

10TH ANNUAL

*Santa Cruz*   
**RIVER**  
RESEARCH DAYS



EVENT PROCEEDINGS  
AND ABSTRACTS

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**OCTOBER 30 – OCTOBER 31, 2018**

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Pima Community College  
Desert Vista Campus, Community Room  
5901 S. Calle Santa Cruz, Tucson, Arizona 85709



SONORAN  
INSTITUTE

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## Introduction

The tenth annual Santa Cruz River Research Days took place on October 30 and 31, 2018. This event is an opportunity for those conducting monitoring, research, restoration or other conservation efforts, focused on environmental or cultural resources along the Santa Cruz River, to share their work and findings through presentations and posters. In honor of this anniversary, this year included a special session to collaboratively identify priority research topics for the next 5 years along the river. This was followed by a field trip to the Midvale Park Floodplain Restoration Project. The following is a brief proceedings of the event, including abstracts of the papers and posters presented.

Proceedings and pdf copies of the presentations and posters from this year and past events can be found at [www.tiny.cc/SCRRD\\_Archive](http://www.tiny.cc/SCRRD_Archive). Other information about this annual event can be found at the Sonoran Institute website [www.sonoraninstitute.org](http://www.sonoraninstitute.org), use the site's search tool by entering "Research Days".

## ***Event Steering Committee***

This year's planning committee included the following individuals and organizations:

Sherry Sass, *Friends of the Santa Cruz River*  
Roger Anyon, *Pima County*  
Cannon Daughtrey, *Pima County*  
Claire Zugmeyer, *Sonoran Institute*  
Amanda Smith, *Sonoran Institute*  
Pat O'Brien, *Southwest Center*  
Forrest Sherman, *SW Arid Grassland Ecology*  
Roger Dorr, *Tumacácori National Historical Park*  
Michael Bogan, *University of Arizona*

## Program

### Tuesday, October 30, 2018

8:30–9:00 am	Sign-in and Refreshments
9:00–9:20 am	<b>Welcome</b>
9:20–9:40 am	Amanda Smith – Sonoran Institute <a href="#"><u><i>The Many Benefits of Effluent in the Santa Cruz River: A Collaborative Water Management Tool</i></u></a>
9:40–10:00 am	Evan Canfield - Pima County Regional Flood Control District <a href="#"><u><i>Valuing the Ecosystem Services of the Effluent-Dependent Santa Cruz River in Pima County</i></u></a>
10:00–10:20 am	Alexandra Stoicof – Wheat Design Group <a href="#"><u><i>El Rio Preserve: Ecological Rehabilitation and Community Connection</i></u></a>
<b>10:20–10:50 am</b>	<b>BREAK</b>
10:50–11:10 am	Hamdhani – University of Arizona <a href="#"><u><i>Dynamics of Water Quality in an Effluent-dominated Reach of the Santa Cruz River, AZ</i></u></a>
11:10–11:30 am	Drew Eppheimer – University of Arizona <a href="#"><u><i>Aquatic Macroinvertebrates of the Lower Santa Cruz River</i></u></a>
11:30–11:50 pm	Kelsey Hollien – University of Arizona <a href="#"><u><i>Implications of Using Treated Wastewater as Habitat for Desert Fishes</i></u></a>
11:50–12:10 pm	Michael Bogan – University of Arizona <a href="#"><u><i>Dragonflies and Damselflies of the Lower Santa Cruz River: Brilliant Biodiversity and Opportunities for Community Engagement</i></u></a>
<b>12:10–1:20 pm</b>	<b>BREAK FOR LUNCH (bring your own)</b>
1:20–1:40 pm	David Quanrud – University of Arizona <a href="#"><u><i>Occurrence, Fate, and Relevance of Emerging Contaminants in the Upper Santa Cruz River at Tumacácori National Historical Park</i></u></a>
1:40–2:00 pm	David Walker – University of Arizona <a href="#"><u><i>Mixture Toxicology of Persistent Organic Pollutants in the Santa Cruz River: Past Research and An Unknown Future</i></u></a>
2:00–2:20 pm	Austin B. Smith - Arizona Game and Fish Department <a href="#"><u><i>Mapping and Quantifying Xeroriparian Across the Arid Deserts</i></u></a>
2:20–2:40 pm	Charles C. Hofer – Arizona Game and Fish Department <a href="#"><u><i>Starting From (Almost) Scratch: Protecting Riparian Habitat in Pinal County</i></u></a>
<b>2:40–3:10 pm</b>	<b>BREAK</b>
3:10–3:30 pm	Elia Tapia - University of Arizona <a href="#"><u><i>Assessing the Long-term Impact of Climate Uncertainties and Binational Land and Water Management Decisions on the Transboundary Santa Cruz Aquifer</i></u></a>
3:30–3:50 pm	Mark Bultman - U.S. Geological Survey <a href="#"><u><i>A Three-dimensional Hydrogeologic Model of the Upper Santa Cruz Basin, Arizona</i></u></a>
3:50–4:10 pm	Olga Hart - Arizona Department of Water Resources <a href="#"><u><i>Expansion of ADWR Modeling and Field Efforts to Develop a Groundwater Flow Model of the Potrero Canyon Area</i></u></a>

4:10–4:20 pm | Evan Canfield – Pima County Regional Flood Control District  
[A \*Multibenefit Channel Modification Project Downstream of Cortaro\*](#)

### Wednesday, October 31, 2018

8:30–9:00 am | Sign-in and Refreshments

#### [INDENTIFYING PRIORITY RESEARCH TOPICS FOR THE NEXT 5 YEARS](#)

Moderated by: Dr. Philip Stoker, University of Arizona, College of Architecture, Planning and Landscape Architecture

9:00–9:15 am | Amanda Smith, Sonoran Institute  
*Introduction and Assessment Results*

9:15–9:45 am | PANEL 1 – NOGALES TO TUBAC  
**Bob Love**, Tumacácori National Historical Park, *Superintendent*  
**Guillermo Valencia**, Greater Nogales and Santa Cruz County Port Authority, *Chairman*  
**Ben Lomeli**, Friends of the Santa Cruz River, *Board member, Hydrologist*  
*Q&A – 15 minutes*

9:50–10:20 am | PANEL 2 – TUBAC TO TOHONO O’ODHAM NATION, SAN XAVIER DISTRICT  
**Sally Pablo**, Tohono O'odham Nation, San Xavier District, *Natural Resources Supervisor*  
**Connie Williams**, Anza Trail Coalition, *Secretary*  
**Laurinda Oswald**, Amado Landowner, *Rancher*  
*Q&A – 15 minutes*

10:25–11:00 am | PANEL 3 – TUCSON TO MARANA  
**Mead Mier**, Pima Association of Governments, *Sustainability Coordinator*  
**Alice Templeton**, Barker Contracting, Inc., *Business Development Director*  
**Jim Conroy**, Town of Marana Parks and Recreation, *Director*  
**John Kmiec**, Marana Water, *Director*  
*Q&A – 15 minutes*

11:00–11:45 am | **Speed Date a Panelist -- Semi-Structured Networking**

11:45–12:00 pm | **Closing Statements and Final Voting on Priorities**

12:00–1:00 pm | **BREAK FOR LUNCH (bring your own)**

1:00–1:15 pm | **FIELD TRIP - Travel Independently to nearby restoration site**

1:15–3:00 pm | [Guided Tour of Midvale Restoration Project](#)

### Poster Presentations (both days)

Sonoran Institute | [Living River: Charting Wetland Conditions of the Lower Santa Cruz River Years  
Pima County 2013-2015](#)

## Meeting Impact and Evaluation Results

We evaluate Santa Cruz River Research Days to do two things – 1) try to assess and track the impact of this annual gathering on conservation efforts, and 2) get feedback from meeting participants to help with planning of future events.

### Quick Summary Measures

OVERALL ATTENDANCE – approximately 100 attendees over the course of 2 days.

UNIQUE AFFILIATIONS – attendees listed 47 different organizations, groups, agencies, university departments, local government, state/federal government, and community members as their affiliation.

### Evaluation Results

Total evaluations received - 30

Of these thirty evaluations:

- Each affiliation option was selected at least once. Options included local government, state/federal government, organization, university, community group, interested individual, and other. Other responses included – San Xavier District and educator.
- Twelve were completed by attendees who attended/participated in both days.

What days did you attend?

Day 1 AM	Day 1 PM	Day 2 AM	Field Trip
22	18	15	3

### QUESTION 1 – What did you find most valuable or interesting in the conference?

Study results
Research studies
The panel discussions on the second day. It was interesting hearing from a variety of individuals with different perspectives on the river.
Updates on University of Arizona studies of Santa Cruz--invertebrates, fish. El Rio Preserve was unknown to me, so I was happy to learn about that area also.
Great mix of presentation topics!
I enjoyed both the presentation and the field trip.
Talks were all high caliber
As always, the networking opportunities relevant to the Santa Cruz River
The dire sewer conditions at the border and the apparent apathy of every government agency to come together to resolve it.
Great scientific presentations.
Collaboration
Diversity of presentations
Research questions
Networking
Seeing what research and development is happening.

Interesting presentations about the Santa Cruz River. Networking. Would have liked to see a few more presentations focusing on early history.
Panel discussions
Helpful information
Many of the presentations - excellent
The vast number of participants
Both the research talks (day 1) and panel discussion on day 2. Amazing to hear similar themes on entire river - great geographic grouping
The people
Greatly appreciated the diversity of different professionals who are collaborating on river projects and solutions to various river challenges.

**QUESTION 2 - Facility**

**Was the space comfortable?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
28	0	2

COMMENTS -

Yes, but would be crowded if turnout increases in future...
Very
Good size for the number of people. Double screens great with speaker in the middle.
A bit confined
Very good

**Could you hear the presentations?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
28	1	1

COMMENTS -

For most part, yes. The microphone setup was suboptimal. If possible, use of wearable microphone would reduce inconsistencies in sound quality among speakers.
Mostly
Never let a person say they can be heard without a microphone. They always wind down.
Thanks for using mics
Microphone failed at times

**Was parking easy?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
27	0	3



**Other comments about the venue?**

I miss the culinary program catering.
Overall, a great event--thanks for all your work organizing it! I had a bit difficulty finding the room. Some additional large signs outside pointing the route, posted around the building, would be very helpful. Also, the angle between screens and podium made it somewhat challenging as a presenter to see the screen, but it worked out OK.
As a speaker, it was difficult to indicate to the audience things to see on the presentation slides. The podium was so far forward, I could not see my slides well. Also, with two screens one side of the audience gets left out when you need to refer to the screen.
Easy to get to from the freeway. Comfortable, good viewing screens.
Perfect, Thanks
Great venue
Good, I was only here from 2:30-4:30
Odd artifact of two screens, one presenter used his laser pointer on only one screen - not viewable from right side of room
Great location, I live off I-19. South end of Tucson is very convenient.
Pima Community College staff helped me find it, they were great!
No computer screen for presenter.
Would have liked the lunch option at the cafeteria like in the past.
Good snacks!
Good room, presenters had a hard time seeing the screen
Geographically well located
Missed the cafeteria this year
Great venue!

**QUESTION 3- Day 1 Comments**

**Were the presentations useful and interesting?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
28	0	2

COMMENTS -

Nice mix of academic work and on the ground projects.
All were good
A good variety of perspectives
Though the more technical areas were outside of my background
More slanted toward the lower Santa Cruz River
Very good information
Most were great

**Was 20 min the right amount of time for each presentation?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
27	1	0

COMMENTS -

Longer time by 5 minutes would help allow for questions.
Would like more upshot and implications
Long enough to communicate key info, not so long that I could not stand less interesting presentations/presenters.
Maybe 15 minutes
Perfect for going into more detail without getting bored

**Other Comments about Day 1**

Last year had some archaeological and early Tucson history. That reminder of human reliance on the water being the reason Tucson exists is a good single talk attitude adjustment.
More balance between upper and lower Santa Cruz River
"Handouts" would be good.

**QUESTION 4 – Day 2 Comments**

**Were morning presentations useful and interesting?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
18	0	12

COMMENTS -

Day 2 moved into more economic benefits and hazards touched upon in the multi-layer mapping discussed on day 1. A key point is that the Loop introduces a symbiotic relationship in preserving the rivers and washes. Access allows recreational pathways for residents to see and then learn to admire the flood channels and wish to see the return of water flowing. The Loop could be a destination attraction. So far it seems win-win. Hope that continues to be so.
The presentation on upper Santa Cruz River including the Nogales International Outfall Interceptor should be followed and a continued topic.
Very interesting and useful to hear all the different perspectives and issues.
Didn't know how these sessions would go, but ended up being great discussions.
Excellent to hear from different parts of the watershed.

**Was the field trip useful/interesting?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
4	0	26

**QUESTION 5 – New Collaboration**

Research Days is designed as a forum for learning. However, we hope this can galvanize new projects and collaborations, and help avoid duplication. The next questions are helping us see if we are meeting this goal.

**Do you know of any new project or collaboration that has arisen in part due to networking that has occurred at Research Days?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
10	11	9

COMMENTS –

I shared with Mead Mier a program started in Durham NC to greatly reduce the use of styrofoam take-out food containers, replacing them with community shared recycled containers. The program is ready to expand to other cities. Downtown Tucson is a great test bed locally.
Michael Bogan, dragonflies
Potential with Austin Smith, mapping riparian corridors
Cost estimates idea for Loop restoration connection to Regional Transportation Authority - contacts made with researchers; homeless mapping/e.coli: University of Arizona connection to Pima Association of Governments made Community Water Coalition connection to Cienega Watershed Partnership reinitiated.
Diana Hadley, A-mountain landfill conversion/restoration to a beneficial use.
Wash in Ambos Nogales was new to me and very important
Learned that there's a new Tubac Community Nature Center in Tubac - opportunities for partnerships with Tumacácori National Historical Park
Groundwater, Climate and Stakeholder Engagement (GCASE) program, University of Arizona and Water Resources Research Center
I'm certain it will for me by next year.
Connection with Pima County regarding some cultural resource work.

**QUESTION 6 – Next Year**

**What do you want to see at next year's conference? Any suggestions or special requests in terms of format, programming etc?**

COMMENTS –

More about Santa Cruz that is in Mexico.
More of the same
I thought the format was excellent and liked the three-panel approach to the sections of Santa Cruz River.
Similar updates especially. Tucson Water's Heritage Project
Include an education panel or presentation
Yes - Have a conference next year! Are there any studies presented in the past that have more results/conclusions since their first presentation?
Identify positive (or other) trends in the health of the watershed
Keep doing panel discussions

Much more awareness of the public policy/solutions to create change opportunities
No suggestions for improvement other than a more structured lunch for increased interaction, but understand the limits from

**Do you prefer having SCRRD during the spring or fall? Previous years have been in the spring, this is the first time we're experimenting with the fall season.**

<u>Spring</u>	<u>Fall</u>	<u>No Preference</u>	<u>No answer</u>
3	7	14	6

**Additional Meeting Feedback**

Thanks
Great job to organizers. Kudos to Bombole too.
Good location between upper and lower Santa Cruz River
Excellent organization (progressive) of presentations, esp. during the 2nd half of morning one. Thanks for all your work, re: putting this together. I respect and appreciate the behind the scenes work of conference coordination. And, all the work the presenters have done, in the field, the lab and at their computers. Thank goodness for this forum for sharing information. An awesomely stimulating day. Thank you!
I'm active in research and education about the effects of open pit mining on the Santa Cruz. I think this would be a good topic to explore - although it generates some controversy - long term implications to the sustainability of the watershed
Thanks!
Thank you so much for bringing us all together!
A screen/laptop at the podium
You did a great job keeping to the schedule. I appreciated the Q&A after each presentation
Thanks for coffee and snacks
Is it possible to provide a list of the "resource" people who participated? To what extent are they available for follow up questions?
Longer time for speed dating, unstructured interaction

## Identifying Research Priorities for the Next Five Years

A Sonoran Institute survey, circulated in the summer of 2018, asked decision-makers, community leaders, and members of research institutions to identify research priorities and to share the factors that influence project selection. Preliminary results were shared in a presentation that introduced a series of panels moderated by Dr. Philip Stoker from the University of Arizona, College of Architecture, Planning, and Landscape Architecture. Community leaders from Nogales to Marana were invited to discuss research projects they feel would be necessary to advance their work along the Santa Cruz River. Following panel discussions, there was a semi-structured “speed date a panelist” to introduce these leaders to researchers and community experts.

A range of current and on-going research topics were generated from the survey and discussion. Research Days participants voted on a list of fifteen research topics. Priority topics and specific research questions discussed will be summarized in a collaborative research agenda that Sonoran Institute will release early in 2019.

### Community Leaders Participating in the Priority Research Panels

#### PANEL 1 – NOGALES TO TUBAC

**Bob Love**, Tumacácori National Historical Park, *Superintendent*

**Guillermo Valencia**, Greater Nogales and Santa Cruz County Port Authority, *Chairman*

**Ben Lomeli**, Friends of the Santa Cruz River, *Board member, Hydrologist*

#### PANEL 2 – TUBAC TO TOHONO O’ODHAM NATION, SAN XAVIER DISTRICT

**Sally Pablo**, Tohono O’odham Nation, San Xavier District, *Natural Resources Supervisor \**

**Connie Williams**, Anza Trail Coalition, *Secretary*

**Laurinda Oswald**, Amado Landowner, *Rancher*

#### PANEL 3 – TUCSON TO MARANA

**Mead Mier**, Pima Association of Governments, *Sustainability Coordinator*

**Alice Templeton**, Barker Contracting, Inc., *Business Development Director*

**Jim Conroy**, Town of Marana Parks and Recreation, *Director*

**John Kmiec**, Marana Water, *Director*

*\*unable to attend*



## Field Trip: Midvale Park Floodplain Restoration Project

Following the special session on October 31<sup>st</sup>, Trevor Hare, Watershed Management Group, and Kieran Sikdar, Holistic Engineering and Land Management, provided an overview of the project site, progress to date, and how goats are being used to control non-native invasive plant species. The goats were present to demonstrate their contribution to site management. About twenty attendees joined the tour.



## Oral Presentations - Submitted Abstracts

(Listed in program order)

### ***The Many Benefits of Effluent in the Santa Cruz River: A Collaborative Water Management Tool***

***AMANDA SMITH | Sonoran Institute***

Angela Melendez | Sonoran Institute

The Santa Cruz River is thriving once again! Effluent is the sole reason the river has year-round flows, but this water supply is not guaranteed to stay in the river. As the quality of effluent has improved, and other sources of water become scarcer, there is increased pressure to direct effluent outside the river channel for other uses or to store it for our long-term water supply.

To make the case for securing water for the river, we need to understand the value that a flowing river brings to the community. Once we measure the river's values and the opportunities we have to enhance them, we can better understand the tradeoffs of different water management decisions. The goal of this report is to help stakeholder assess the full range of opportunities for investing effluent in the river.

We will also need to work together. Collaboration on water management is essential for reaching the best outcome, yet in practice it can be quite complex. The differing management roles and responsibilities of the many organizations interested in the Santa Cruz River make it challenging to find the right balance. How might a change in the way one organization manages the Santa Cruz River impact a different organization's goals? Are there ways to coordinate management of our river to create an ideal scenario that meets everyone's interests?

This assessment addresses both of those needs. We collaboratively identified what should be maintained and enhanced along the river corridor, while recognizing what areas might benefit from new water releases. With this information, stakeholders can be more aware of the full range of opportunities for using effluent to invest in the Santa Cruz River that would enhance our collective values. The tool can help water managers to identify mutually benefitting arrangements and to understand trade-offs within the scope of their organizations work as well as the work of others.

### ***Valuing the Ecosystem Services of the Effluent-Dependent Santa Cruz River in Pima County***

***EVAN CANFIELD | Pima County Regional Flood Control District***

John Shepard | Sonoran Institute

Maya Kocian | Earth Economics

Using a benefit transfer concept, where ecosystem services are assigned based on land cover, the effluent-dependent Santa Cruz is estimated to provide more than \$32 mil/yr in ecosystem services, such as improved water quality, flood mitigation, climate regulation and habitat. A two-foot grid land cover map provided the basis for the valuation, assigning spatial values to water, trees/shrubs, irrigated land, and desert/grassland/shrub classes. Valuations for each cover class were derived from Earth Economics Ecosystem

Services Valuation database for comparable cover classes evaluated elsewhere. The study provided an awareness level evaluation, which can be further refined. The study identified gaps in the analysis and provided recommendations for how the evaluation can be refined, and how the ecosystem services valuation process can be used to weigh alternatives for the Santa Cruz River Management Plan – Grant to Trico currently being implemented by the Pima County Regional Flood Control District. The presentation will make time for soliciting audience considerations and insights to the ecosystem valuation process.

### ***El Rio Preserve: Ecological Rehabilitation and Community Connection***

***ALEXANDRA STOICOF | Wheat Design Group***

On the west bank of the Santa Cruz River in the Town of Marana, El Rio Preserve is a rich riparian landscape and critical linkage to our regional ecology. Over 238 species of birds have been recorded at El Rio. These habitats in the Southwest are increasingly important in supporting more breeding birds than all other Western habitats combined.

Apart from its ecological significance, El Rio Preserve is also a valued community asset. An extensive survey conducted on El Rio revealed that the community's top priority was "riparian rehabilitation," followed by "environmental education." The Preserve's location between residential neighborhoods, along the Loop Trail, and adjacent to a neighborhood park and future disc golf course makes it an important component to the local recreational network.

Recent efforts by the Town of Marana in collaboration with local design and engineering firms are leveraging these unique community aspects of El Rio towards ecological rehabilitation. One considered approach was limited human access in effort to best protect the fragile ecosystem. During the design process, we recognized how valuable community commitment is to nature preservation and have instead pursued this approach. It is proven that as people become connected to a place, their level of ownership increases which leads to advocacy and stewardship. As we reconnect El Rio with the community and transform the landscape into a multi-use destination for nature activities, we are advocating for healthy lifestyles and healthy ecosystems.

Recent initiatives are translating years of ideas and advocacy into concrete actions. A pollinator garden was installed at the trailhead and a non-profit "Friends of El Rio" ambassador group is underway. The design team has submitted plans for three phases that begin with an initial trailhead and interpretive area and eventually will lead to a more extensive network of trails.

### ***Dynamics of Water Quality in an Effluent-dominated Reach of the Santa Cruz River, AZ***

***HAMDHANI | School of Natural Resources and the Environment, University of Arizona***

Drew Eppheimer | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

In Arizona, the Santa Cruz River system is one of several river systems that have experienced groundwater drops and loss of perennial flow due to groundwater pumping and drought. Along with Gila River and Salt River, the Santa Cruz River currently has artificial, perennial reaches that are supported by effluent discharge from wastewater treatment plants. The return of perennial reaches has brought back habitat for numerous of aquatic



and riparian taxa. However, since these reaches are artificially supported by effluent they no longer have a natural flow regime or natural water quality gradients. Little research has been conducted on the water quality gradients along these perennial effluent-dominated reaches. The objective of this study is to quantify physical and chemical water quality gradients downstream from the effluent outfall. Beginning in August 2017, we have collected water quality data (e.g. DO, pH, conductivity, nutrient levels) monthly from six reaches spaced ~2 miles apart along the effluent-dominated lower Santa Cruz River, and will continue to do so through 2019. Additionally, we will expand our study to include other effluent-dominated reaches of Santa Cruz, Salt, and Gila rivers, as well as reference streams unaffected by effluent input. The findings of this study will help us understand how effluent can be used to restore perennial river habitats in arid climates.

### ***Aquatic Macroinvertebrates of the Lower Santa Cruz River***

***DREW EPPEHIMER | School of Natural Resources and the Environment, University of Arizona***

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Kelsey Hollien | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

In arid climates, increasing water use has resulted in the loss of surface water resources. For example, much of the Santa Cruz River in southern Arizona lost perennial flow in the mid-1900s due to extensive groundwater pumping. However, portions of the river have been artificially reborn through effluent discharge from wastewater treatment plants. This effluent discharge has created aquatic habitat, but it is not known how taxa have responded to the artificial flow regime and water quality dynamics. We collect monthly samples along the lower Santa Cruz River at six reaches near Tucson, AZ. This monthly collection includes benthic multihabitat and drift net sampling and has uncovered a surprisingly diverse community yielding >100 aquatic macroinvertebrate species within the effluent-dominated lower Santa Cruz River. Our sampling has also revealed the presence of microplastics (such as micro beads from personal care products) in this treated wastewater. As urban development continues, discharge of effluent into rivers and streams will become more common. Continued research is needed to determine the viability of treated wastewater to augment or replace natural flows and to incorporate ecosystem services into effluent management.

### ***Implications of Using Treated Wastewater as Habitat for Desert Fishes***

***KELSEY HOLLIEN | School of Natural Resources and the Environment, University of Arizona***

Drew Eppehimer | School of Natural Resources and the Environment, University of Arizona

Zach Nemec | School of Natural Resources and the Environment, University of Arizona

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Larissa Lee | School of Natural Resources and the Environment, University of Arizona

David Quanrud | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

Discharge of treated wastewater and upgrades to water reclamation facilities have been instrumental in returning aquatic biodiversity and riparian habitat to the previously dry Santa Cruz River. The endangered Gila topminnow has recently recolonized the effluent-dependent reaches of the river, but the long-term health effects of living in effluent and the potential for these fish to persist in effluent reaches are unknown. Using non-

native Western Mosquitofish in the lower Santa Cruz River as a proxy for native topminnow, we explore the challenges of living in effluent-dependent streams, including (1) fluctuating water levels, (2) the potential for microplastics to impact diet, and (3) the effects of emerging contaminants on sexual maturation. Diurnal fluctuations in discharge of effluent create daily drying events in the lower reaches of the river, which can result in the stranding and death of fish. Furthermore, in drift samples we have found microplastic concentrations as high as 5.56 particles/m<sup>3</sup>. However, in our diet analysis on a subset of 200 mosquitofish, we only documented one ingested plastic microfiber. Among the expected prey items that occur in the water column, such as midge larvae, we have also found taxa such as aquatic snails, which suggest some benthic foraging by mosquitofish. Finally, our preliminary analysis has revealed a sex ratio heavily biased towards females (10.1:1), which is higher than ratios from published studies of natural systems (4.4:1). We hypothesize this pattern could be due to estrogen compounds, which can be common in effluent-dominated systems, inhibiting the sexual maturation of males. Faced with increasing population growth and uncertainties of climate change, effluent-dominated systems will become increasingly important sources of aquatic habitat, but further studies are needed to assess their ability to support native fish.

### ***Dragonflies and Damselflies of the Lower Santa Cruz River: Brilliant Biodiversity and Opportunities for Community Engagement***

***MICHAEL BOGAN*** | *School of Natural Resources and the Environment, University of Arizona*

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Drew Eppheimer | School of Natural Resources and the Environment, University of Arizona

One of the most diverse groups of aquatic invertebrates in the effluent-supported lower Santa Cruz River is the Odonata, which includes dragonflies and damselflies. Their larval life stages are aquatic and the colorful adults hunt insect prey, seek shelter, and mate in riparian areas. In this presentation, we will (1) summarize what is known about odonate diversity along the lower Santa Cruz, (2) discuss the potential of these species to draw people to the river, and (3) explore ideas for community science projects focusing on dragonflies and damselflies. We surveyed for adult and larval odonates at 10 sites along the lower Santa Cruz from April 2017 to July 2018. We gathered additional records from regional taxonomic experts (Rich Ballowitz, Doug Danforth, and Pierre Deviche) as well as photo-verified records from iNaturalist (348 observations from 36 observers). In total, 40 species of dragonflies and damselflies are currently documented from the lower Santa Cruz, which represents 42% of species known from the entire Santa Cruz basin and 29% of species known from the state of Arizona. Thirty-five of those species occur in the effluent-supported riverine reaches, with an additional five species known from Sweetwater Wetlands but not the river. Several of the most abundant species are also among the most colorful of all odonates, including the Roseate Skimmer, Mexican Amberwing, Flame Skimmer, and American Rubyspot. These beautiful taxa, and the ease of seeing them, could draw people to the river in much the same way colorful birds draw people to other locales in southern Arizona. Developing community science monitoring projects, utilizing iNaturalist or other platforms, could help connect local residents to the river and provide important phenological and species diversity data to improve management of effluent-supported habitats in the lower Santa Cruz River.

## ***Occurrence, fate, and relevance of emerging contaminants in the Upper Santa Cruz River at Tumacácori National Historical Park***

***DAVID QUANRUD*** | *School of Natural Resources and the Environment, University of Arizona,*

Finnian Freeling | TZW Technologiezentrum Wasser, Karlsruhe, Germany

Pharmaceuticals and personal care products (PPCPs), pesticides, and other trace organics, sometimes collectively referred to as “contaminants of emerging concern” (CECs) are found in heavily impacted as well as relatively pristine environments and are of potential concern to ecosystems and human health. The National Park Service (NPS) has an interest in assessing the significance and potential risk of CECs in the effluent-dependent Santa Cruz River at Tumacácori National Historical Park (TUMA). Toward that end, NPS has collected samples for CEC analysis since 2011 at TUMA and at other locations within the Upper Santa Cruz watershed. This study examined occurrence, transport, and ecological relevance of a variety of CECs in the Upper Santa Cruz River. Samples were analyzed by the USEPA Region 8 Laboratory or by the USGS National Water Quality Laboratory. Considering all 38 grab samples collected from the river at TUMA during 2011-2015, 106 CECs were detected, including PPCPs, pesticides, and other “wastewater indicator” compounds typically present in effluent. Samples collected near the outfall of the Nogales International Wastewater Treatment Plant, located 16 km upstream of the park, suggest that effluent is the main source of CECs in the river at TUMA. For most of the detected compounds, concentrations decreased considerably between the effluent outfall and the park, indicating that natural attenuation processes act to reduce potential detrimental effects of CECs to the watershed. However, 16 CECs were identified as posing potential risk to aquatic organisms at TUMA, based on comparisons between measured concentrations and predicted no-effect concentrations. Fifty-eight CECs were detected in riverbed sediments at TUMA, including pesticides, pesticide metabolites, flame retardants, and others. Two CECs in sediment were identified as posing potential ecological risk.

## ***Mixture Toxicology of Persistent Organic Pollutants in the Santa Cruz River: Past Research and An Unknown Future***

***DAVID WALKER*** | *University of Arizona*

Few studies have been done of the physiological effects water from the Santa Cruz River below wastewater treatment plant (WWTP) outfalls has on organismal and human health. One study done prior to WWTP upgrades showed a vast array of persistent organic pollutants (POPs) causing extensive hormonal dysregulation in native fish species (Walker, 2008). Dysregulation could not be assigned to a specific pollutant and was likely the result of a mixture of POPs found in the river at the time. WWTP upgrades have significantly reduced the amount of nutrients and conventional pollutants in treated effluent, especially ammonia levels. However, nutrient removal processes do not necessarily remove POPs from treated effluent to levels lower than those needed to exert physiological harm. Jia et al. (2016) examined levels of glucocorticoids from treated effluent samples taken from three WWTPs near Tucson and one from Los Angeles, California. Samples of treated effluent collected from the Agua Nueva and Ina Road WWTPs had dexamethasone equivalent/L (Dex-EQ) levels of 60-70 ng/L. Glucocorticoid (GC) concentrations of 0.1-1.0 µg/L in vertebrates can increase plasma glucose concentration and the related gene expression (PEPCK), increase the serum concentrations of free amino acids, and may cause androgenization or feminization of fish. GCs crosstalk with neuroendocrine pathways and could affect xenobiotic metabolism related toxicity. GCs have also been shown to suppress aryl hydrocarbon (AhR) receptors in human

cells. Recent evidence suggests sex ratios in Gila topminnow in the river downstream of WWTPs are highly skewed toward females (10.1:1 f/m) compared to other rivers (pers. comm Drew Eppheimer, UA). Mixture toxicology of POPs, many of which are not regulated by the EPA, in the Santa Cruz River, to wildlife and humans, is currently unknown. Making this determination will require in vivo and in vitro testing which, as of yet, has not been done.

### ***Mapping and Quantifying Xeroriparian Across the Arid Deserts***

***AUSTIN B. SMITH | Arizona Game and Fish Department***

In the arid Southwest, riparian habitat supports nearly 80 percent of wildlife. Specifically in Arizona, about 60 percent of over 800 wildlife species depend on this rare habitat type. These important riparian areas occupy less than two percent of total land in the Southwest, and only 0.4 percent in Arizona. Amongst the riparian habitat is a lesser known concept of riparian communities called desert riparian, or xeroriparian. Xeroriparian persists with excess local rainfall, creating short infrequent surface water floods (usually for only a few hours each year), and providing a greater availability of water for luxuriant vegetation growth. This vegetation growth is vital to wildlife movement corridors, avifauna breeding and nesting sites, and predator protection, respectively. As urban sprawl continues across the arid deserts, landscape disturbances and fragmentation will be a greater risk to this riparian habitat.

The Arizona Game and Fish Department (Department), along with an array of partners, are undertaking the task to map and quantify riparian areas across Arizona. Due to the diversity of the landscape, it is important to ensure that the uniqueness of the different riparian communities is represented, not to be shadowed by a “one model fits all” approach. The Department partnered with Oblate Affects to map and quantify not only xeroriparian, but mesic- and hydroriparian across the arid deserts. In preliminary results for a sample area within Pinal County, AZ, the Oblate Affects’s model (n = 1830 acres) exemplifies a 970 percent increase in quantifiable riparian habitat over the current Department’s State Wildlife Action Plan riparian layer (n = 171 acres). These results illustrate ambitious progression for this model to leverage a greater approach for quantifying riparian areas. In addition to viewing the progress of mapping riparian habitat, this presentation will provide insight to the development of a multi-agency/citizen science mobile data collection application to inventory riparian communities.

### ***Starting From (Almost) Scratch: Protecting Riparian Habitat in Pinal County***

***CHARLES C. HOFER | Arizona Game and Fish Department and Pinal County***

Pinal County is the fastest growing county in Arizona with a population that has more than quadrupled since 1990. These rapidly changing landscapes threaten the open spaces and rural character that make the County unique. Some of these habitats most at risk are fragile riparian areas and wildlife corridors found throughout the County. Although Pinal County does not currently have robust riparian habitat tools in place, the County is now laying the groundwork through a collaborative effort with the Arizona Game and Fish Department and local NGOs. The goal of these efforts is to provide tools for planners, developers, and the general public to identify, classify, and help protect these vital and vanishing habitats. As the County continues to grow, integrating these tools into planning and development processes will help ensure the functionality of riparian areas and help

maintain connectivity between open spaces, while setting the stage for more effective County-wide habitat conservation measures in the future.

### ***Assessing the Long-term Impact of Climate Uncertainties and Binational Land and Water Management Decisions on the Transboundary Santa Cruz Aquifer***

***ELIA TAPIA*** | *University of Arizona, Water Resources Research Center*

Eylon Shamir | Hydrologic Research Center

Current and future Santa Cruz River discharge is an increasing concern for water managers in the United States (U.S.) and Mexico. Population growth and changes in land use have led to increased groundwater demand in the Transboundary Santa Cruz Aquifer (TSCA). These human activities, coupled with climate uncertainties, influence the hydrology of the Santa Cruz River basin and the Santa Cruz Aquifer. This research demonstrates the use of a Water Budget Model as a tool for assessing the long-term impact of climate uncertainties and human activities on the water balance. The study area comprises a portion of the TSCB that is located between the Nogales International Wastewater Treatment Plant (NIWTP) and the northern boundary of the Santa Cruz Active Management Area (SC-AMA). Different scenarios of Santa Cruz River natural flows and the releases of treated effluent from NIWTP are introduced to depict changes associated with climate uncertainties and land and water management decisions. This research will improve the available knowledge of the hydrologic conditions of the TSCA on how natural and anthropogenic variables affect water sustainability. The produced information will assist decision-making processes related to land and water resources in the area and provide relevant information for the formulation of the Assured Water Supply Rules in the SC-AMA.

### ***A Three-dimensional Hydrogeologic Model of the Upper Santa Cruz basin, Arizona***

***MARK W. BULTMAN*** | *U.S. Geological Survey*

William R. Page | U.S. Geological Survey

Data from recently published U.S. Geological Survey reports on the geology, hydrogeology, and basin bedrock morphology of the Upper Santa Cruz basin have been integrated to produce a three-dimensional (3D) hydrogeologic model of the basin. The three major hydrogeologic units of the Upper Santa Cruz basin are: a lower basement confining unit consisting of Jurassic, Cretaceous, and Tertiary (Paleocene and Oligocene) rocks; a middle unit composed entirely of the Miocene Nogales Formation; and an upper unit consisting of late Miocene to Holocene surficial deposits. The location and geometry of the units and their bounding faults in the model are based on geologic mapping, cross sections, and geophysical interpretations. Faults concealed by basin sediments are identified based on magnetic and gravity gradients, conductivity-depth transforms (CDTs) derived from time-domain electromagnetic data, and geologic interpretations. These interpretations resulted in identification of the range-front faults along the Mount Benedict horst block, the estimated locations of fault-controlled canyons west of Mount Benedict, the edges of buried lava flows, and numerous concealed faults and contacts. The CDTs also helped to delineate a region of elevated bedrock and potential claystone aquitards in the Nogales Formation that may control the Potrero Canyon wetlands, located near the confluence of the canyon with Nogales Wash. Analyses of the CDT's combined with other geophysical data suggests a deep basin northeast of the intersection of Arizona State Highway 82 and the Santa Cruz River, referred to as the Highway 82 microbasin. These 3D model hydrogeologic units and faults define the geometry, structure, and thickness of

the aquifer system that provides water to Nogales, Arizona and surrounding communities. The 3D model was released with a viewer that anyone with access to a Microsoft Windows based computer can use to load, view, and study the model interactively in three dimensions.

### ***Expansion of ADWR Modeling and Field Efforts to Develop a Groundwater Flow Model of the Potrero Canyon Area***

***OLGA HART*** | *Arizona Department of Water Resources*

Keith Nelson | Arizona Department of Water Resources

The Arizona Department of Water Resources is working to develop a new, more complete groundwater model of the Santa Cruz Active Management Area (AMA). The new model will improve our scientific understanding of the basin, particularly in areas previously lacking coverage, and facilitate more informed management of the Santa Cruz AMA.

In this talk, we highlight recent progress made to expand the SCAMA model boundary into the Potrero (Nogales) sub-basin. Although attempts had been made over the years to model the area, the hydraulic connection between the local, locally semi-confined aquifer at Potrero and the regional unconfined aquifer is complex and remained insufficiently understood. In October 2017, ADWR began constructing a local groundwater flow model to test alternative conceptual models and calibrate aquifer properties and boundary conditions. Historic head and flow observations were supplemented by several new field work efforts, the results from which were incorporated into model development, testing, and calibration. Although the Potrero model is only an interim step towards ADWR's new AMA-wide model, various alternative conceptual models (ACMs) were evaluated. These ACMs were used to explore plausible answers to the following four questions:

1. Does an aquitard exist in the model domain, and if so, how extensively?
2. Do faults play a role in defining flow patterns in the study area? Do they serve to inhibit or promote flow? Do they contribute to significant anisotropy in hydraulic conductivities?
3. What contributes to perennial surface discharge near the Las Lagunas de Anza wetlands, despite nearby pumping and riparian evapotranspiration? Does groundwater seepage occur from below, or is the area fed by lateral/surface recharge along Nogales Wash and Potrero Creek?
4. From where does the majority of groundwater inflow to the sub-basin originate? What is the relative contribution of underflow from the south compared to that of mountainfront recharge in the west?

We will discuss interim interpretations and the integration of results from recent field activities initiated by ADWR, and several recently-completed and ongoing USGS studies.

### ***A Multibenefit Channel Modification Project Downstream of Cortaro***

***EVAN CANFIELD*** | *Pima County Regional Flood Control District*

James DuBois | Pima County Regional Wastewater Reclamation Department

Effluent has a tendency to flow against the soil cement bank protection, which can compromise its structural stability requiring expensive repairs. At Cortaro Rd, the effluent passed from the west soil cement bank, under the bridge to the soil cement east bank resulting in hazards to both banks. In June, 2018, the Pima County Regional Flood Control District modified the channel to permanently move flows away from the east bank to the center of the channel, while also increasing the flow area by distributing flows down three paths. The result to date has been increased infiltration, and a wider riparian corridor. While the flow path to the east has been cut off from effluent flow, it still receives water in storm events. This presentation will describe the modifications, note the changes in flow volumes downstream of the project, and describe the improvement in the riparian corridor. As a modification to flow that improves recharge of the effluent, the project can be considered 'constructed' under state statutes, thus doubling the recharge credits for the reach. The improved infrastructure protection, riparian corridor and recharge credits indicate that this project could be a template for additional projects in the corridor.

## Poster Presentations - Submitted Abstracts

### ***Living River: Charting Wetland Conditions of the Lower Santa Cruz River***

***CLAIRE ZUGMEYER*** | *Sonoran Institute*

Amanda Smith | Sonoran Institute

Evan Canfield | Pima County Regional Flood Control District

James Dubois | Pima County Regional Wastewater Reclamation Department

Anna Martin | Pima County Regional Wastewater Reclamation Department

Julia Fonseca | Pima County Office of Sustainability and Conservation

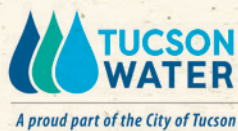
Brian Powell | Pima County Office of Sustainability and Conservation

Wendy Burroughs | Pima County Natural Resources Parks and Recreation

Throughout Arizona the release of effluent is maintaining flows of many river reaches. Along the Santa Cruz River in Pima County, two major regional facilities release effluent into the river, created a stretch of the river with year-round flow from Northwest Tucson to Marana. These two facilities underwent significant upgrades in 2013. The release of higher-quality water is a key ingredient in supporting wetland health along the river, but how can we gauge conditions of this valuable ecosystem and community amenity? Pima County and Sonoran Institute partnered to develop an annual Living River report series to track and communicate wetland conditions. Modeled on the reports Sonoran Institute pioneered in 2008 for the river near Nogales, these reports document annual change to gain insight into the river's wetland health. Five annual reports have been published, four since the upgrade, which document improved wetland health by examining changes in 16 environmental indicators along a 23-mile stretch of the river. Notable findings include: improved river water quality; improved aquatic habitat, including the return of the endangered Gila topminnow and other fish; and sustained aquifer recharge at about 36,600 acre-feet per year, nearly double the pre-upgrade rate, despite an 8% reduction in volume of water released to the river. This report series won the 2018 National Environmental Achievement Award for Public Information & Education from the National Association of Clean Water Agencies and is a 2018 finalist for the Common Ground Award, an annual award organized by Metropolitan Pima Alliance.



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# SCRRD 2018 Proceeding

*by* Hamdhani Hamdhani

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## ***Dynamics of Water Quality in an Effluent-dominated Reach of the Santa Cruz River, AZ***

**HAMDHANI** | *School of Natural Resources and the Environment, University of Arizona*

Drew Eppheimer | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

In Arizona, the Santa Cruz River system is one of several river systems that have experienced groundwater drop and loss of perennial flow due to groundwater pumping and drought. Along with Gila River and Salt River, the Santa Cruz River currently has artificial, perennial reaches that are supported by effluent discharge from wastewater treatment plants. The return of perennial reaches has brought back habitat for numerous of aquatic and riparian taxa. However, since these reaches are artificially supported by effluent they no longer have a natural flow regime or natural water quality gradients. Little research has been conducted on the water quality gradients along these perennial effluent-dominated reaches. The objective of this study is to quantify physical and chemical water quality gradients downstream from the effluent outfall. Beginning in August 2017, we have collected water quality data (e.g. DO, pH, conductivity, nutrient levels) monthly from six reaches spaced ~2 miles apart along the effluent-dominated lower Santa Cruz River, and will continue to do so through 2019. Additionally, we will expand our study to include other effluent-dominated reaches of Santa Cruz, Salt, and Gila rivers, as well as reference streams unaffected by effluent input. The findings of this study will help us understand how effluent can be used to restore perennial river habitats in arid climates.

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## ***Aquatic Macroinvertebrates of the Lower Santa Cruz River***

**DREW EPPEHIMER** | *School of Natural Resources and the Environment, University of Arizona*

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Kelsey Hollien | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

In arid climates, increasing water use has resulted in the loss of surface water resources. For example, much of the Santa Cruz River in southern Arizona lost perennial flow in the mid-1900s due to extensive groundwater pumping. However, portions of the river have been artificially reborn through effluent discharge from wastewater treatment plants. This effluent discharge has created aquatic habitat, but it is not known how taxa have responded to the artificial flow regime and water quality dynamics. We collect monthly samples along the lower Santa Cruz River at six reaches near Tucson, AZ. This monthly collection includes benthic multihabitat and drift net sampling and has uncovered a surprisingly diverse community yielding >100 aquatic macroinvertebrate species within the effluent-dominated lower Santa Cruz River. Our sampling has also revealed the presence of microplastics (such as micro beads from personal care products) in this treated wastewater. As urban development continues, discharge of effluent into rivers and streams will become more common. Continued research is needed to determine the viability of treated wastewater to augment or replace natural flows and to incorporate ecosystem services into effluent management.

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## ***Implications of Using Treated Wastewater as Habitat for Desert Fishes***

***KELSEY HOLLIEN | School of Natural Resources and the Environment, University of Arizona***

Drew Eppheimer | School of Natural Resources and the Environment, University of Arizona

Zach Nemec | School of Natural Resources and the Environment, University of Arizona

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Larissa Lee | School of Natural Resources and the Environment, University of Arizona

David Quanrud | School of Natural Resources and the Environment, University of Arizona

Michael Bogan | School of Natural Resources and the Environment, University of Arizona

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### ***Opportunities for Community Engagement***

***MICHAEL BOGAN | School of Natural Resources and the Environment, University of Arizona***

Hamdhani | School of Natural Resources and the Environment, University of Arizona

Drew Eppheimer | School of Natural Resources and the Environment, University of Arizona

One of the most diverse groups of aquatic invertebrates in the effluent-supported lower Santa Cruz River is the Odonata, which includes dragonflies and damselflies. Their larval life stages are aquatic and the colorful adults hunt insect prey, seek shelter, and mate in riparian areas. In this presentation, we will (1) summarize what is known about odonate diversity along the lower Santa Cruz, (2) discuss the potential of these species to draw people to the river, and (3) explore ideas for community science projects focusing on dragonflies and damselflies. We surveyed for adult and larval odonates at 10 sites along the lower Santa Cruz from April 2017 to July 2018. We gathered additional records from regional taxonomic experts (Rich Bailowitz, Doug Danforth, and Pierre Deviche) as well as photo-verified records

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