Biocontrol Agent For *Tamarix* spp.		
3:55-4:15	James Hatten, U.S. Geological Survey	Designing Decision Support Tools for Southwestern Willow Flycatcher Conservation with Consideration of the Distribution and Expansion of the Tamarisk Beetle		
4:15-4:35	Juan Solis, Civil Engineering Department	Water Stress in Desert Willows (*Chilopsis linearis*) Planted in Clinoptilolite Zeolite for Riparian Rehabilitation	**4:05-4:55 Selenium Panel: Riparian and Wetland Restoration Challenges and Opportunities in Selenium Impacted Watersheds** Moderated by Dave Kanzer with the Colorado River District. Panelists Creed Clayton, U.S. Fish and Wildlife Service; Lesley McWhirter, U.S. Bureau of Reclamation; Jason Roudebush, Ducks Unlimited; and James Roberts, U.S. Geological Survey, will discuss the impacts/ramifications of selenium on riparian and wetland restoration in Mesa County and along the Gunnison River.	
4:35-4:55	Patty York, Colorado Department of Agriculture	Colorado's EDRR Strategy: Using Genetic Testing to Inform Management of Native vs. Non-native *Phragmites* in Colorado		
4:55-5:05	**CLOSING REMARKS**			
5:05-7:00	**POSTER/EXHIBITOR SESSION, HAPPY HOUR, SILENT ART AUCTION | LOUNGE** Join us for appetizers and drinks at the Poster Session, Happy Hour, and silent art auction! Talk with poster presenters and vendors, catch up with familiar faces, and network with new ones. Each attendee receives a complimentary drink. Cash bar also available.			

AGENDA | WEDNESDAY, FEBRUARY 7, 2018

7:30-8:30 AM	Registration & Light Breakfast - Atrium			
Time	**Speaker**	**Presentation Title**		
Plenary Session				
8:30-8:35	Welcome and Opening Remarks - South Ballroom			
Regional Riparian Assesments | South Ballroom				
8:35-9:05	Megan Friggens, Forest Service/RMRS	A Spatially Explicit and Quantitative Vulnerability Assessment for Riparian Habitats in the Four Corners Region		
9:05-9:35	Brad Udall, Colorado State University	The Colorado River Hot Drought: How Higher Temperatures are Reducing Streamflows in the American West		
9:35-10:05	Bill Whitacre, Western Governors' Association	Western Governors Association Invasive Species Data Management Initiative		
10:05-10:35	**BREAK | Atrium**			
Concurrent Session				
Mapping and Technology | West Ballroom			**Large-Scale Planning Considerations | East Ballroom**	
10:35-10:55	Sinan Abood, USDA Forest Service	Application of Open Source Data in USFS Riparian Areas Inventory Mapping	Steve Ryder, Colorado Department of Agriculture	Transforming the Weed "Whack-A-Mole" Management Approach
10:55-11:15	Anna Schrenk, Friends of Verde River Greenway	A Dynamic Model for Managing Field Data	Nicole Seltzer, River Network	Using Stream Management Plans To Set and Realize River Health Goals in Colorado
11:15-11:35	Richard Alward, Aridlands, LLC	150 Hectares per Hour: Comprehensive Restoration Monitoring Using Drones & Multi-Spectral Sensors	Bo Shelby, Oregon State University	Recreation Habitat vs. Ecological Habitat in Riparian Restoration: Are They Different, And Can We Manage For Both?
11:35-11:55	Matt Lewis, Bureau of Land Management	The Use of UAS (drones) to Measure Weed Treatment Effectiveness along the White River in Utah	Lisa Clark, University of Denver	Differences Among Managers Correlate with Plant Community Traits in Tamarisk Removal Projects
11:55-1:05	**LUNCH | South Ballroom | 1st President's Award Presentation**			

Concurrent Session				
Remote Sensing | West Ballroom			**Russian Olive | East Ballroom**	
1:05-1:25	Jilian LaRoe, NASA DEVELOP	Utilizing NASA Earth Observations to Delineate Riparian Corridors and Evaluate Invasive Species Cover In The Verde River Watershed	Dennis Worwood, Utah State University Extension	Vegetative Reproduction in Russian Olive – Implications For Control
1:25-1:45	Dan Carver, NASA DEVELOP	Utilizing NASA Earth Observations to Evaluate Invasive Species Cover In Riparian Areas of The Colorado River Basin	Ron Patterson, Utah State University Extension	Herbicide Control Options for Russian Olive
1:45-2:05	Kristin Davis, NASA DEVELOP	Evaluating Invasive Species Cover Influence on Water Evapotranspiration Rates in The Colorado River Basin Using NASA Earth Observations	Alex Engel, Grand Staircase-Escalante Partners	Treatment of Russian Olive using the Frill Cut Method in the Escalante Watershed
2:05-2:25	Brian Woodward, Colorado State University	Mapping Riparian Corridor and Vegetation Change in the Colorado River Basin	Kaleb Heinrich, University of Mary Hardin-Baylor	Interactive Effects of Russian Olive and the Common Carp on Linked Stream-Riparian Food Webs
2:25-:2:45	Nicholas Young, Colorado State University	Mapping Tamarisk Change across the Colorado River Basin: Trials, Tribulations and Lessons Learned	Natalie West and Erin Espeland, U.S. Department of Agriculture	Re-Organize and Re-Assemble: Community Change and Restoration after Russian Olive Removal
2:45-3:15	**BREAK | Atrium | Close of Silent Art Auction**			
Plenary Session				
Partnerships				
3:15-3:35	Ashlee Simpson, University of Arizona	An Online Management Strategy and Case Study Platform to Facilitate Conservation and Restoration in the Southwest		
3:35-3:55	Bruce Rittenhouse, Bureau of Land Management	Dolores River Restoration Partnership: A Private and Public Collaboration		
3:55-4:55	**3:55-4:55 Panel: The Escalante River Watershed Partnership; A Study in Cooperation** Moderator: Lindsay Murdoch, Cross-Watershed Network. Panelists: Dave Bastian, Utah Conservation Corps/Utah State University; Sue Fearon, Grand Staircase Escalante Partners; and Stephanie Minnaert, Grand Staircase Escalante Partners			
4:55-5:00	**CLOSING REMARKS**			
5:30-7:30	**SOCIAL HOUR AT BARONS BAR & GRILL | 539 Colorado Ave.** Located in Downtown Grand Junction, stretch your legs and take the short walk to Baron's. You are on your own for meals and drinks. Baron's offers gourmet sandwiches, local beers, plus, billiards and a shuffle board.			

FIELD TRIP AGENDA | THURSDAY, FEBRUARY 8, 2018

Time	Logistics	Speaker	Description
Option 1: EDDMapS Workshop | East Ballroom			
8:00 am - 12:30 pm	Workshop will be located in the East Ballroom of the University Center at CMU. Coffee and light snacks will be provided.	Rebekah D. Wallace EDDMapS Data Coordinator	This interactive workshop will be a hands-on demonstration of EDDMapS, a useful system for reporting and mapping invasive species, biocontrol agents, and more. Participants will walk through bulk data submission, record verification process, data querying, and more. This will also include an EDDMapS Pro demonstration, a system for land managers and professionals to download maps and data, view records off line and in the field, create revisits and new records, and sync data back at the office. Weather permitting, it may also include adventuring outside to explore reporting through the EDDMapS West smartphone app.
Option 2: Funding Workshop - Mastering Common Challenges of Private Fundraising | West Ballroom			
8:30 am - 11:00 am	Workshop will be located in the West Ballroom of the University Center at CMU. Coffee and light snacks will be provided.	Kristen Jespersen, Tamarisk Coalition, Illene Roggensack, Third Sector Innovations, Lindsay Murdoch, Cross-Watershed Network	This fundraising training, led by Third Sector Innovations, Tamarisk Coalition, and Cross-Watershed Network, will hone in on the top five challenges that watershed groups face in fundraising (e.g. board development, capacity building, prospecting, donor communications/foundation relations, and making the ask) and provide some concrete best management practices and lessons learned. This will be an interactive session.
Option 3: Palisade Insectary | 750 37 8/10 Rd, Palisade, CO			
9:00 am-11:00 am	This will be an indoor and outdoor trip. Meet at 750 37 8/10 Rd, Palisade, CO 81526 at 9:00 am.	Dan Bean, Insectary Manager for the Colorado Department of Agriculture	You've heard about the tamarisk beetle and other insects wandering around in the riparian corridors of the West, but have you seen them up close? Have you admired the backside of a *Coniatus splendidulus* lately? This will be a short indoor walking tour of the Colorado Department of Agriculture, Palisade Insectary. The Insectary has long been a promoter of the use of biological control in weed and insect pest management and is home to about 20 different species of biological control agents. Join us for a closer look at these insects and the unique rearing processes, as well general information on past and future efforts by the CDA's Biological Pest Control Program. * Please Note: Those interested in this trip are responsible for their own transportation; we are happy to help you arrange a carpool with other attendees if requested. Participants are advised to leave Grand Junction at 8:30 am to allow for driving time. The Palisade Insectary tour will begin at 9am.

POSTER PRESENTERS

FEBRUARY 6-7 in the Lounge Join us for the Poster Session at 5:00 pm on February 6th to visit with poster presenters and vendors, catch up with familiar faces, and network with new ones. Enjoy a compilmentary glass of beer or wine and appetizers.	
Alejandro Salas, New Mexico State University	Sequestration of Arsenic by Cattail in Drainage Canal
Amanda Kuenzi, Mountain Studies Institute	Invasive Phreatophyte Removal in the Animas River Watershed: Community-based Stewardship
Amanda Stahlke, University of Idaho	Genomic Tools Reveal Hybridization, Admixture, and Differential Establishment Among Introduced Tamarisk Beetle *(Diorhabda* spp.) Source Populations
Anna Schrenk & Emily Garding, Friends of Verde River Greenway	VWRC: A Collaborative Approach to Improving Riparian Areas in the Verde Watershed
Ben Bloodworth, Tamarisk Coalition	Tamarisk Coalition Annual Tamarisk Beetle (*Diorhabda* spp.) Distribution Map
Cindy Adams, SGM and Jennifer Ward, WCAO Bureau of Reclamation	Habitat Mitigation at Orchard Mesa Wildlife Area
Earl Conway, New Mexico BASS Nation	Increasing Game Fish Carrying Capacity at the Elephant Butte Reservoir
Garrett Gibson, New Mexico State University	Estimating Consumptive Water Use of Saltcedar Using a Polynomial Function and Heat Units
Ian Moffit, University of Denver	*Salix* Recovery After the Control of *Tamarix* Across the Southwest United States
Jamela Thompson, Litzsinger Road Ecology Center	Riparian Restoration in an Urban Ecology Center
Jennifer Holmes and Matthew Johnson, Colorado Plateau Research Station; James Hatten, U.S. Geological Survey	Using the Yellow-billed Cuckoo as an Umbrella Species to Inform Riparian Restoration in the Southwest
Juan Olivares, New Mexico State University	Green Earthen Embankments for Controlling Soil Erosion
Kara Dohrenwend, Rim to Rim Restoration and Southeast Utah Riparian Partnership	Site Conditions over the Long Term: Collaborating to Evaluate Vegetation Changes, Beetle Activity and Current Conditions in SE Utah
Kristina Kline, Bird Conservancy of the Rockies	Successful Riparian Restoration in Southwest Colorado through Connecting Conservation Collaboratives
Luke Javernick, WorldWater.Today	Leveraging Low-Cost Technologies in UAS, GIS, and IoT to Achieve Greater Conservation Impacts
Luke Javernick, WorldWater.Today	River Hydraulics, Morphology, and Vegetation: New Research into Maximizing a River's Potential to Remove Invasive Vegetation and Recent Achievements in Modeling Vegetation Removal
Nina Louden, Colorado Department of Agriculture	Mapping, Monitoring, and Future Management for Biological Control of Tamarisk in the Arkansas River Basin (2008-2017)
Noël Fie, California Polytechnic State University	Hydrologic and Vegetative Response to Meadow Restoration and Upslope Harvest in a Montane Meadow

Ondrea Hummel and Chris Sanderson, Tetra Tech; Eduardo González, Colorado State University; Patrick Shafroth, U.S. Geological Survey; Miranda Kersten and Gina Dello Russo, Save Our Bosque Task Force	Comparing Habitat and Avian Species Response to Biocontrol and Mechanical/Chemical Control of Invasive Woody Vegetation in Socorro County, NM
Pablo Soto, New Mexico State University	Establishing Vegetation for Riparian Rehabilitation Using Solar Powered Irrigation Pump
Scott Shahverdian, Utah State University	Using Beaver Dam Analogs and Post-Assisted Log Structures to Restore Instream Channel Complexity on the Lower San Rafael River, Utah
Sinan Abood, U.S. Department of Agriculture Forest Service	Application of Open Source Data in USFS Riparian Areas Inventory Mapping

PRESENTATION ABSTRACTS

Abstracts are listed chronologically. Presenting authors are denoted by an asterisk.

Tuesday, February 6th

WHERE WE'VE BEEN AND WHERE WE'RE GOING

South Ballroom
8:35-10:20

USDA-APHIS Southwestern Willow Flycatcher Conservation Program

Kai Caraher[1]

[1]USDA-APHIS-PPQ-PHP-Permitting and Compliance Coordination, Riverdale, Maryland, USA; kai.caraher@aphis.usda.gov

APHIS seeks opportunities to contribute funding or resources for actions within our authority on southwestern willow flycatcher conservation projects. The agency's assistance should enable land managers or conservation organizations to improve or increase other beneficial actions for the species.

Planning for Healthy River Systems

Peter Skidmore[1]

[1]The Walton Family Foundation, Bozeman, MT USA; pskidmore@wffmail.com

Healthy river systems are dynamic systems that include both aquatic and riparian components. Watershed-scale impacts of development, forestry and grazing, the regulation and diversion of flows, and conversion of floodplains and physical impacts to the channel are collectively leading to the decline of river-dependent species and the myriad values and benefits we derive from healthy rivers. This is particularly pronounced in the southwestern United States where causes of river degradation are well understood, but traditional management and restoration actions fail to address causes at appropriate scales and most restoration actions fail to provide long-term benefit. Despite roughly $1B annual expenditures on river restoration nationally, these trends continue.

Looking forward, river management will be more effective and make better use of limited restoration funds by adhering to two basic principles. First, river restoration and conservation strategies should be prioritized in a watershed context with an understanding of the dominant causes of impact or threat and

of constraints on recovery. Second, rivers should be managed as delineated corridors that integrate river channel and floodplain management. Within the context of these two basic principles, river management and restoration strategies will benefit from an understanding and application of conceptual models that illustrate drivers and constraints on components of river health, from an understanding of dynamic river processes including disturbance regimes, and integration of concepts of channel deformability into all scales of conservation and restoration planning.

Riparian Research and Management: Past, Present, Future

Roy Johnson[1], Steven Carothers[2]*, Deborah Finch[3], Kenneth Kingsley[4], and John Stanley[5]

[1]Research Associate, Museum of Northern Arizona, Emeritus Professor, University of Arizona and retired Research Scientist, National Park Service, Tucson, Arizona, USA; rroylois@aol.com
[2]Founder and Senior Scientist, SWCA Environmental Consultants, Inc., Flagstaff, Arizona, USA; scarothers@swca.com
[3]Biological Scientist and Program Manager, USDA Forest Service, Rocky Mountain Research Station, Albuquerque, New Mexico, USA; dfinch@fs.fed.us
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This paper presents a summary of an upcoming publication of a two volume General Technical Report (GTR) from the Department of Agriculture's Rocky Mountain Research Station, Fort Collins, Colorado. The report focuses on riparian habitats in the American Southwest and Pacific West. More than 50 authors with decades of research experience provide information on a variety of topics concerning arid land riparian habitats including a review on the origins of the science of riparian ecology and management lessons learned over a several decade period beginning with the phreatophyte control efforts in the late 1950s. Sixty years ago, arid land riparian habitats were not valued for their disproportionate values to wildlife, nor were their contributions to overall ecosystem function within watersheds widely recognized. This largely changed as the science of riparian ecology steadily gained a foothold, beginning in the 1960s and 1970s to the present, as riparian values and the needs and opportunities for conservation were realized. Relevant chapters identifying current additional research needs focus on the unintended consequences of biological control and, the need to evaluate riparian conditions necessary for allowing natural and active restoration and re-establishment of native woody vegetation in areas where tamarisk previously dominated. Among other subjects treated, chapters in the report also provide updated documentation on the value to wildlife of cottonwood-willow gallery forests, mesquite and tamarisk bosques, and mixed deciduous riparian woodlands as well as evaluation of riparian habitat losses, degradation and gains along some western rivers.

Emerging Approaches for Managing and Restoring Resilient River-Riparian Ecosystems

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Abstract not available.

RESTORING FOR WILDLIFE

West Ballroom
10:45-12:05

Water and Birds in the Arid West: Habitats in Decline

Chad Wilsey[1], Lotem Taylor[2]*, Nicole Michel[3], and Karyn Stockdale[4]

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Water and Birds in the Arid West: Habitats in Decline is a comprehensive assessment of the relationships that exist among birds, water, and climate change in the region. Although riparian zones account for less than 5% of the southwestern landscape, they support over 40% of all bird species found in the region and over 50% of breeding bird species. These include 400 species along the lower Colorado River. If current western water trends continue and are compounded by climate change, many bird species face diminished and degraded habitat in the future. Native riparian trees and shrubs such as cottonwood-willow ecosystems that provide productive habitat for birds and other wildlife are disappearing as a result of water development—including damming, flow regulation, surface water diversion, and groundwater pumping. Hydrology changes have also spurred the spread of non-native plants, particularly tamarisk, throughout the Colorado River Basin—reducing biodiversity and the number and variety of birds in many riparian habitats. Populations of the following breeding birds, once common along the Colorado River, have experienced significant regional declines: Bell's Vireo, Yellow Warbler, Yellow-breasted Chat, and Summer Tanager. Three species, Yuma Ridgway's Rail, Western Yellow-billed Cuckoo, and Southwestern Willow Flycatcher, are now listed as federally threatened or endangered, and at risk of extinction if current trends continue. Climate change is projected to exacerbate habitat declines across the basin, reducing water supply, raising temperatures and aridity, and disrupting phenology—the timing of seasonal natural phenomena such as spring floods, plant flowering, and insect hatching. In this session, we will share the major findings of this public-facing report and discuss Audubon's strategies for engagement to promote creative, sensible water solutions for birds and people.

Restoration and Management of Non-native Riparian Wildlife Habitat in the Southwest

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Non-native trees, including tamarisk (also known as salt cedar; *Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), and Siberian elm (*Ulmus pumila*) have naturalized in riparian areas throughout the western United States replacing woodlands once dominated by cottonwood (*Populus* spp.) and willow (*Salix* spp.). The loss of native riparian vegetation has been linked to a decline in many riparian wildlife populations, particularly breeding and migratory birds. Although non-native trees often have lower habitat value than native riparian vegetation, they can provide habitat for some wildlife species, especially where native

riparian vegetation has difficulty persisting. In many areas of the Southwest, non-native vegetation may provide the only available habitat for some wildlife species. Non-native riparian trees are targets of large-scale chemical, physical, and biological control efforts costing millions of dollars per year. Removal sites may be unsuitable for the desired replacement vegetation if environmental conditions favoring non-natives (e.g., soil salinity, deep groundwater, infrequent or absent flooding) preclude establishment and survival of native riparian plants. The ultimate goal of riparian restoration projects should be the reestablishment of native riparian plant communities and a return to a more natural flow regime. Given the vast extent of tamarisk, Russian olive, and Siberian elm on the landscape and the extensive efforts to control or eradicate these species, it is important to fully understand the costs and benefits of non-native vegetation management to wildlife. If desired replacement vegetation is not quickly restored, non-native removal could lead to temporary habitat loss and a reduction in local wildlife populations. Managers should carefully balance non-native removal with protecting critical wildlife habitat. This presentation summarizes the current understanding of wildlife use of non-native riparian habitats, and provides recommendations for restoration of riparian habitats following control of non-native trees.

Biological Control of Tamarisk (*Tamarix* spp.) Reduces Bird Abundance, Density and Richness: Implications for Southwestern Riparian Habitat and Management

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Tamarisk (*Tamarix* spp.) are among the most successful non-native invasive plants in southwestern United States riparian systems and tamarisk control has become a high management priority in the southwest. In 2001, the tamarisk leaf beetle (*Diorhabda carinulata*) was released as a biological control agent to control tamarisk. Since 2001, tamarisk leaf beetles have spread throughout the southwest including riparian habitat previously thought to be inhospitable. The primary effect of tamarisk leaf beetles on tamarisk is defoliation, and this can potentially change habitat structure and insect food base for riparian nesting birds. Unfortunately, little information is available on how birds respond to the tamarisk leaf beetle and the changes it causes to riparian areas, but these data could be important for management purposes. During the summer of 2013 and 2014 we used point counts to quantify avian abundance, density and richness in areas that varied in the amount of native vegetation and tamarisk defoliation along the Virgin River. We found bird abundance, density and richness were positively correlated with percentage of native vegetation cover and were negatively correlated with percentage of tamarisk defoliation. Our results highlight the need for active restoration in areas where tamarisk defoliation has occurred to maintain bird abundance, density and richness along riparian systems in the southwest.

Effects of Tamarisk Defoliation on Southwestern Willow Flycatchers

Mary Anne McLeod[1]

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Tamarisk leaf beetles (*Diorhabda* spp.), released in the western U.S. as biocontrol for tamarisk (*Tamarix* spp.), began defoliating breeding areas of the federally endangered southwestern willow flycatcher (*Empidonax traillii extimus*) in 2008 along the Virgin River around St. George, Utah. Beetles then expanded their range downstream, affecting multiple flycatcher breeding sites along the Virgin and Muddy Rivers in subsequent years and arriving at additional breeding sites along the Lower Colorado and Bill Williams Rivers in 2017. Breeding sites vary in their floristic composition and thus have been affected to varying degrees by defoliation and subsequent mortality of tamarisk. Following the initial year of defoliation in St. George, flycatchers moved into nearby sites that consisted primarily of native vegetation. Very little native vegetation was present farther downstream on the Virgin River, and flycatchers in downstream areas continued attempting to breed at sites that contained a significant tamarisk component; however, reproductive output was poor, and the number of breeding flycatchers dropped from 14 to 3 pairs in the years following initial defoliation. In 2017, flycatcher breeding sites at Topock Marsh, the Bill Williams River, and Alamo Lake were defoliated during the flycatcher breeding season, and all flycatchers that attempted to nest in these defoliated areas experienced complete reproductive failure. Tamarisk beetles are continuing to expand farther into the flycatcher's breeding range in both Arizona and New Mexico. Beetles are likely to arrive at several large flycatcher sites, some of which consist primarily of monotypic tamarisk, in the next few years. Active restoration of native riparian woodlands in watersheds where flycatchers currently nest primarily in tamarisk is urgently needed to provide flycatchers with alternate nesting sites.

FUNDING PANEL

East Ballroom
10:45-12:05

Lessons Learned in the Pursuit of Private Funding

Miranda Kersten[1], Anna Schrenk[2], Kristen Jespersen[3], Stephanie Minneart[4]

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This moderated panel, moderated by Illene Roggensack with Third Sector Innovations, will feature speakers from numerous restoration partnerships, and Tamarisk Coalition staff, who all participated in the Restore Our Rivers fundraising campaign. Each panelist will talk about their experiences, successes, and challenges in expanding their resource development to include more private funding.

EMERGING TAMARISK RESEARCH

West Ballroom
1:05-2:45

Trait Variation across *Tamarix* Populations

Randy Long[1]

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Recent results from a common garden study in Yuma, Arizona and a set of greenhouse experiments have shown that there is substantive trait variation across populations of *Tamarix spp.*. In both studies populations were found to be locally adapted to site conditions. These patterns were witnessed across large and small scales. The Yuma common garden study investigated variation among populations across an elevational gradient across Arizona, looking at adaptations to cold temperatures over a large spatial scale. Meanwhile the greenhouse experiments used a set of populations from the Cibola National Wildlife Refuge that were collected from sites less than two kilometers apart, but the two sites differed in groundwater salinity. Differences in phenology, carbon allocation and anatomy were witnessed at the Yuma common garden. The local, low elevation, populations exhibited less conservative traits than those from high elevations. Similarly, in the greenhouse experiments plants from higher salinities exhibited more conservative traits than those from low salinity sites. The populations in both studies that performed best in controlled environments were those not subjected to conditions that would promote hydraulic failure, either extreme cold temperatures, freeze thaw events, or low water availability due to high salinity. However, in the greenhouse experiment it was shown that the plants from high salinities outperformed those from the more favorable site when they were both subject to increased salinity stress. These results indicate that *Tamarix* populations have high levels of intraspecific variation and are locally adapted to many sites across its range in the southwest.

Local Adaptation to Frost Improves Drought Tolerance in *Tamarix*

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The presence of *Tamarix ramosissima * chinensis* in the western US has resulted in significant modification of riparian ecosystem structure, biogeochemistry and species biodiversity, and has been the focus of significant research linked to its water use requirements and associated impacts on ecohydrological processes. More recently, it has been the focus of functional trait-based research linking resource allocation to the capacity of *Tamarix* to cope with herbivory, fire and drought. To better

understand patterns of local adaptation in resource allocation and associated drought tolerance, *Tamarix* cuttings sourced from populations across a broad climate gradient were planted in an experimental common garden. We hypothesized that populations from warm climates with little or no freezing limitations would display a greater reduction in growth, leaf area and whole-canopy gas exchange compared to populations from colder climates in response to drought. We measured plant water relations and radial growth in 20 two-year old trees sourced from high (frost-adapted) elevation and low (non frost adapted) elevation prior to, and during a three-month drought treatment. Stem water use was up to 30% higher in populations from high elevation sites compared to low elevation sites. Water use per unit leaf area in low elevation source populations declined by 65% compared to a 35% decline in high elevation populations relative to pre-drought conditions. Mean canopy stomatal conductance was on average 40% greater in the highest elevation source population compared to the lowest elevation population over the course of the measurement period. In addition, high elevation source populations showed a 60% greater radial growth compared to low elevation source populations over the same time period. These results suggest that *Tamarix* populations from low elevation regions are more sensitive to drought compared to high elevation regions. These results further suggest that effectiveness of restoration and management practices may vary depending on geographic location.

Changes in Tamarisk Leaf Beetle Distribution and Abundance, and the Effects on Saltcedar Health in the Middle Rio Grande Bosque

Keara Bixby[1]*, Kim Eichhorst[2]

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In order to control saltcedar (*Tamarix* spp.), one of the most successful invasive plants in the riparian areas of the Southwest, the tamarisk leaf beetle (*Diorhabda* spp.) was introduced as a method of biological control between 2001-2010. As the beetle migrated into New Mexico, the Bosque Ecosystem Monitoring Program (BEMP) began to monitor the beetle's distribution and abundance, as well as relative saltcedar health and percentage of defoliation on selected individuals. Over 260 miles of the Middle Rio Grande Bosque were monitored using 29 different research sites.

Due to BEMP's unique role as a long-term citizen science research organization, BEMP has been able to focus on the vegetative changes before and after the introduction of the beetle. Looking at both vegetative coverage and litterfall data from native and non-native species, BEMP strives to determine what impacts this beetle is having on the overall coverage of saltcedar in the bosque, and the monthly response in defoliation both before and after the introduction of this biocontrol. Through our long-term data we can compare these changes and illuminate what ecological responses have occurred as a result of the tamarisk leaf beetle presence.

Riparian Vegetation Response to Biological Control of *Tamarix* and Fluvial Processes along the Virgin River: 2009-2017

Pat Shafroth[1]*, Steven Lee[2], Rebecca Sherry[3], Steven Ostoja[4], and Mathew Brooks[2]

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Biological control by beetles in the genus *Diorhabda* is causing substantial defoliation and mortality of *Tamarix* spp. along many western rivers, paving the way for subsequent changes to plant community composition and structure, and consequent effects on wildlife populations and ecosystem processes. Other drivers of riparian ecosystem dynamics, such as flood disturbance, are operating simultaneously. Developing sound restoration strategies and tactics for western rivers with a significant *Tamarix* component requires understanding both effects of biological control and other drivers of vegetation change.

Since 2009, we have monitored vegetation composition and cover, and floodplain topography on 24 transects along a ~40 mile stretch of the Virgin River in Nevada and Arizona. *Tamarix* was the most frequently occurring and abundant plant at the beginning of our study. *Diorhabda* arrived at our uppermost reach in 2009 and had spread throughout the study area by 2012. Defoliation effects of the beetle on *Tamarix* cover were relatively minor in 2009-2011 but widespread by 2012. In addition to effects of biological control, in December 2010, a large flood greatly altered the topography and vegetation along the Virgin River.

We describe changes to riparian vegetation resulting from both flood effects and biological control along the Virgin River between fall 2009 and spring 2017. Flood effects on topography and vegetation were greatest in our upper reaches, where the cover of live *Tamarix*, *Pluchea sericea and Salix* spp. decreased, and dead *Tamarix and Bromus* spp. increased. Biological control effects were greatest in the lower reaches in our spring 2015 sampling, where we observed mortality or near total die-back of most *Tamarix*. Early recolonization of fomer *Tamarix*-dominated areas was slow and dominated by *P. Sericea* in 2015. By 2017, significant growth of native woody taxa (e.g., *Salix* spp., *Prosopis pubescens*) had occurred along many of our monitoring transects.

In 2009 we started monitoring the vegetation composition and cover, soils, and topography along a 40 mile stretch of the Virgin River in Nevada and Arizona in anticipation of invasion by *Diorhabda* beetles being used as biological control on *Tamarix*. In December 2010 a large flood event occurred along the river, drastically altering the local topography and vegetation cover. This event occurred at the front of the invasion by *Diorahbda*, which continue to defoliate extant stands of *Tamarix* along this section of the river. By spring 2015, major defoliation had occurred throughout our study area resulting in shifts in the plant communities. We describe changes to riparian plant communities over a six year period between Fall 2009 and Spring 2015. We also expand on previously reported work by discussing the interaction of flooding with *Tamarix* defoliation, possible trajectories of the riparian communities and our ongoing plans for monitoring along the Virgin River.

Flood disturbance resulted in different species compositions dependent on local erosion or deposition. In general, flooding had a positive influence on recruitment of native woody species (e.g., *Pluchea sericea,*

Salix sp.) in once *Tamarix* dominated areas. *Tamarix* mortality from defoliation was heaviest in areas that had the highest *Tamarix* cover, suggesting a density dependent relationship between *Diorhabda* beetles and *Tamarix*. The interaction between flooding and beetle defoliation showed larger changes to the plant communities in flooded areas than those not impacted by the flood event. Major flood events, like the one in 2010 can offer a window of opportunities for native plant species to re-colonize riparian habitats. Flooding on the Virgin River is episodic and an important part of the dynamics that shape the riparian communities. With the establishment of *Diorhabda* to the region, we have reason to expect more persistent mixed stands of riparian vegetation than in the past.

Measuring Changes in Tamarisk Evapotranspiration in a Riparian Ecosystem near Shiprock, NM

Pamela L. Nagler[1]*, W. Joseph Waugh[2], Edward P. Glenn[3], Christopher J. Jarchow[1,3]

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Tamarisk (*Tamarix* spp.) is a non-native tree that competes with native species for water in riparian corridors of the southwestern U.S. We studied the effects of changes in riparian plant communities dominated by tamarisk on evapotranspiration (ET) rates at uranium mill tailings sites. We used an unmanned aerial system (UAS) to acquire high resolution spectral data needed to estimate spatial and temporal variability in ET measurements in riparian ecosystems at uranium mill tailings sites adjacent to the San Juan River near Shiprock, New Mexico, and the Colorado River near Moab, Utah. UAS imagery allowed us to monitor changes in phenology, fractional greenness, ET, and on water resources at these sites. We timed ground data and UAS image acquisition with an August 2016 Landsat image to assist with spatiotemporal scaling techniques. We measured leaf area index (LAI) and sampled biomass on tamarisk, cottonwood (*Populus* spp.), and willow (*Salix* spp.) within the UAS acquisition areas to scale leaf area on individual branches to LAI of whole trees of a given genera. Ground validation of vegetation cover types (n=24) was done with a GPS for over a hundred locations. UAS cameras included a Sony Alpha A5100 for species-level mapping (using the 24 vegetation cover types) and a MicaSense Red Edge five-band multispectral camera to map Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI). The UAS products were correlated with satellite imagery. NDVI and EVI were calibrated across UAS, Moderate Resolution Imaging Spectrometer (MODIS) and Landsat images using regression and ET was calculated using NDVI, EVI, ground meteorological data, and an existing empirical algorithm. Our goal is to scale plant water use acquired from UAS imagery to Landsat and/or MODIS to provide a time-series documenting long-term trends in plant species cover or vegetation community structure with relationships of ET and groundwater elevation.

COMMUNITY AND PARTNERSHIPS

East Ballroom
1:05-2:45

Save Our Bosque Task Force: Connecting Our River to Our Community

Miranda Kersten[1]* and Gina Dello Russo[2]

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Since 1994, the Save Our Bosque Task Force (SOBTF) has worked to preserve, protect, and enhance central New Mexico's Rio Grande and its unique riparian ecosystem. As a non-profit organization, we aim to build resilience within our rural, underserved community through outreach, education, habitat restoration, and wildfire protection. We work on the ecosystem level, often collaborating on large-scale restoration projects. We are unique in that we were founded as a bridge between government agencies and private citizens. We are a partnership in action with diverse professional backgrounds that bring complementary resources to our efforts. We developed a shared vision by increasing the connection between our community and the river and are successful in our efforts because we reach out to our partners and other stakeholders to discuss ways that we can assist one another. For 23 years, the SOBTF was an all-volunteer organization; however, our participation in the Restore Our Rivers Initiative has allowed us to increase our organization's capacity and hire a program director as well as expand our reach and our role in community. In the past, we have supported research, and now, we are actively becoming involved in research. We have developed and implemented an Internship Monitoring Program on our own and on our partners' projects. With this added capacity, we will focus on building our science-based strategies to address large-scale riparian ecosystem health and sustainability within our watershed. One example is a fire rehabilitation project envisioned to evaluate long-standing infrastructure benefits and determine how best to withstand future water shortages, deliver water to downstream users, and provide and protect wildlife habitat diversity along the Rio Grande.

"Urban" Stream Transitions: Mill Creek in Moab Utah

Kara Dohrenwend[1]

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Mill and Pack Creeks connect the La Sal Mountains to the Colorado River running through Moab and Spanish Valley. Like many creeks in small towns and cities it has served as a water supply for irrigation and for drinking, produced power, run through pastures, and at times been neglected and forgotten. In 2004 efforts to regenerate native plant communities along the creeks started with small patches where Russian olive and tamarisk were removed. 13 years and over 125 acres later, the riparian area has changed significantly - now providing pedestrian and bicycle transportation, and open spaces with native plants and vistas through town. Projects coordinated by Rim to Rim Restoration involve over 30 land owners, Moab City, the Grand County School District and Grand County, and now coordinates with work upstream on Bureau of Land Management land. 10 years of vegetation response monitoring and

persistence applying for funding has led to development of a Riparian Plan for Moab City (in process now) to set a path forward towards future management of private and public portions of Mill and Pack Creeks.

Gila Watershed Partnership 1992-2017 a Story of Sustainability

William K. Brandau[1]

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This presentation will review the Gila Watershed Partnership's (GWP) history and reflects on its growth, successes, challenges and sustainability. GWP is a locally driven watershed organization that has been an active participant in the Upper Gila Watershed in South Eastern Arizona. It has worked on watershed issues, projects and restoration efforts for 25 years. GWP is currently enthralled in restoration efforts in the front of the tamarisk leaf beetle arrival and the potential effects after its arrival. The Upper Gila Watershed has had multiple restoration efforts spanning almost 100 years. GWP has had to adapt and make many changes; it has experienced a history of high staff turnover, conflicts, and partnerships between people and resources. Few efforts and organizations have sustained themselves through these circumstances. This presentation will review GWP's history, provide insights into organizational sustainability and address the roots of its successes, challenges and its future. Reflections of founding members, its partners, employees and funders will be reviewed to see what they believe has led to the organization's success from its beginnings as an all-volunteer group to a robust organization with a bright future.

Community Driven River Stewardship and Student Education along the Gunnison and Colorado Rivers

Ryan McConnell[1]*, Robert Gay[1]

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Since 2013, Colorado Canyons Association has been actively engaged in riparian monitoring and restoration in conjunction with the Bureau of Land Management (BLM) and volunteers who form the core of our river-based citizen-science team. In 2017 our river stewardship program was able to assist the BLM perform its monitoring and resource management duties by providing concrete, on-the-ground service projects that have provided field data to land managers and actively improved riparian conditions.
In 2017, nearly 200 volunteers participated in ten river stewardship programs along the Gunnison and Colorado Rivers. Each trip generally had a different theme or mission, based on the overall management objectives of the individual BLM field offices. Three trips focused on general clean-ups, removing trash and debris along the river banks. Other trips focused on surveying for native plants, installing protective anti-beaver cages around young cottonwood (*Populus fremontii*) trees, and the removal of invasive tamarisk (*Tamarix* spp.) from eight acres of BLM-administered land along the Colorado River, and herbicide application on an acre of Russian knapweed (*Rhaponticum repens)*.

Furthermore, nearly 50 students participated in educational rafting trips focused on Leave No Trace principles, riparian ecology, restoration, and careers in ecological sciences. Engaging students in

experiential education creates long-term sustainability of restoration efforts by building a base of recreationalists and ecological restoration workers.

In 2018 our river stewardship program will continue to implement and assist BLM river-corridor management goals by again bringing citizen scientists onto the rivers of western Colorado while our educational programs build future restoration leaders. Specific goals and targets include operating an experiential science and adventure camp on the Colorado River, expanding geographic focus to the Gunnison Gorge National Conservation Area, and hiring seasonal staff allowing us to double trip offerings.

Community Engagement Guidelines for Excellence – New Free Resources and Tools

Sarah R. Johnson[1]

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During this interactive presentation, participants will be introduced to the new Community Engagement: Guidelines for Excellence from the North American Association for Environmental Education. The guidelines were created by environmental educators, for environmental educators who want to work in partnership with communities to strengthen the underpinnings of well-being—environmental quality, social equity, shared prosperity, and the capacity to pursue these goals together.

These guidelines draw on best practices honed by scholars and practitioners in diverse fields including education, environmental education, social change, community development, communication, sociology, management, government, and business. Drafts of this document were reviewed by a large number of educators and other experts who work with communities across North America. The resulting document reflects our collective wisdom. Whether you work with youth or adults, on behalf of an organization, or as an individual, these guidelines and the accompanying resources can help you design programs that strengthen the interwoven strands of environment and community. They point to steps for creating more inclusive working environments that support social equity, effective partnerships and coalitions, and long-term change. And, to help you prepare for this work, the guidelines highlight needed skills and resources, how to put those in place, and the kinds of outcomes you might expect.

Participants will learn about the new Community Engagement: Guidelines for Excellence, discover recent best practices for creating partnerships with communities to strengthen the underpinnings of well-being—environmental quality, social equity, shared prosperity, and the capacity to pursue these goals together, and consider how to implement best practices in their community.

EMERGING RIPARIAN VEGETATION RESEARCH

West Ballroom
3:15-4:55

Vegetation Response to *Tamarix* Control in the Colorado and Middle Rio Grande: A Collaborative Study Including 416 Sites

Eduardo González[1,2,3*], Anna A Sher[2*], Robert M Anderson[2], Robin F Bay[2], Daniel W Bean[8], Gabriel J Bissonnete[16], Bérenger Bourgeois[5,6], David J Cooper[4,12], Kara Dohrenwend[15], Kim D Eichhorst[11], Hisham El Waer[2], Deborah K Kennard[9], Rebecca Harms-Weissinger[10], Annie L Henry[2], Lori J Makarick[13], Steven M Ostoja[14], Lindsay V Reynolds[3,4], W Wright Robinson[7], Patrick B Shafroth[4]

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Response of vegetation following control of invasive *Tamarix* trees along U.S. southwestern rivers has been mostly assessed locally (i.e., river reach), with poor spatio-temporal replication, and/or has not tested the effects of the *Tamarix* biocontrol, *Diorhabda* spp. We collected vegetation, environmental and management data following *Tamarix* control in 244 treated and 172 reference sites across six U.S. states, from published and unpublished sources in a collaboration of 16 institutions that have been monitoring the outcomes of *Tamarix* control for almost two decades in the Colorado and Rio Grande. This represents the largest comprehensive assessment to date on the vegetation response to the four most common *Tamarix* control methods. Biocontrol alone reduced the abundance of *Tamarix* less than direct removal by burning, mechanically using heavy machinery, or chain-saw/hand removal, whose effectiveness increased with lower temperatures, higher precipitation, and follow-up treatments for *Tamarix* resprouting. The abundance of exotics decreased relative to natives, due primarily to the removal of *Tamarix*; native species only increased slightly in absolute terms, likely because sites were measured on average only five years post-treatment. Active revegetation did not consistently improve native cover. *Tamarix* control, especially by burning and heavy machinery, often promoted secondary invasions of

exotic forbs such as *Acroptilon repens* (Russian knapweed), *Bassia scoparia* (common kochia) and *Salsola tragus* s.l. (Russian thistle). However surprisingly, noxious weeds did not decrease over time and not consistently as the result of herbicide follow-up. The abundance of hydrophytic species representing early stages of riparian succession such as *Salix exigua* (coyote willow) was much lower in treated than in native reference sites, suggesting that weed control is not enough for recovery of these species if there is no concurrent restoration of fluvial processes. These results can help inform future management of *Tamarix*-infested rivers, increasing native biodiversity and reducing exotics abundance.

How Two Generations per Season Became Six: Evolving Photoperiod Cues and Shifting Temperature Regimes Alter the Life History and Phenology of *Diorhabda carinulata*, A Biocontrol Agent for *Tamarix* spp.

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Introduced populations of the northern tamarisk beetle, *Diorhabda carinulata*, originated from two collection points in central Asia, one in western China and one in southern Kazakhstan. Initial releases of *D. carinulata* failed to establish at more southern locations in western North America due in part to seasonal mistiming of dormancy (diapause) linked to shorter day lengths encountered by the northern-adapted beetles at more southern latitudes. Evolving critical day length (CDL; the day length at which 50% of the population enters diapause) has allowed beetles to remain reproductively active later into the season which has in turn allowed more generations per season. At the outset of the tamarisk biocontrol program the CDL for diapause induction in *D. carinulata* was approximately 14 hr 40 min. As beetles have moved southward the CDL has decreased by as much as two hours in a dramatic display of rapid evolution. Shorter CDLs have extended reproductive activity later into the season. Linking CDL to voltinism (number of generations per year) is critical for understanding population dynamics along a latitudinal gradient but, surprisingly, traditional models for determination of voltinism do not take photoperiod into account. A recently developed degree-day phenology model combines detailed spatial climate data, latitude- and date-specific photoperiods, and development and photoperiod response parameters to determine voltinism in newly introduced species. We use this model to link evolution of CDL in *D. carinulata* to shifts in voltinism and phenology at specific locations in the southwestern US.

Designing Decision Support Tools for Southwestern Willow Flycatcher Conservation with Consideration of the Distribution and Expansion of the Tamarisk Beetle

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Since its initial release in 2001 as a biocontrol agent, the tamarisk beetle (*Diorhabda* spp.) has impacted habitat in parts of the federally endangered Southwestern Willow Flycatcher's range. Beetle releases were terminated in 2010, but their populations continue to expand, with the potential of further impacting flycatcher populations, especially those using habitats dominated by tamarisk. Thus, there's an urgent need to identify flycatcher habitat and to prioritize areas for restoration to native-dominated habitats that are resilient to the impacts of the beetle. The recently published model by J. Hatten of Southwestern Willow Flycatcher breeding habitat is a powerful tool for identifying potential flycatcher habitat across its breeding range. Habitat can be summarized at multiple spatial scales, from range-wide (including parts of seven states) down to an individual riparian patch. In addition, the model can be used to assess how and where habitat changes over time. We will demonstrate how, when combined with information on Tamarisk Beetle distribution and projected dispersal, the model can be used to identify potential flycatcher habitat that is most at-risk of degradation by the beetle. This information, along with updated data on the Southwestern Willow Flycatcher's current distribution, can be a powerful decision support tool for agencies concerned with Southwestern Willow Flycatcher conservation.

Water Stress in Desert Willows (*Chilopsis linearis*) Planted in Clinoptilolite Zeolite for Riparian Rehabilitation

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Dessert willows (*Chilopsis linearis*) plants are commonly grown in the southwestern part of the United States as ornamental trees or shrubs. They also grow naturally in the wild and are known for their beautiful flowers, tolerance to drought, and ease of maintenance. As part of a rehabilitation project in an urban riparian environment at Sunland Park, New Mexico, desert willows and other vegetation native to the region were planted in natural zeolite-filled-boreholes and in in-situ riparian sandy soils. The natural zeolite was used for the purpose of wicking water from groundwater to the roots of the plants so that no surface irrigation would be required. As a control, similar plants were grown in in-situ riparian sandy soils. The restoration site was located by the Rio Grande and adjacent to a drainage canal on the border of Sunland Park, NM and the city of El Paso, TX. Native vegetation were planted as a replacement of exotic saltcedar which was obstructing the drainage canal and also considered as a nuisance by the neighbors. To better understand the water stress endured by the plants, midday stem water potential (ψ) of the plants grown in zeolite filled boreholes and in-situ riparian sandy soils under two zones of depth to the

groundwater of 1.21 m and 2.14 m, respectively was conducted during the pre-monsoonal and post-monsoonal periods of 2016. The ψ was significantly higher (more negative) for plants grown in-situ soils compared to those grown in zeolite during the pre-monsoonal season but no significant difference was observed during post-monsoon.

Colorado's EDRR Strategy: Using Genetic Testing to Inform Management of Native vs. Non-native *Phragmites* in Colorado

Patty York[1]

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Common reed (*Phragmites australis* spp. *australis*) was added to the Colorado Department of Agriculture's (CDA) Noxious Weed Program's Watch List in 2012. Surveys addressing distribution and behavior of this plant were sent out in 2014 and 2016. It became apparent in the 2016 "extended" survey that responders were not often confident that they were able to differentiate between native and invasive populations in the field, based on physical characteristics alone.

Some populations of *Phragmites* in the state had undergone genetic testing by a Chicago Botanic Gardens study in 2014. From that study, CDA knew of at least two invasive populations in the state, along with about a dozen native populations. With so many native populations at risk, the urgency to confirm the distribution of non-native *Phragmites* populations grew.

CDA contracted with the Weed Lab at Colorado State University (CSU) in the summer of 2017, to perform a genetic study of statewide *Phragmites* populations. Funding for 200 samples was allocated, and CSU received 185 samples. A genetic map of native vs. non-native *Phragmites* is one of the deliverables of the contract, and the results will be used to inform whether or not (and how) *Phragmites* should be managed in Colorado.

GRAZING PANEL

3:15-4:05
East Ballroom

Shelly Simmons[1]*, Bruce Fickenscher[2]*, Robbie LeValley[3]*, Laria Lovec[4]*

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[4]CO State Range Lead, Bureau of Land Management, Denver, CO, USA; llovec@blm.gov

This panel will be moderated by Shelly Simmons with the Tamarisk Coalition. Panelists will explore grazing policy on public lands and riparian management practices on private lands, with an emphasis on conservation and restoration practices beneficial to riparian ecosystems and landowners/land managers alike. Parameters that indicate an upward trend in riparian condition following the implementation of best management practices will be discussed as well as private land management examples from local and regional producers. Panelists will include range management specialists, researchers,and private landowners who are also livestock producers.

SELENIUM PANEL

4:05-4:55
East Ballroom

Riparian and Wetland Restoration Challenges and Opportunities in Selenium Impacted Watersheds

Dave Kanzer[1]*, Lesley McWhirter[2]*, Creed Clayton[3]*, James J. Roberts[4]*, Jason A. Roudebush[5]*

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[5]Water Resource Specialist, Ducks Unlimited, Fort Collins, CO 80525, USA; jroudebush@ducks.org

This panel will be moderated by Dave 'DK' Kanzer. Panelists will discuss the impacts/ramifications of selenium on riparian and wetland restoration in Mesa County and along the Gunnison River.

February 7th

REGIONAL RIPARIAN ASSESMENTS

South Ballroom
8:35-10:05

A Spatially Explicit and Quantitative Vulnerability Assessment for Riparian Habitats in the Four Corners Region

Megan Friggens[1]* and Max Smith[2]

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As part of an effort by the Southern Rockies LCC to initiate Landscape Conservation Planning in the Four Corners Landscape, we developed a framework to produce spatially explicit map products to facilitate collaborative planning. These maps were based on data relating to plant and animal communities associated with riparian corridors along mainstems and tributary streams in the San Juan and Little Colorado Basins. We used a framework that measures three elements, exposure, sensitivity and adaptive capacity, to assess vulnerability of riparian systems to disturbances. Vulnerability increases with increasing exposure and sensitivity and decreases with increasing adaptive capacity. Using these concepts, we identified spatial data and indicators through a series of adaptation forums and literature review that represent exposure to threats and issues, sensitivity or response to exposure, and adaptive capacity within riparian systems. Riparian exposure indices include change in flow volume or timing, groundwater and surface water use, presence of major dams and riparian vegetation departure. Indicators of sensitivity include high/very high wildfire potential, presence of critical habitat for threatened or endangered species, and streamside riparian vegetation. Adaptive capacity considers presence of protected land, subsurface heterogeneity, springs, and natural cover. Areas with the highest vulnerability include watersheds draining into the San Juan River in Utah and New Mexico, watersheds of the Little Colorado River and its tributaries in Arizona, watersheds draining into the Rio Grande from San Juan Mountain headwaters to the Middle Rio Grande, and watersheds draining the Sangre De Christo Mountains. Potential areas of conservation opportunity (low vulnerability) include stream sections within the Abajo Mountain of Utah, the San Juan Mountains of Colorado, watersheds scattered throughout the Little Colorado River Basin of Arizona, the Sangre De Christo Mountains of Colorado and New Mexico, several ranges in New Mexico, and several watersheds along the lower Pecos River.

The Colorado River Hot Drought: How Higher Temperatures are Reducing Streamflows in the American West

Brad Udall[1]

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The nation's two largest reservoirs, Lakes Mead and Powell, were brim full in the year 2000. Four short years later, they had lost enough water to supply California its Colorado River share for over 5 years. Now, seventeen years later, these reservoirs have still not recovered. A primary cause of the reservoir declines is the ongoing drought which started in 2000. The period from 2000 to 2014, the worst 15-year drought in the gaged record, had annual flow declines of over 19%. A similar 15- year drought in the 1950s had annual flow declines of 18%. The 2000-14 period, however, had only 75% of the precipitation reduction that occurred in the 1950s, begging the question of what caused the more recent, most severe drought on record? The answer is simple: higher temperatures. From 2000 to 2014, temperatures in the Upper Basin of the Colorado River, where most of the river runoff is produced, were 1.6 Fahrenheit higher than the 20th century average. About one-third of the 2000-14 flow decline was likely due to higher temperatures in the basin. High temperatures cause earlier snow melt, which in turn leads to a longer growing season and thus more water demand from plants.

The net impact of all these warming-related factors is nearly 4% less flow per degree Fahrenheit warming. With temperatures projected to rise as much as 9F by 2100, this bodes ill for future flows.

Western Governors Association Invasive Species Data Management Initiative

Bill Whitacre[1]

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Western Governors are committed to helping land managers in the West fight invasive species. As part of this work, the Western Governors' Association (WGA) has launched a three-year initiative to improve the management and exchange of invasive species data in the West. During the initiative, WGA will develop three separate, but related, products: a West-wide invasive species risk-assessment tool; a new set of voluntary, non-regulatory data management standards and exchange protocols; and a western invasive species data portal and clearinghouse. WGA Policy Advisor Bill Whitacre will discuss the genesis of the initiative, work to date, and next steps.

MAPPING AND TECHNOLOGY

West Ballroom
10:35-11:55

Application of Open Source Data in USFS Riparian Areas Inventory Mapping

Sinan Abood[1,3]*, Linda Spencer[2]

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Riparian areas are dynamic, transitional ecotones between aquatic and terrestrial ecosystems with well-defined vegetation and soil characteristics. Riparian areas are a small percentage of our managed landscape (<1%) and provide irreplaceable values. Two staff areas at the USDA Forest Service have coordinated on a two phase project to support the National Forest in their forest planning revision efforts and rangelands riparian business needs at the Forest Plan and allotment management levels. The newly developed Riparian Buffer Delineation Model (RBDM) v5.x utilizes open source data such as US Geological Survey (USGS) streams/water gauges/digital elevation models data, Fish & Wildlife Service (FWS) wetlands data, Natural Resources Conservation Service (NRCS) soil data and National Agricultural Statistical Service (NASS) land cover data. This approach recognizes the dynamic and transitional natures of riparian areas by accounting for hydrologic, geomorphic and vegetation data as inputs. Results from phase one would suggest incorporating functional variable width riparian mapping within watershed management planning to improve protection and restoration of riparian functionality and biodiversity.

A Dynamic Model for Managing Field Data

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Friends of Verde River Greenway designed dynamic mobile applications for efficiently collecting and managing invasive species inventory, monitoring and treatment data. Friends leads the Verde Watershed Restoration Coalition, a multi - stakeholder watershed scale restoration effort in the Verde Watershed focusing on invasive plant management and other challenges in the riparian corridors. Now in our sixth field season, Friends oversees the work of five treatment crews, one monitoring crew, and one native seed collection crew. Our restoration work focuses on treatment of four primary woody invasive species: saltcedar (*Tamarix* spp.*),* giant reed (*Arundo donax*), tree of heaven (*Ailanthus altissima*), and Russian olive (Elaeagnus angustifolia) as well as secondary weed infestations. Over the years, we've recognized a need for effective data management solutions coupled with efficient field data collection methods and recently began developing solutions using Collector for ArcGIS. Collector for ArcGIS allows us to more easily collect, synchronize, and manage field data relative to other methods we've used in the past.

Having meaningful and manageable data means being able to analyze, share, and assess our accomplishments and their effectiveness with greater ease. Friends will share "lessons learned" from previous data management systems and walk you through VWRC's dynamic data management system.

150 Hectares per Hour: Comprehensive Restoration Monitoring Using Drones & Multi-Spectral Sensors

Richard Alward[1]* and Tamera Minnick[2]

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We are evaluating the use of a multi-spectral sensor mounted on an unmanned aerial system (UAS or "drone") platform for monitoring ecological restoration success in riparian areas. A rigorous, quantitative monitoring program is essential for ensuring and documenting restoration success, as well as for early detection of restoration shortcomings in order to allow for adaptive management. Ecological monitoring is frequently the most expensive component of the restoration budget and thus may not receive sustained support. Identifying monitoring methods that provide the necessary information, at reduced costs, is a major motivator for this project. We have demonstrated that our approach is effective at estimating vegetation cover, especially trees and shrubs, compared to traditional methods such as line-point-intercept. For instance, the area of successful, or failing, regrowth following tamarisk removal can be calculated with 8 cm resolution and tracked over time. Our current task is to identify reflectance signatures for key species at two riparian restoration sites on the Colorado River in Grand Junction, CO. Using drone-collected remotely sensed imagery is economically efficient – requiring as few as 20% of the person-days in the field to collect vegetation cover data from an entire restoration site, thus monitoring need not be constrained by a shortage of trained personnel nor limited growing seasons. Restoration practitioners will benefit from this approach by being better able to implement cost-effective monitoring programs that will help them stay informed about the status of their projects, and avoid costly remediation on failed restoration sites. Regulatory agencies, landowners, and the general public will benefit from these reduced costs, as well as reduced erosion and secondary weed infestations, increased wildlife habitat, and improved recreational opportunities.

The Use of UAS (drones) to Measure Weed Treatment Effectiveness along the White River in Utah

Matt Lewis[1]*, Dan Emmett[2]

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In 2014, the Vernal Field Office began treating Russian-olive (*Elaeagnus angustifolia*) along the White River in northeastern Utah. We used unmanned aerial systems (UAS, "drones") to measure weed conditions pre- and post-treatment. We used a 3DR Solo aircraft equipped with a Ricoh GR II camera and programmed autonomous flights to capture aerial imagery that was then processed through computer software. This allows for aerial imagery with a 3 mm pixel size. Photos were taken every 5 seconds at a height of approximately 125 feet above ground level. Each flight lasts from eight to ten minutes. Flight

logs are pulled and a gpx file of the flight is created using Mission Planner. Photos are then post-processed through Geosetter to geotag each photograph. The geotagged photos are then aligned and processed through Photoscan. From here we can create orthomosaic maps and digital elevation models that can be opened in GIS software (ArcMap) and polygons can be drawn around the treated areas to estimate acreage. Moreover, the use of mobile applications (*e.g*. Tower) can provide a reliable way of accurately surveying the same area through time by re-using pre-programmed flight paths (*i.e*. transects). We were able to capture approximately 122 acres of treatment areas in a two field day session. The data collected using UAS will provide land managers an accurate and cost effective way of measuring weed treatment effectiveness over time.

LARGE-SCALE PLANNING CONSIDERATIONS

East Ballroom
10:35-11:55

Transforming the Weed "Whack-A-Mole" Management Approach

Steve Ryder[1]

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As noxious weed managers, restoration professionals and volunteers and others working beside us, we can fall into the trap of treating the same or similar populations of plants over and over again, sometimes with questionable results, and without a broader vision. This trap, or rut, is easy to fall into as we work, year after year, in an environment of scarcity, both financial and otherwise.

Describing we fall into this rut and how we can get out – and stay out – are the two primary purposes of this presentation. We will discuss internal and external motivations for why we do this work. Audience interaction is expected as we explore questions of why we've chosen this work; or as volunteers, why have we decided to devote our precious time and energy to these endeavors. We will explore the chronic nature of the limitations we face with an eye toward transforming them into opportunities that can sustain us and provide both internal and external rewards.

Come prepared to discuss what in your mind constitutes "success"; what are "rewards" that you value; and how you and your colleagues can become more effective by re-defining your work, and less likely to fall into the "whack-a-mole" syndrome.

Using Stream Management Plans To Set and Realize River Health Goals in Colorado

Nicole Seltzer[1]

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The development of Stream Management Plans for 80 percent of locally prioritized rivers is a key action in Colorado's Water Plan. The State of Colorado pledged to allocate $15 million in grant funds over three years to achieve this goal. This talk will review the required components of a stream management plan, and highlight how several Colorado communities are using the planning process to set and achieve river health goals. It will also discuss River Network's project to enlarge the pipeline of local coalitions that are interested, ready and capable of undertaking stream management plans, and how we are capturing best practices and lessons learned to improve the state of the science.

Recreation Habitat vs. Ecological Habitat in Riparian Restoration: Are They Different, and Can We Manage for Both?

Bo Shelby[1]*, Doug Whittaker[2]

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[2]Confluence Research and Consulting

Do "real people" (visitors) care about riparian restoration? Data from Yosemite Valley show that river users define recreation habitat differently than scientists define ecological habitat. But they strongly support restoration goals, and will accept structural modifications or change their own behavior to accomplish those goals. Can we create recreation habitat during riparian restoration? Data about river camps from Oregon's Deschutes River show the site characteristics that are important to river runners. Examples from the Green and Colorado Rivers show how projects can be more or less successful in developing high quality recreation habitat while restoring ecological habitat.

Differences among Managers Correlate with Plant Community Traits in Tamarisk Removal Projects

Lisa B. Clark[1]*, Eduardo González[2,3], Rebecca Lave[4], Nathan Sayre[5], and Anna Sher[6]

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Riparian *Tamarix* control projects vary widely in their success at meeting project goals. Researchers have investigated the role of removal methods including biocontrol and the environment (climate, hydrology, landscape, soil properties) to explain this variability, but the human component (manager characteristics, attitudes, and approach) has rarely been explored. Our NSF-sponsored research asks the following question: do management approach, manager characteristics, or managers' attitudes toward nature or

science correlate with restoration outcomes? To address this question, we have vegetation data from 244 *Tamarix* control sites and 172 reference sites in the Southwest US and survey data from 45 corresponding managers (373 sites). With the use of Kruskal-Wallis tests and non-parametric regressions, we have found that most management approaches and manager characteristics and attitudes do correlate with plant community composition. For example, collaboratively managed projects are associated with a more native plant community than other agencies (manager characteristics). Of particular interest is the influence of goal prioritization; for instance, a high prioritization of plant-related goals (management approach) is correlated with vegetation characterized by a more native gallery forest, which would suggest that project goals may translate into the desired plant community. We also tested the assumption that managers who have a more positive attitude toward science and thus use scientifically-sound resources and practices will have better project outcomes (as defined both by managers and scientists, management attitude), but this was not the case. Through this project, we will be able to give insight into how best to improve future human intervention on ecosystems, particularly invasive species control.

REMOTE SENSING

West Ballroom
1:05-2:45

Utilizing NASA Earth Observations to Delineate Riparian Corridors and Evaluate Invasive Species Cover in the Verde River Watershed

Jilian LaRoe[1]*, Tim Mayer[2], Dan Carver[3], Sarah Carroll[4], Leana Schwartz[5], Amandeep Vashish[6], and Chanin Tilakamonkul[7]

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Riparian corridors in the semiarid Colorado River Basin act as an interface between terrestrial and aquatic systems. These corridors also play an important role in maintaining biodiversity, providing wildlife habitat, controlling erosion, and buffering both pollutant and nutrient runoff. Understanding the extent of riparian corridors is the first step in identifying how human modification, large scale ecological change, and invasive species such as Tamarisk (*Tamarix* spp.) are affecting the ecosystem services provided by these corridors. This project utilized both hydrological and SRTM terrain data to map the current maximum potential riparian corridor area in the Verde River watershed of Arizona. Landsat 5 and Landsat 8 were used to generate spectral indices and map riparian vegetation within the maximum potential riparian corridor for both 2010 and 2016. These maps allow the Walton Family Foundation to prioritize future ecological restoration areas as well as to evaluate the efficacy of previous management efforts in the Verde watershed. In addition, a replicable tutorial of the team's methodologies provide support for partners' ongoing efforts to manage riparian corridors and invasive species.

Utilizing NASA Earth Observations to Evaluate Invasive Species Cover in Riparian Areas of the Colorado River Basin

Dan Carver[1]*, Tim Mayer[2], Kristin Davis[3], Megan Vahsen[4], Emily Campbell[5], Julia Sullivan[6], and Chanin Tilakamonkul[7]

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Riparian corridors are inhabited by unique and biodiverse plant communities that provide important wildlife habitat and maintain the overall health of rivers. The spread of invasive species such as tamarisk (*Tamarix* spp.*)* impacts the ecosystem functionality of this river basin by altering flow regimes, sediment loads, and control erosion. This project utilized Landsat 5, Landsat 8, and Sentinel-2 to map tamarisk cover in 2006 and 2016 in the Green River watershed of the Colorado River Basin. Landsat 5 and Landsat 8 maps were employed to identify the change in percent tamarisk cover between 2006 and 2016. Due to the higher resolution of Sentinel-2 imagery, a comparison of Landsat 8 and Sentinel-2 tamarisk cover maps was performed for 2016. Both Landsat 5 and Sentinel-2 models predicted higher tamarisk percent cover than the Landsat 8 model. These invasive species cover maps and in-depth tutorials allow partners at the Walton Family Foundation to create effective management plans and reproduce this methodology for future planning.

Evaluating Invasive Species Cover Influence on Water Evapotranspiration Rates in the Colorado River Basin Using NASA Earth Observations

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Riparian plant communities are vital to water quality, erosion control, biodiversity, and functionality of river ecosystems. Russian olive (*Elaeagnus angustifolia* L.) is an invasive riparian species that is displacing native riparian species such as cottonwoods (*Populus* spp.) and willows (*Salix* spp.) in semiarid environments throughout the western United States. Invasive species such as Russian olive have been shown to alter riparian evapotranspiration rates, streamflow, and sediment regimes. Quantifying the effect of Russian olive presence in the Colorado River Basin is vital for water resource management. In this study, the team 1) Mapped the distribution of Russian olive in the San Juan River (a tributary of the Colorado River) using Landsat 5, Landsat 8, and Sentinel-2 imagery; 2) Compared the accuracy of models created using Sentinel-2 and Landsat 8 imagery; and 3) Examined the relationship between

evapotranspiration rates from 2006 to 2016 and the change in Russian olive cover. We utilized NASA Earth Observations, Landsat 5, Landsat 8, and Sentinel-2, to identify predictor variables. Software for Assisted Habitat Modelling (SAHM) was used to implement multiple classification algorithms, including Maximum Entropy (MaxEnt), Boosted Regression Trees (BRT), Generalized Linear Model (GLM), Multivariate Adaptive Regression Splines (MARS), and Random Forest (RF). Models were compared to determine which approach best predicted Russian olive presence. Our products allow the Walton Family Foundation to further improve their management and restoration efforts in the Colorado River Basin.

Mapping Riparian Corridor and Vegetation Change in the Colorado River Basin

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The Colorado River Basin (CRB) is a massive and ecologically diverse watershed with riparian ecosystems that serve multiple functions important for plants, wildlife and human health. However, the structure and function of these riparian ecosystems have been negatively impacted by dams and diversions, climate change, and non-native invasive species in recent years. Our goal was to map riparian corridors based on topography and vegetation. Specifically, we 1) defined topographical features that delineate the maximum extent of the riparian corridor, 2) used remote sensing to detect riparian vegetation, 3) integrated topographical and vegetation layers to define riparian areas, and 4) examined how riparian corridors changed between 2006 and 2016. We used the Valley Bottom Extraction Tool (V-BET), a freely available ArcMap Toolbox, to map valley bottoms across the CRB. We then used National Agriculture Imagery Program digital images to collect riparian vegetation cover within the V-BET extent at two time steps; 2006 and 2016. We combined these data with remotely sensed composited spectral predictors of riparian vegetation and Random Forests classification models within Google Earth Engine at defined EPA

level III ecoregions in the CRB. We then differenced the two years to obtain vegetation change maps. All riparian models performed well with arid ecoregions performing better than higher-elevation ecoregions. The amount of riparian vegetation change varied by ecoregion with the majority of ecoregions showing increases in vegetation cover and only two showing a decrease in vegetation cover over the time period. Across the CRB, there was a net 2.1% increase in riparian vegetation cover from 2006 to 2016. We show an efficient and accurate approach to mapping riparian vegetation across large spatial extents. The maps generated can be used for riparian vegetation status and monitoring for land managers across the CRB.

Mapping Tamarisk Change across the Colorado River Basin: Trials, Tribulations and Lessons Learned

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The Colorado River Basin (CRB) covers over 600,000 km^2 across seven states and supports riparian ecosystems that provide important wildlife habitat and are critical determinants of water quality and quantity. The structure and function of these riparian ecosystems are negatively impacted by dams and diversions, climate change, and non-native invasive species such as tamarisk (*Tamarix* spp.). Mapping the distribution of tamarisk across the CRB can provide a powerful tool for assessing environmental impacts and formulating effective control strategies while also providing a means to evaluate management efforts. In this presentation, we will present the data, tools and analyses used to approach this daunting objective of modeling the distribution of tamarisk in 2006 and 2016 across the CRB and the ensuing results. We collected dozens of disparate datasets of tamarisk locations across the basin and augmented these with additional targeted and project-specific data collection efforts then combined these data with over 6TB of Landsat remote sensing data. We used these data in multiple correlative modeling algorithms such as Random Forest and Maxent, different methods such as varying the absence/background data and the predictor variables used to identify the approach that performed the best. We evaluated the ability of Landsat data to detect the annual phenological changes in tamarisk and compared this to co-occurring riparian species such as willow and cottonwood. We found data quality to be a limiting factor across the

basin due to the temporal, spatial, and quality required for robust mapping with Landsat imagery. However, where data were sufficient, accurate maps of tamarisk cover change were generated that could be compared against documented management activities. Annual phenological differences in tamarisk were detected across the basin as well as between co-occurring species, although the magnitude varied. Our results provide regional changes maps and a framework for large-scale mapping efforts in the future.

RUSSIAN OLIVE

East Ballroom
1:05-2:45

Vegetative Reproduction in Russian Olive – Implications For Control

Dennis Worwood[1]* and Ron Patterson[2]

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For 12 years the authors researched ways to minimize regrowth after Russian olive (*Elaeagnus angustifolia*) trees are felled, shredded or uprooted. Russian olive's ability to produce copious crown sprouts and root suckers complicates control because regrowth is difficult to kill, often requiring multiple herbicide treatments. Most crown sprouts originate from epicormic buds, which are common on the trunk of Russian olive trees. All root suckers, and some crown sprouts grow from adventitious buds originating in callus tissue or lateral meristems. For unknown reasons, and unlike some other root-suckering woody species, Russian olive roots (broken or intact) must be very shallow or exposed to produce suckers. In one study, broken Russian olive roots left exposed after trees were uprooted produced 300 times more suckers than broken roots that were buried immediately after tree removal. Excavation of buried roots one year after trees were uprooted showed that the roots were still alive, but had no callus, bud or sucker development. When severed Russian olive roots in open and backfilled trenches were compared, roots in open trenches produced 230 times more suckers than roots in backfilled trenches. In contrast, burial did not inhibit shoot production from Russian olive crowns after trees were felled or shredded. Root suckering can be minimized by burying exposed roots after Russian olive trees or stumps are uprooted. On sites where Russian olive roots are not shallow or exposed, suckering is unlikely unless roots are disturbed. On these sites, regrowth can be minimized or prevented by treating remaining crown tissue with herbicide or by completely removing crown tissue. On sites where roots are shallow or exposed because of soil conditions or erosion, provision should be made for both crown sprout and root sucker control. This may include treating both remaining crown tissue and emerging root suckers with herbicide.

Herbicide Control Options for Russian Olive

Ron Patterson[1]* and Dennis Worwood[2]

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Since 2005 the authors have researched herbicide control methods of Russian olive (*Elaeagnus angustifolia*). Russian olive, once touted as a conservation tree, has been shown to have a deleterious effect on sensitive, arid environments. Its ability to produce crown sprouts and root suckers, after being cut down, complicates control efforts because such regrowth is difficult to kill. Herbicide treatment prior to, or at the time of removal, has the potential to reduce regrowth. Because the pubescent surface of the leaves limits herbicide penetration, foliar application of herbicide to Russian olive is mostly ineffective. Trials conducted on foliar application to regrowth after Russian olive stump removal resulted in 10% control. Frill-cut can be effective during the growing season. Glyphosate treatments from May through October yielded 83 – 100% control; November through April treatments ranged from 52 – 81% control. Basal bark treatment, which can kill smaller trees and epicormic buds on larger trees, is most effective when a penetrating additive is used, but the results depend on the application technique and products used. Various basal bark treatments resulted in 41 – 100% control, evaluated at least 12 months after treatment. The cut-stump application method has proven to provide the most effective regrowth control, regardless of the time of year treatment was applied. Over a period of three years, over 350 trees were treated with glyphosate and imazapyr. Only two treated stumps had any sprouts after evaluation two years later. In all studies control trees exhibited vigorous regrowth. Studies are being conducted to determine if basal-bark treatment prior to stump removal, will greatly reduce the regrowth of Russian olive after removal. The cut-stump method with glyphosate or triclopyr is the current recommendation due to the targeted nature of the application, low application rates, and excellent control any time of the year.

Treatment of Russian Olive Using the Frill Cut Method in the Escalante Watershed

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The frill cut method of treating Russian olive, an invasive woody species, has played an increasing role in the tactics of reducing woody invasives in the Escalante Watershed over the past 4 years. This method used in tandem with cut stump is allowing treatment to move more efficiently, which has helped the Escalante River Watershed Partnership (ERWP) in continuing to achieve goals in the light of the remote, dense areas remaining for primary treatment. Treatment of Russian olive on public lands of the Escalante Watershed has been going on for 17 years and many lessons on herbicide, biomass management and treatment techniques have been learned. Recently the frill cut method of treatment has been applied and adapted to the needs of this watershed. This method has allowed the retreatment crew to be more mobile and the primary treatment crews to treat more acres in the same amount of time. While this

method has brought many successes, there are some challenges as well. There have been varying rates of success of the frill cut method across the many treatment sites and different styles of frill cutting are being tested. Retreatment of frill cut Russian olive requires different methods than retreatment of other primary treatment methods and ERWP has set up plots to test these methods. The frill cut method, as it's implemented by ERWP, requires some decision making, and teaching this method to conservation crews has been an important task. ERWP has partnered with a wide variety of groups from the Southwest Exotic Plant Management Team to the Wilderness Volunteers, and adapts treatment methods to each group's abilities. There have been many successes and some challenges with the frill cut method, and ERWP is working to adapt the method to work effectively in a wide variety of situations.

Interactive Effects of Russian Olive and the Common Carp on Linked Stream-Riparian Food Webs

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Multiple invasive species may interact, influencing one another and generating synergistic effects on food webs and ecosystem processes. We investigated the interaction between two non-native species widespread in the western USA: common carp (*Cyprinus carpio*) and Russian olive (*Elaeagnus angustifolia*), an invasive riparian tree associated with di-nitrogen fixation. Deep Creek, Idaho was an International Biological Program site in the early 1970's; at that time carp were rare and Russian olive was absent. Subsequently, Russian olive was introduced and now forms a dense stand, increasing allochthonous inputs and nitrogen-rich benthic organic matter. Since 1971, carp density has increased ~4X (an increase our bioenergetic analysis suggests could not have been sustained by pre-Russian olive resources) and ~40% of gut contents consist of olives. A small-scale, short-term experimental removal of these subsidized carp caused ~3-fold increases in organic matter and chlorophyll-*a* concentration, suggesting they may limit algae and macrophyte biomass. Moreover, carp that consumed nitrogen-rich olives excreted 2-3X more nitrogen (ammonium, total dissolved nitrogen, and total nitrogen) compared to those that had not, which may amplify recycling and export from streams invaded by both species. This scenario is characteristic of an 'invasional meltdown,' with attendant changes in food webs and ecosystem processes.

Re-Organize and Re-Assemble: Community Change and Restoration after Russian Olive Removal

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Weed invasions can drive shifts in the structure and composition of riparian systems that persist after weeds are controlled. Revegetation after invasive species removal may restore desirable plants, but how communities will respond, or repel further invasions, is uncertain. We are evaluating the long term success and consequences of Russian Olive removal and subsequent active revegetation on plant and insect communities along the Yellowstone River in eastern Montana. Russian Olive removal resulted in a resprout rate of less than 5%, though resprouting occurred up to two years post-removal, and continued seedling recruitment requires spot herbicide controls even after 5 years. Vegetation establishment was successful: nearly all planted species increased over time, and spilled over into control plots. Community responses to management have been nuanced. Both native perennial grasses and annual bromes have increased over time, and invasive perennial grass cover is much higher in controls compared to revegetated plots. Insect communities responded initially to removal treatments, and continue to become less similar to and more diverse in removals than areas still invaded by Russian Olive. However, we have not yet detected a directional influence of revegetation on insect communities. Future research will allow us to better understand how seedbank longevity and microhabitat variation may contribute to the long-term consequences of Russian Olive management.

PARTNERSHIPS

South Ballroom
3:15-4:55

An Online Management Strategy and Case Study Platform to Facilitate Conservation and Restoration in the Southwest

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A common need identified by restoration practitioners is a forum for sharing lessons learned from both successful and unsuccessful projects. The Desert Landscape Conservation Cooperative (LCC), a bi-national, self-directed, non-regulatory regional partnership across the Mojave, Sonoran, and Chihuahuan Desert regions of the southwestern United States and northern Mexico, relies on intensive collaboration in all phases of science and conservation development to provide such partners with the tools they need to achieve shared ecological, cultural, and socioeconomic goals and objectives. With support from the USDA Southwest Regional Climate Hub, the Desert LCC and USDA Rocky Mountain Research Station are addressing this need by creating a user-friendly web portal to synthesize and catalogue on-the-ground actions that achieve identified conservation goals. This web portal is structured with a suite of management strategies, including methods to restore degraded habitat or promote resilience of habitat in good condition. Each management strategy is populated with specific real-world examples ("case studies") of adaptation, restoration, and/or mitigation actions that have worked to sustain or re-establish healthy, productive ecosystems. Case studies provided by a diverse group of collaborators describe outcomes, lessons learned and available resources (such as project reports, presentations and datasets). More importantly, the toolbox will facilitate direct communication between resource managers and practitioners with on-the-ground experience by creating a community of practice that improves the ability of managers to respond to emergent issues over time. Through the case study approach, users will be able to identify potential tradeoffs or co-benefits of various adaptation approaches and connect with experienced practitioners. This functionality will streamline the process of determining "where" and "how" management actions should be implemented to meet key conservation and restoration targets.

Dolores River Restoration Partnership: A Private and Public Collaboration

Bruce Rittenhouse[1]

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Abstract not available.

PARTNERSHIP PANEL

The Escalante River Watershed Partnership; A Study in Cooperation

Dave Bastian[1]*, Sue Fearon[2]*, and Stephanie Minnaert[3]*

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This panel will be moderated by Lindsay Murdoch with the Cross-Watershed Network. The health of the Escalante River is being threatened. It's facing an uncertain future due to invasive plants and animals and increasing human presence. However, two communities are rising to the challenge to save it in incredibly unique ways while making a difference in the lives of the local residents and youth from the region and beyond. Join a panel made up of Dave Bastian, Projects and Partnerships Coordinator with the Utah Conservation Corps (UCC), Sue Fearon, Private Lands Program Coordinator with the Grand Staircase Escalante Partners (GSEP) and Stephanie Minnaert, Public Lands Program Coordinator with GSEP, as they discuss the challenges and rewards of working with public and private land managers and a local and national workforce of conservation corps members and contractors. They will cover the journey of engaging private land owners, public lands managers, and highlight the value they've seen in matching the workforce to the project to achieve lasting outcomes.

POSTER ABSTRACTS

Posters are listed alphabetically by presenting author's first name.

Sequestration of Arsenic by Cattail in Drainage Canal

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Arsenic is a naturally occurring mineral found widely in the environment throughout the United States and other parts of the world. It is primarily found in groundwater and in certain forms (i.e. inorganic form) is considered toxic to human. This study investigates whether cattails (*T. Latifolia*) in its natural environment can absorb arsenic. Samples of surface and ground water, soil, and plant and root tissues were collected from cattails growing in a drainage canal and tested for presence of arsenic. The samples were collected during the growing and non-growing season of 2017. The drainage canal at the study location intercepts groundwater flow in addition to occasional flood runoff and intercepted irrigation drainage. The objective of the study was to determine if cattails can sequester arsenic in the drainage canals and reduce its quantity in the water before reaching the rivers. The long-term goal is to use cattails in the design of natural systems in an effort to improve water quality in urban drains, canals and ponding systems. Preliminary results of the study are presented.

Invasive Phreatophyte Removal in the Animas River Watershed: Community-based Stewardship

Amanda Kuenzi[1]

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The "Animas River Removal and Replacement of Invasive Phreatophytes" project, which became better known as "The Russian Olive Removal Project", is a collaborative effort between Mountain Studies Institute (MSI), the Southwest Conservation Corps (MSI), La Plata Open Space Conservancy (LPOSC), the Animas Watershed Partnership (AWP), and La Plata County (LPC). The goals of this project were to: improve riparian ecology and biodiversity by reducing invasive phreatophytes (primarily Russian olive, but also tamarisk) and seed sources; improve wildlife habitat; enhance recreation access; protect water quality and supply; and empower stewards and volunteers to achieve ecological restoration. Our objectives were to: build relationships with landowners who have invasive phreatophytes on their parcels in order to gain permission for treatment; create an education and tree replacement incentive program to empower ecological restoration in the region; apply integrated management to 300-350 acres to improve riparian vegetation and wildlife habitat for new treatment; and monitor/re-treat 150 acres to achieve 75% reduction or better in phreatophytes and seed sources. Treatments occurred on private property parcels within the 32-mile stretch of the Animas River corridor and floodplain between Baker's Bridge and the Colorado border with New Mexico. Treatments also extended along powerline ROW's,

irrigation ditches, and other features. Our project has been widely successful, reaching over 60 private landowners. We continue to actively work towards our goals, recognizing that a longer-term effort is needed to eradicate invasive phreatophytes and build climate resilience for the riparian woodlands and wetlands of the Animas River watershed.

Genomic Tools Reveal Hybridization, Admixture, and Differential Establishment Among Introduced Tamarisk Beetle (*Diorhabda* spp.) Source Populations

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Since 2001, six source populations of the tamarisk beetle cryptic species complex (*Diorhabda* spp.) have been introduced for biological control (biocontrol) of tamarisk (or saltcedar; *Tamarix* spp.): *D. carinata* from Uzbekistan*, D. carinulata* from China and Kazakhstan*, D. elongata* from two sites in Greece*,* and *D. sublineata* from Tunisia. As the range of introduced tamarisk beetles continues to grow in North America and impact riparian ecosystems, it is critical to understand the genome-wide factors leading to establishment and spread of this biocontrol agent. Here we present ongoing work, using novel genomic techniques, to understand how rapid evolution of tamarisk beetles might impact risk and effectiveness in tamarisk biocontrol. We used restriction site associated DNA sequencing (RADseq) to genotype over 500 beetles across both introduced and native range populations and quantified the proportion of ancestry for six genetic clusters. We show differential establishment across source populations, extensive gene flow and hybridization, and that proportions of ancestry do not necessarily reflect introduction history. We have also assembled a reference genome of *D. carinulata*. By aligning RADseq reads to this reference genome, we can begin to identify genes associated with rapid evolution of ecologically-relevant traits such as diapause, dispersal, and host-specificity behavior. Our work is generally supported by previous morphological and genetic work but also updates the distribution of hybrids in N. America, improves resolution, and empowers further inference.

VWRC: A Collaborative Approach to Improving Riparian Areas in the Verde Watershed

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The Verde Watershed Restoration Coalition (VWRC) is a multi-stakeholder group made up of federal and state agencies, private landowners, corporations, and non-profit organizations working together on a

watershed-scale initiative to manage invasive plants. The Verde River Cooperative Invasive Plant Management Plan, a five-year plan, was competed by VWRC in 2010. The plan includes not only ecological goals but also equally important social, economic and management goals.

In 2011 the plan came to life through a collaborative effort between VWRC partners led by Friends of Verde River Greenway. We hired support staff, engaged private landowners, completed mapping on three demonstration projects, formed a Steering Committee, and held an invasive plant mapping workshop.

In 2012, we formed partnerships with the Coconino Rural Environment Corps (CREC) now Arizona Conservation Corps (AZCC) and The Vetraplex. We started implementation in earnest, putting young adults and veterans to work removing invasive non-native plants from riparian areas within the Verde Watershed. Field crews focus on treating four primary woody invasive species: saltcedar (*Tamarix* spp.), giant reed (*Arundo donax*), tree of heaven (*Ailanthus altissima*), and Russian olive (*Elaeagnus angustifolia*), as well as secondary weed infestations. Since the inception of the project, field crews and VWRC partners have removed over 7,800 acres of invasive plants on over 70 miles of streamside habitat on both public and private lands. VWRC is using "lessons learned" from past seasons to inform our adaptive management process. Come visit our poster to learn more about our accomplishments and lessons learned.

Tamarisk Coalition Annual Tamarisk Beetle (*Diorhabda* spp.) Distribution Map

Ben Bloodworth[1]

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Poster represents the 2017 version of the annually produced map showing the spread and current distribution of tamarisk beetles (*Diorhabda* spp.) across North America. Four species of tamarisk beetles have been dispersing across western North America for more than a decade. This poster shows distribution and patterns of dispersal that now have beetles occupying territory from Mexico to Oregon and California to Oklahoma. This map illustrates points of known beetle distribution from 2007 to 2017 and "absence" points where no beetles were detected in 2017. Data for this poster were provided by more than 70 partners across western North America.

Habitat Mitigation at Orchard Mesa Wildlife Area

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The Grand Valley Water Users Association (GVWUA) was awarded funding under the Salinity Control Program to support the lining of 5,125 feet of the Government Highline Canal (GHC) Reach 1A Middle as part of the Basinwide Salinity Control Program for 2016-2018 winter seasons. The Salinity Control Program per the Colorado River Basin Salinity Control Act (43 U.S.C. 1571-1599), requires that this project

will need to replace incidental fish and wildlife values foregone in association with the implementation of salinity control projects. The GVWUA, in cooperation with the US Bureau of Reclamation (Reclamation), has implemented a habitat mitigation project at the Orchard Mesa Wildlife Area (OMWA) to comply with this regulation. The successful implementation of this Habitat Mitigation Plan will offset wildlife habitat loss from the GVWUA's projects (including the Canal Lining Project) by creating a total of 5.908 habitat units of mitigation as a result of this project.

The goal of this Habitat Mitigation is to assure that there is no net loss in wildlife value by improving the function and value of OMWA. Habitat replacement will be beneficial to wildlife, cost effective, viable, and manageable for the life of the project. The overall objective of this plan is the long-term eradication of noxious weeds (*Tamarix parviflora*, *Elaegnus angustifolia*, *Cardaria draba*, *Lepidium latifolium, Acroptilon repens,* and *Cirsium arvense)* in the mitigation area where noxious weeds will cover no more than 5% of the project area. A secondary objective is the native to non-native ratio of 80% native to 20% non-native cover throughout the project area. Noxious weeds are treated both mechanically and chemically.
The poster will show methods used to determine amount of habitat units needed for mitigation, methods used to evaluate the habitat mitigation success, measures to treat noxious weeds, project challenges, and examples of success after year one.

Increasing Game Fish Carrying Capacity at the Elephant Butte Reservoir

Earl Conway[1]

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The Southwest Adapt-a-Cove project at Elephant Butte Reservoir in south-central New Mexico demonstrated that it is possible to cost effectively mimic the "New Lake Effect" and increase the game fish carrying capacity of the reservoir by restoring sacrificial native vegetation to the shorelines during summer lake draw downs. If successful, the project may lead to cost saving methods to vastly improve recruitment and growth in many western reservoirs. Over 100 native plants were evaluated for their potential application. Many were very difficult to start in the harsh conditions. Research, field observations and lab experiments are continuing to shape the strategy that will be attempted in 2018 to "chase the shoreline" with innovative seeding and planting techniques. Some of the successes and failures have been documented and presented to fish biologists along with the story of three high school students that won innovation awards for their unique approach to the problem. A discovery during a field survey may also have revealed one "silver bullet" plant, the Goodding's willow that could change Elephant Butte reservoir forever. A major effort is beginning to establish thick stands of the willows in mudflats where only tamarisk were growing. The predicted low snowpack is also making it critical that the 2018 planting campaign is successful as there may not be the same opportunity for several years.

Estimating Consumptive Water Use of Saltcedar Using a Polynomial Function and Heat Units

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Consumptive water use or evapotranspiration (ET) for crops and riparian vegetation is required in the hydrologic budget of a region for water management purposes. The demand for managing water in near real-time is increasing due to scarcity of water especially in arid environments. Due to this near real-time demand, water managers and decision makers are increasingly interested in the computer based hydrologic models to provide estimates of water budget of a region. Current hydrologic models use either direct measured values or indirect calculated values that depend on meteorological data as input to the model. A methodology for estimating ET of saltcedar (*Tamarix* spp.) using a polynomial crop coefficient as a function of heat units is presented. This methodology could easily be implemented as an improvement in estimating ET of saltcedar in existing hydrologic models.

Salix Recovery after the Control of *Tamarix* across the Southwest United States

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The objective of this research was to determine if there is a correlation between the abundance of *Salix* and *Tamarix* and if it is possible to remove *Tamarix* in a way that increases the abundance of post-removal *Salix* over time. To address these questions, we analyzed vegetation data collected from more than 80 sites across the southwest from 2000 to 2014 where *Tamarix* had been removed and data was available for both before and after the removal had taken place. *Tamarix* removal was carried out using either low-intensity removal methods (chainsaw removal and chainsaw removal followed by systemic herbicide), high-intensity removal methods (heavy equipment and/or controlled burns) and/or biological control with the *Diorhabda* beetle. Most sites had the biological control present at the time of removal. To determine if *Salix* recovers after *Tamarix* removal, analyses were performed to determine if *Tamarix* removal method and/or environmental variables explained *Salix* cover in change in cover. Overall, we observed a negative correlation between *Tamarix* and *Salix* cover, and where *Tamarix* was removed using high-intensity removal methods *Salix* cover increased over time. Several environmental variables were also important for explaining *Salix* cover, including elevation and soil texture. Overall, removal method type and the presence of *Tamarix* were more significant for explaining *Salix* cover than environmental variables. Understanding *Salix* recovery in *Tamarix* restoration sites is of critical importance due to its value to wildlife, particularly endangered birds. Analyses such as these can help guide prioritization of restoration efforts and selection of *Tamarix* removal methods.

Riparian Restoration in an Urban Ecology Center

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Recent restoration efforts at the Litzsinger Road Ecology Center (LREC) have largely been shaped by anticipated municipal sewer construction that will significantly alter a large section of riparian habitat. The LREC is a thirty-four acre outdoor environmental education center for students and consists of hardwood bottomland woodland, prairie installations, and a section of Deer Creek. The flashy hydrology of the urbanized Deer Creek watershed causes intense flooding events, a high rate of lateral bank erosion, and an accelerated compressing and meandering of the channel downstream. Restoration efforts have been focused on reestablishing an herbaceous and grassy understory in the section of woodland that is actively used for educational programs. The unmanaged section of woodland where construction will be clear-cutting is currently dominated by the invasive bush honeysuckle, *Lonicera mackii* and a groundcover of invasive wintercreeper, *Euonymus fortuneii*. Ecological monitoring is conducted to measure restoration progress and also to serve as baseline data for future comparisons post-construction. This includes half-meter quadrat grid monitoring of herbaceous species, tree and shrub surveying, erosion monitoring, and water quality monitoring. Current restoration management is based on anticipated disturbance from construction and invasive plant species, how to continue erosion mitigation, and native plant establishment.

Using the Yellow-billed Cuckoo as an Umbrella Species to Inform Riparian Restoration in the Southwest

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Umbrella species can be an informative tool to guide restoration actions in that restoring and conserving habitat for an umbrella species indirectly protects other species (animals and plants) that comprise the ecological community. As an umbrella species, the Yellow-billed Cuckoo can guide decisions regarding riparian restoration such as prioritization and selection of locations for restoration, determining minimum size of restoration areas and reserves, and determining the vegetation composition, structure, and processes needed to restore healthy riparian ecosystems of the Southwest. We identified Yellow-billed Cuckoo breeding habitat requirements using cuckoo presence and absence data, aerial photos and satellite imagery, logistic regression, and a hierarchical modeling approach. These models identified several key features associated with Yellow-billed Cuckoo breeding habitat at multiple spatial scales: (1) a 4.5 ha core area of dense cottonwood-willow vegetation, (2) a large (72 ha) native, heterogeneously-dense forest around the core area, (3) limited tamarisk cover within the 72 ha patch around the core area, and (4) moderately rough topography. The odds of Yellow-billed Cuckoo occurrence decreased rapidly as the amount of tamarisk cover increased or when cottonwood-willow vegetation decreased. These results contrast with models for Southwestern Willow Flycatcher habitat in that the cuckoo's modeled minimum patch size of 72 ha is 16-fold greater than the flycatcher's, and larger than estimates

of minimum patch sizes for most riparian obligate birds. We propose that, given the cuckoo's need for large patches of riparian habitat dominated by native cottonwood-willow cover, the Yellow-billed Cuckoo is an optimal umbrella species for assessing riparian restoration target conditions. We provide recommendations for restoring Yellow-billed Cuckoo habitat and concomitantly providing quality habitat for other members of the riparian community.

Green Earthen Embankments for Controlling Soil Erosion

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Protection of earthen embankments from erosion in the arid regions where water is scarce has been a challenge. Soils of embankments, for example in the southern parts of New Mexico, are often sandy and are vulnerable to erosion from wind and water. While these earthen embankments can be protected by gravel and rocks, the cost of material and labor is high and often are not aesthetically pleasing; and using grasses would require irrigation. This study investigated the use of hardy ice plants (*Delosperma cooperi*) on an earth embankment. These ice plants are heat and drought tolerant, require less water to grow, and aesthetically pleasing because of their bluish color and carpet of high color flowers. They also provide nectar for the insects and water, which is stored in their stems, for the birds. The study started in September 2017 at Reinventing Nation's Urban Water Infrastructure (ReNUWIt) Test-Bed site, Sunland Park, New Mexico and is in progress. Preliminary results are presented.

Site Conditions over the Long Term: Collaborating to Evaluate Vegetation Changes, Beetle Activity and Current Conditions in Southeast Utah

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Abstract not available.

Successful Riparian Restoration in Southwest Colorado through Connecting Conservation Collaboratives

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Successful conservation projects are often the result of strong partnerships between several entities, including non-profits, private landowners, and state and federal agencies. Bird Conservancy of the Rockies (BCR) is a non-profit whose efforts connecting conservation collaboratives have led to several

successful riparian restoration projects in southwest Colorado. Partners in these projects include the Southwest Wetland Focus Area Committee, Colorado Parks and Wildlife (CPW), Natural Resources Conservation Service (NRCS), private landowners, Watershed Partnerships, and many others. BCR's Private Lands Wildlife Biologists are unique partner positions based out of NRCS offices. These positions connect conservation organizations through restoration projects that utilize Farm Bill program funding and other specialized state grants. Projects range from riparian area fencing to streambank stabilization and revegetation. These collaborations foster a diversity of restoration knowledge which allows for utilization of a variety of restoration techniques as well as the ability to compare the successes of different techniques. Conservation organizations are also connected through small funding programs that BCR manages. BCR offers mini-grants through CPW that help fund landowner workshops, student mentorship, and education and outreach events. This unique way of connecting conservation collaboratives allows for diverse funding options, increased restoration success, and community engagement.

Leveraging Low-Cost Technologies in UAS, GIS, and IoT to Achieve Greater Conservation Impacts

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Conservation projects are often limited by small budgets and resources, which requires managers to choose either a concentrated effort in a small area (i.e. reach scale) or small projects spread throughout larger areas (i.e. several reaches or watershed). Datasets often required are aerial imagery, digital elevation models (DEMs), digital surface models (DSMs), vegetation mapping and indices, and water quality. Collecting new datasets is often cost prohibitive (e.g. aerial imagery, LiDAR, or water quality analysis). Alternatively, projects often have access to freely available datasets; however, these are often low-quality, low-quantity, incomplete, or represent past conditions that are no longer relevant.
Recent advances in new, low-cost technologies offer new opportunities to collect unprecedented data and process into valuable information. On the reach scale, UAS, or drones, provide opportunities to capture low-cost orthoimagery, which can generate vegetation species maps, DEMs, and DSMs if conducted properly. On the basin scale, new and low-cost technologies in the Internet of Things (IoT), such as water quality sensors deployed within basins and equipped with cloud communication, can send valuable real-time data. When coupled with geographic information systems (GIS), these data can be quickly imported, process raw data, and generate maps of valuable information that can inform both GIS experts and non-experts.

These challenges and opportunities have been pursued by the nonprofit WorldWater.Today. Our mission is to mobilize researchers, technologies, and unique funding to achieve the greatest water conservation impacts. This presentation will demonstrate the use of: i) UAS and Structure-from-Motion, which provides a low-cost method to produce high quality DEMs of river environments; ii) low-cost water quality instruments (sondes) that are equipped with GPS and capable of sending real time data; and iii) ArcGIS portal, which provides a user friendly, web-based GIS portal that can receive and process raw real-time data into valuable information for river managers.

River Hydraulics, Morphology, and Vegetation: New Research into Maximizing a River's Potential to Remove Invasive Vegetation and Recent Achievements in Modeling Vegetation Removal

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The interdisciplinary knowledge and ability for river managers to effectively predict flood risks, restore rivers, and assess future alterations are currently restricted to the limited understanding of how river hydraulics, morphology, and vegetation alter a river's planform, effect sediment mobility, and control the surrounding habitats.

Recent research using vegetated flume experiments of braided rivers has investigated how slight alterations and manipulations to channel bifurcation and avulsion can significantly increase morphologic changes and vegetation removal. In terms of conservation, we seek minimal intervention with maximum benefit, and these results have demonstrated that small flood events with slight manipulations can have similar morphologic and vegetation removal responses as large flood events. Such findings need further research, but may be a viable approach for vegetation removal and reconnecting degraded floodplains. Additional research used these flume experiments data, and investigated the numerical model Delf3D's ability to predict hydraulics, morphology, and vegetation interactions. Results showed that the model's hydraulics performed well, while the morphology (including bank erosion) was mediocre under short simulation durations (i.e. single flood events). However, while the vegetation inclusion provided representative hydraulic results, the vegetation presence was static and had negative feedback to local morphology. Specifically, no amount of erosion or shear stress could remove the vegetation, which made the morphology excessively stable under flood conditions. Assessment of the observed flume experiments revealed that bank erosion was the dominant mechanism for vegetation removal. Therefore, to improve the model, a simple updating code was developed that removed vegetation in areas of bank erosion. Results of the added functionality showed that this dynamic vegetation updating improved the model's ability to represent river hydraulics, morphology, and vegetation interactions.

Mapping, Monitoring, and Future Management for Biological Control of Tamarisk in the Arkansas River Basin (2008-2017)

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The Colorado Department of Agriculture has been releasing and monitoring the establishment of tamarisk beetles in the Arkansas River basin of eastern Colorado for nine years as of 2017. The CDA, Insectary, began collecting northern tamarisk beetles (*Diorhabda carinulata*) from populations in western CO for release in eastern CO beginning in 2008. In 2009 the CDA and collaborators set up two monitoring sites in eastern CO. By 2011, well established beetle populations were observed along multiple tributaries of the Arkansas River near Pueblo, CO. More tamarisk monitoring sites were set up in 2012, 2013, 2014, and 2015. Currently the CDA Insectary monitors eight sites in the Arkansas River basin. As of 2013 monitored sites near Pueblo and Walsenburg had undergone mass defoliations over consecutive years. In 2014, tamarisk beetle abundances and damage increased across sites with major tamarisk infestations at

John Martin and Adobe Creek reservoirs. In 2014, beetles were collected and moved within eastern CO for the first time in the history of the project. Despite large scale establishment and tamarisk damage measured in 2014, beetles decreased across sites in 2015. In 2016 through 2017 we measured further decreases. Although many regions of the Arkansas River basin had yet to have beetle establishment and subsequent defoliation by 2014, regions which were defoliated over consecutive years were not expected to show such significant declines in beetle abundances over the past three years. Here, we present maps of the regions where beetles had established and defoliated tamarisk in eastern CO. We look at climate variations in these regions and propose other factors that may be contributing to declining beetle abundances along with future strategies for success and monitoring plans in 2018.

Hydrologic and Vegetative Response to Meadow Restoration and Upslope Harvest in a Montane Meadow

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Montane meadows play a key role in the physical and biological processes of coniferous forests in the western United States. Meadows in the Sierra Nevada and Cascades face a myriad of threats including: overgrazing, habitat degradation associated with recreation, fire prevention/regime alteration, and habitat fluctuations tied to climate change. In some western regions, nearly half of all meadow habitat has been lost due to conifer encroachment, the invasion of conifers into a meadow biotic community. The goal of this research is to quantify and compare the hydrologic response before and after encroached conifer removal and upslope forest thinning on two meadows in the Sierra Nevada: the Marian Meadow and the Control Meadow. A post-restoration goal is to quantify the results of revegetation plots on the research site (Marian Meadow) by analyzing establishment success rates of three different meadow seed species. The analysis includes revegetation techniques, species' wetland status, and water table elevations. A before after control intervention (BACI) study design is used to determine the response of the Marian Meadow to upslope forest thinning and encroached conifer removal. The Control meadow was not altered during the study periods. A water budget is used to quantify the hydrology of the meadows which incorporates volumetric soil moisture, groundwater table elevation, evapotranspiration, and snowmelt. Electrical resistivity method (ERT) is used to characterize the sub-surface environment for specific points during the study, therefore increasing spatial interpretation of soil and groundwater. Standard least squared regression is used to test changes in groundwater depth, soil moisture content, and total moisture content between the research site and control site meadows. The removal of conifers from an encroached meadow appears to promote soil moisture and water table depth conditions indicative of a meadow and meadow plant community types.

Comparing Habitat and Avian Species Response to Biocontrol and Mechanical/Chemical Control of Invasive Woody Vegetation in Socorro County, NM

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The introduction and proliferation of tamarisk leaf beetle (*Diorhabda* spp.) [TLB] for the biological control of tamarisk (*Tamarix* spp.) since 2001 has initiated landscape-scale compositional shifts in riparian vegetation communities and altered habitat conditions, however little is known regarding if and how the TLB may impact restoration projects. It has been assumed TLB defoliation may render post-treatment mechanical or chemical treatments unnecessary, however such presumptions may erroneously characterize successional processes after TLB defoliation events.

Exotic vegetation such as tamarisk is a common nesting substrate and major habitat component for the federally endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (flycatcher) and threatened Yellow-billed Cuckoo (Coccyzus americanus). The biocontrol of tamarisk may result in a reduction of habitat and population decline for the flycatcher and/or cuckoo. Moreover, reductions in tamarisk vegetative cover may cause increases in Russian olive (*Elaeagnus angustifolia*) abundance and additional management problems.

In 2018, the Socorro Valley Wildfire Hazard Mitigation Project (Project), a large-scale (1300-acre) mechanical and herbicide control project targeting tamarisk and Russian olive along the eastern floodplain of the Rio Grande near Socorro, New Mexico, will be implemented. The removal of non-native vegetation provides an opportunity to examine vegetation recovery as it relates to species structure and composition. Vegetation, avian and TLB data was collected during the 2017 growing season at 30 selected locations within the Project. Preliminary data is presented to understand baseline pre-treatment conditions and provide a reference to examine post-treatment patterns and dynamics related to vegetation composition and structure, and associated habitat conditions. The study will document and analyze system responses related to riparian habitat structure and plant community alterations, as well as resulting changes to avian species richness and composition within these stands. The ongoing monitoring of riparian systems altered by TLB is critical to understand impacts to vegetation and the avian community.

Establishing Vegetation for Riparian Rehabilitation Using Solar Powered Irrigation Pump

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Growing plants for rehabilitation purposes in riparian areas of arid environments where groundwater is deeper than 10ft without irrigation is challenging. Methods that apply deep planting for trees under these

groundwater tables are not very successful and planting of grasses or bushes is even impossible. While water from the rivers, streams or canals could be available and in the vicinity of the rehabilitation area, conventional pumping of water to irrigate the plants require pumps that use electricity, diesel, gasoline or propane. Electricity is often not available in these remote areas and pumps that use fossil fuels require regular operation and maintenance, and are not environment-friendly. This project investigated the use of solar pump to irrigate plants with minimum amount of water so they can establish in an area where depth to groundwater is deeper than 10 ft. Solar irrigation system design for the riparian rehabilitation project at the Re-inventing Nation's Urban Infrastructure (ReNUWIt) Test-Bed is presented.

Using Beaver Dam Analogs and Post-Assisted Log Structures to Restore Instream Channel Complexity on the Lower San Rafael River, Utah

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The lower San Rafael River is currently characterized by low geomorphic complexity, poor riparian condition and a highly altered flow regime. These conditions threaten the persistence of three native fishes, the flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*Catostomus discobolus*) and roundtail chub (*Gila robusta*). Previous work has indicated that low physical complexity, especially a lack of pool habitat, is a limiting factor for all three species. As part of a larger restoration effort that includes tamarisk removal and native riparian species plantings, we implemented a pilot restoration project that relied on 'cheap and cheerful' woody restoration structures, including beaver dam analogs and post-assisted log structures to initiate processes that increase physical complexity. Our results suggest that restoration structures increased complexity, as measured by changes in topography and consequently water depth, at the scale of individual structures. Primary instream responses to structures included the creation of scour pools, mid-channel and lateral bars and bank erosion. By altering local hydraulics, restoration structures also caused grain sorting and exposed gravels within a channel dominated by a sand substrate. We believe the results from our pilot treatment provide sufficient justification for continued restoration along the lower San Rafael River. More importantly our experience highlights the importance of ongoing and long-term monitoring of restoration projects in order to more effectively learn from and address widespread stream degradation in different environments at different spatial scales. In addition to our initial geomorphic results, we provide recommendations for future management and monitoring actions, as well as present possible future pathways of channel change on the lower San Rafael River.

Application of Open Source Data in USFS Riparian Areas Inventory Mapping

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Riparian areas are dynamic, transitional ecotones between aquatic and terrestrial ecosystems with well-defined vegetation and soil characteristics. Riparian areas are a small percentage of our managed landscape (<1%) and provide irreplaceable values. Two staff areas at the USDA Forest Service have coordinated on a two phase project to support the National Forest in their forest planning revision efforts and rangelands riparian business needs at the Forest Plan and allotment management levels. The newly developed Riparian Buffer Delineation Model (RBDM) v5.x utilizes open source data such as US Geological Survey (USGS) streams/water gauges/digital elevation models data, Fish & Wildlife Service (FWS) wetlands data, Natural Resources Conservation Service (NRCS) soil data and National Agricultural Statistical Service (NASS) land cover data. This approach recognizes the dynamic and transitional natures of riparian areas by accounting for hydrologic, geomorphic and vegetation data as inputs. Results from phase one would suggest incorporating functional variable width riparian mapping within watershed management planning to improve protection and restoration of riparian functionality and biodiversity.

THANK YOU FOR JOINING US!

Tamarisk Coalition staff and Board of Directors would like to thank everyone involved with the 2018 Riparian Restoration Conference.

The success of this conference is the result of the presenters and exhibitors who take the time to share their experience, knowledge, and resources with the restoration community; the sponsors, whose generous support helps us keep registration affordable; and the participants, whose consistent support and passion toward successfully achieving riparian restoration goals keeps this conference viable year after year.

We look forward to seeing you again at our 2019 conference next February at the Desert Botanical Garden in Phoenix, Arizona scheduled for February 5-7, 2019. Visit our website for more details as they become available: www.tamariskcoalition.org.

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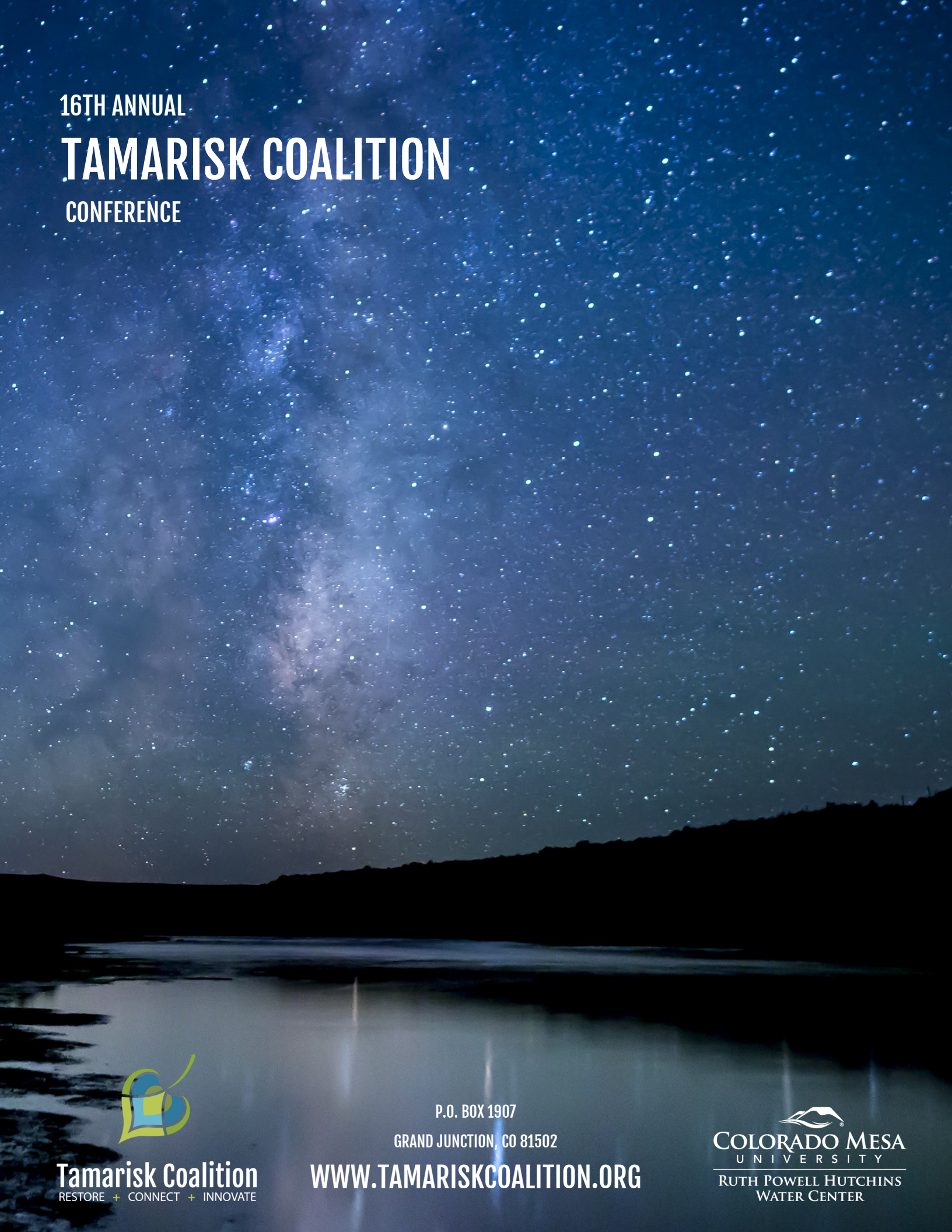

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