

Santa Cruz 
RIVER
RESEARCH DAYS



EVENT PROCEEDINGS
AND ABSTRACTS

MARCH 25 – MARCH 26, 2021

Zoom Virtual Event



SONORAN
INSTITUTE

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Introduction

The 2021 Santa Cruz River Research Days took place virtually on March 25 and 26, 2021. 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. This year included a special session focused on the theme of capital improvements along the river and two virtual field trips. The following is a brief proceedings of the event, including abstracts of the topics presented.

Proceedings and pdf copies of the presentations from this year and past events can be found at www.tiny.cc/SCRRD_Archive. Other information about this annual event can be found at the Sonoran Institute website 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:

Ben Lomeli, *Friends of the Santa Cruz River*

Cannon Daughtrey, *Pima County*

Luke Cole, *Sonoran Institute*

Claire Zugmeyer, *Sonoran Institute*

Roger Dorr, *Tumacácori National Historical Park*

Michael Bogan, *University of Arizona*

Program

Thursday, March 25, 2021

9:50	Zoom meeting opens
10:00 a.m.	Welcome Luke Cole and Claire Zugmeyer, Sonoran Institute <i><u>A Living River—Charting Santa Cruz River Conditions</u></i>
10:20 a.m.	Dawn Rocha, Tonto National Forest Tribal Monitor Program/Westland Resources Daniel McNair, Westland Resources <i><u>Culturally important riparian trees in southern Arizona: a behind-the-scenes look at ethnobotanical collaboration and research methods</u></i>
10:40 a.m.	Pablo Rocha, School of Natural Resources and the Environment, University of Arizona <i><u>Bird community structure within three distinct reaches of the lower Santa Cruz River</u></i>
11:00 a.m.	Michael Bogan, School of Natural Resources and the Environment, University of Arizona <i><u>Patterns of dragonfly diversity and recolonization along the effluent-dependent Santa Cruz River</u></i>
11:20 a.m.	BREAK
11:30 a.m.	Ian Murray, Pima County Office of Sustainability and Conservation <i><u>Gila topminnow expansion into the effluent Santa Cruz River highlights the importance of ‘managed’ waters for native fish conservation in southern Arizona</u></i>
11:50 a.m.	Eleonora Demaria, Pima County Regional Flood Control District <i><u>Using effluent water to preserve the Gila Topminnow habitat in the Santa Cruz River</u></i>
12:10 p.m.	Drew Eppehimer, School of Natural Resources and the Environment, University of Arizona <i><u>Lower Santa Cruz River flow intermittence: discharge fluctuations, stream drying, and fish death</u></i>
12:30 p.m.	BREAK
1:00 p.m.	Virtual Tour—New Southern Arizona Heritage & Visitor Center
Special Session—Inspiring New Work	
1:20 p.m.	Jared Renaud, College of Architecture, Planning and Landscape Architecture, University of Arizona <i><u>Santa Cruz Food Sources: Regional Plant Education for a More Sustainable Future</u></i>
1:30 p.m.	Angelantonio Enriquez Breault, Ironwood Tree Experience <i><u>Reconciliación en El Rio / Reconciliation on the River</u></i>
1:40 p.m.	Luke Cole, Sonoran Institute <i><u>A low-tech method to quantify trash in the Santa Cruz River and identify its sources</u></i>
1:50 p.m.	Carolyn Shafer, Town of Patagonia Flood and Flow Committee <i><u>The Sonoita Creek Watershed</u></i>
2:00 p.m.	Lee Ann Woolery, Citizen Artist™ <i><u>Citizen Artist™ a new participatory science research opportunity to study the Santa Cruz River</u></i>

2:10 p.m.	Ricardo Santos Hernández, Visual artist, protector of the Santa Cruz River <u>Bi-National Santa Cruz River Río Compartido/Shared River Exhibition</u>
2:20 p.m.	BREAK
2:30 p.m.	James G. Brown, Pima County Regional Wastewater Reclamation Department <u>PFAS in Biosolids: A Southern Arizona Case Study</u>
2:50 p.m.	Kelsey Hollien, School of Natural Resources and the Environment, University of Arizona <u>Microplastic pollution in the effluent-dependent lower Santa Cruz River during baseflow and post-flood conditions</u>
3:10 p.m.	Hamdhani, School of Natural Resources and the Environment, University of Arizona <u>Seasonal and longitudinal water quality dynamics in three effluent-dependent rivers in Arizona</u>
3:30 p.m.	Chat with Presenters Happy Hour
4:30 p.m.	End of Day 1

Friday, March 26, 2021

9:50	Zoom meeting opens
THE INFRASTRUCTURE OF A RESILIENT RIVER	
10:00 a.m.	Welcome
10:10 a.m.	Evan Canfield, Pima County Regional Flood Control District <u>Identifying Projects to Improve the Santa Cruz River Northwest of Tucson</u>
10:30 a.m.	Scott Altherr, CMG Drainage <u>The Multiple Uses of a Modeled Terrain in the Lower Santa Cruz River</u>
10:50 a.m.	Evan Canfield, Pima County Regional Flood Control District Kevin Payne, Kimley-Horn Will Wilhelm, Kimley-Horn <u>Santa Cruz River Corazon Reach Stream Restoration</u>
11:10 a.m.	BREAK
11:20 a.m.	Kevin Payne, Kimley-Horn John Spiker, Town of Oro Valley (formerly Pima County Regional Flood Control District) <u>El Corazon Bank Protection and River Park</u>
11:40 a.m.	Maya Teyechea and Dick Thompson, Tucson Water <u>Santa Cruz River Heritage Managed Recharge Project at 18 months</u>
12:00 p.m.	BREAK
12:30 p.m.	Virtual Tour—El Rio Preserve Bank Protection
12:50 p.m.	Luke Cole, Sonoran Institute <u>Survey results from resident engagement for the Pima County Santa Cruz River Management Plan</u>
1:10 p.m.	Kendall Kroesen, Mission Garden <u>Competing Visions for Capital Investment on the Tucson Reach</u>
1:30 p.m.	Francisco Lara-Valencia, Arizona State University <u>Borderless solutions for a bordered river: Green infrastructure in Ambos Nogales</u>
1:50 p.m.	Panel Discussion

2:20 p.m.	BREAK
2:30 p.m.	Elia M. Tapia Villaseñor, Universidad de Sonora <i><u>A Water Balance Model for the Santa Cruz River Aquifer in Mexico</u></i>
2:50 p.m.	Jennifer G. Duan, Department of Civil Engineering and Engineering Mechanics, University of Arizona <i><u>Incorporating Climate Change on Flood Magnitude and Frequency Analysis in the Upper Santa Cruz River</u></i>
3:10 p.m.	Eve Halper, Reclamation Phoenix Area Office <i><u>Projected Changes to the Lower Santa Cruz River Hydroclimate – Results of Collaborative Study between the Bureau of Reclamation and Local Partners</u></i>
3:30 p.m.	Justin Clark, Olga Hart, and Dianne Yunker, Arizona Department of Water Resources <i><u>ADWR Groundwater Modeling in the Santa Cruz River Basin: International Boundary to Picacho Peak</u></i>
3:50 p.m.	Chat with Presenters Happy Hour
4:30 p.m.	Thank you for staying till the end!

Virtual Happy Hours: Chat With The Presenters

At the conclusion of each day—and in lieu of in-person happy hours—presenters and attendees had an open-format discussion about topics discussed during Research Days. Here we present a summary of topics discussed at the end of each day.

Day 1

Artistic research: Lee Ann Woolery led a discussion on the value of artistic research in the study of ecological concepts. The conversation touched on pairing artistic research with “standard” research to create a holistic assessment of ecological quality. Interested parties were encouraged to contact Lee Ann to discuss or participate in her research.

Conservation Effluent Pool: earlier in the day, Pima County’s Eleanora Demaria broke the news that a Conservation Effluent Pool (CEP) allotment had been awarded to Pima County. This CEP allotment will ensure that the flows between the Agua Nueva and Tres Rios wastewater reclamation facilities remains uninterrupted using high-quality effluent. Discussions explored the sources, application, and access of CEP water.

Species mobility and ecosystem revitalization: we continue to see new, often native species establishing populations in the new Tucson Water Heritage Project reach in downtown Tucson. But where did those species come from? This conversation explored where the early-arriving riparian species—like dragonflies—could have originated and how less-mobile species—like fish—come to inhabit the Santa Cruz.

Day 2

Green Infrastructure—design from unlikely sources: In his presentation on Green Infrastructure, Francisco Lara noted that schoolchildren in *Ambos Nogales* were invited to envision what a green community would look like. Where possible, these visions were incorporated into final designs. A hearty conversation followed where panelists and attendees discussed opportunities for community input on infrastructure design and use.

Heritage Project Part 2: during the infrastructure panel, Tucson Water shared a preliminary plan for an upstream extension of the downtown Tucson Heritage Project reach. Using the reclaimed water from the Tucson Airport Remediation Project (TARP), the city is exploring where and when to introduce new flows into the Santa Cruz River.

— —

We thank all attendees and participants who were able to lend their time and thoughts at the conclusion of each day. When we return to our in-person format, we look forward to raising a glass with you, thinking big, and celebrating our jewel in the desert—the Santa Cruz River.

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 – the highest interest yet in this event with over 200 people registering and 158 people who attended one or both days (Day 1 – 126, Day 2 – 114, both days – 88). During registration process, people were asked about their topic of interest. Ecology was most popular with 78% of attendees selecting this choice. Cultural and Engineering were close seconds at 17% and 16% respectively. A small number, 5%, selected “Other”, and the remaining 15% didn’t answer this question.

As our first virtual conference with real-time interpretation provided – we could provide greater participation from a broad geography. Most attendees (78%) were from a city in the Santa Cruz River Watershed (66% in Tucson). Around 22% of attendees were from outside of the watershed, of which 10% were joining from Mexico. The virtual format allowed people to join from as far away as Hawaii, Philadelphia, and Indonesia! Unfortunately, it does not appear like we had attendees from Nogales, Sonora. More extensive outreach will be needed to boost participation from the Mexico portion of the watershed.

UNIQUE AFFILIATIONS – We didn’t collect affiliation with registration. However, a poll done on the morning of March 26 indicated that we had the following categories represented:

Nonprofit/Las organizaciones sin ánimo de lucro	9	16%
Federal government/Gobierno federal	7	12%
Interested individual/Persona interesada	17	30%
Local government/Gobierno local	15	26%
Community group/Grupo de la comunidad	3	5%
Academic/Académico	5	9%
State government/Gobierno estatal	1	2%

Evaluation Results

Total evaluations received - 42

Of these 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 – consultant and retired engineer.
- Twenty-three were completed by attendees who attended/participated in both days.
- Twenty-six were completed by first-time attendees.

What days did you attend?

Day 1 AM	Day 1 PM	Day 2 AM	Day 2 PM
29	30	29	27

What did you find most valuable or interesting in the conference?

It was really wonderful to hear about the variety of projects that are taking place in our watershed, and learn about volunteer opportunities to support the work that is going on.
All of the program that I was able to watch was of interest.
Wildlife and wetlands restoration and diversity of species returning as habitat is restored!
Presentations
I found just about everything valuable. I found it interesting how many different research projects are working in tandem to create a better environment for both the natural world but also the one we carve out for ourselves.
Loved the translation, and the breadth and quality of topics covered. The breadth and imagination of the SCRRD is one of my favorite parts of this conference each year. Kudos!
The mexican connections... I need cross-boundary collaboration to do better work
Mission Garden speaker
-- translation! -- art, culture, and science combo! -- manager and researcher interactions!
All presentations were great, on time, and well organized.
La información en muchos temas La traducción en español Los contactos que se pueden hacer con los presentadores
I liked the structuring of the conference, which included a wide variety of topics and research to present a relatively well-rounded palette of updates, news, questions, etc.
The wide variety of topics--it's a complex system and in addition to the science, it was great to see art and cultural components addressed as well.
A broad mix of talks.
It was all good.
The PFAS Biosolids Study by Pima County. Also the Q&A and happy hour discussions were valuable added info.
not sure i could point to anyone presentation as being the "most" valuable, they were all good...
The Thursday short segments
The use of LiDAR in data acquisition by CMG.
The quality of the talks. The mix of topics was well balanced.
All
The variety of presentations. Sustainability to concrete construction.
Me gustó ver proyectos similares que se llevan a cabo en AZ. Me perdí el primer día.. lo puedo ver grabado?
Hearing about the work conducted by NGOs, management agencies, and artists on the river. Always nice to hear points of view beyond academia
The diversity of subject matter provided insights into multiple aspects of the river and our community
Information on projects/work to enhance the River-Mission Gardens, Heritage Project
Variety of perspectives and data sets about the river.
I appreciated the diversity of presenters and topics. Very professional.

Although I don't have the technical background I know enough to have been very impressed with the quality and diversity of the research. I also appreciate that both study/research and action go hand in hand. I was especially interested in the Nogales Sonora report.
As interested observers and non-Tucsonans, we found the entire presentation to be informative. The Santa Cruz River is Jewel in the Desert - rescued, managed and enjoyed. Thank you!
The GIS component in most if not all the presentations I saw :)
Mike Bogan and his students. Birds talk by Carlos Rocha. Ian Murray's presentation. Kendall Kroesen's talk. Trash flood video.
So much of it! I appreciated that there were folks talking about art, and I appreciated that there were talks in English and Spanish with translation. Those things seemed to open up the scope quite a bit!
The early history of the Santa Cruz was fascinating. I was primarily looking to hear Dr. Bogan and researcher Pablo. Surprisingly I found I was also interested in the microplastic problem and other pollutants. I wasn't planning to join for the 2nd day on flood control but liked the first day so much I did. That day too taught me a lot.
Todo verdaderamente una excelente conferencia.
A lot of thought went into the program and it was really well-run. Thanks Claire, Luke, and everyone else that made this happen. I hope to attend next year!

We know that it can be draining to stare at the computer for hours. How did the virtual format work for you?

Were you able to join only because it was virtual??

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
20	19	3

COMMENTS -

Because it was in the middle of work days, I was able to catch some of it in between meetings. Wish I could've listen to & seen the whole thing.
Not necessarily, but we were able to get more of our staff to participate and attend because it was virtual, which was much appreciated.
I will attend in person in the future
It is the best way to do this considering pandemic restrictions.
Until Covid is history. Although having a virtual format in the future is worth consideration.
Otherwise I couldn't attend, because I'm in Mexico and borders are closed.
I could have attended in person if it was available.
I think generally I would be available to attend in-person, but the meeting coincided with a very busy time this year, and so I would not have been able to attend as many talks if it were not virtual.
I probably could have come to an in-person meeting to do my presentation. But the convenience of virtual is undeniable. Maybe there can be a hybrid format in the future.
I could commit to take 1 day off from work but not both days
I don't live in Tucson and I wouldn't be able to assist otherwise, but living in the same watershed the information is super valuable so given the opportunity there's no chance I'd miss it!

Were there enough breaks?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
36	3	3

COMMENTS -

Thank you for planning the breaks into the day. Makes a big difference!
About right for this number of presentations. Was able to break away as needed by turning off camera & mic.
El de lunch fue corto
Especialy in the afternoon, at least one extra 10-15 minute break would be appreciated.
I had plenty for time for lunching my dry sandwich.
Haha I found it all happening very soon but maybe it was my attempt to multitask.
Kind of. I can get up and move around during a virtual talk w/o being disruptive, and I took advantage of that, but more breaks would be nice.

Did you like the Chat with presenters?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
30	3	9

COMMENTS -

I did not use this feature, but I think that it was a great idea.
I don't think that worked well. Could not hear speaker during Happy Hour, only those with video. Just saw several heads nodding, but did not hear questions. Not a complaint; just new technology.
Did not use.
To address more quickly my questions.
Did not participate
I liked that it did not break into small groups
It was an opportunity to hear about specific research in a less formal platform.
The only thing I would ask if repeated next year - that each person speaking state their name and their affiliation. Not knowing who all the players were, it was challenging to keep up with the different perspectives on the topic at hand.
I'm going to say yes because I like the idea of it BUT I missed it :(This is something I don't recall being aware of.
Breakout rooms and small groups chats are a very important part of making virtual conferences work, IMO.

Were the presentations a good length?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
36	3	3

COMMENTS -

I feel that the format and time length allowed for more speakers. I was happy with the time that my team was allowed, it made it easier to decide what information to share with everyone.
Maybe a little longer
About right to accommodate this number of presentations.
And on time! Kudos to both Luke moderating and the presenters staying on time.
Just the right amount of time to get the necessary information about the research projects.
I think a little bit shorter ppt would have been good for me. No more than 15'
I would have liked to seen them go 15 minutes.
Yes. The amount allowed for comprehensive presentations without running too long and possibly losing the listener.
Excellent warning system when speakers were nearing the time limit.

This is the first year we've offered real-time Spanish/English interpretation.**Was this a valuable addition to the event?**

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
35	2	5

COMMENTS -

I am fluent in both Spanish and English so I did not use the translation feature, but I do believe that this is a very important addition.
well done
Excellent! Worked beautifully. Wonderful addition
Yes! This feature is amazing as it can make it so much more accessible.
Most definitely. Likely a factor for the high attendance both days.
Si, perfecto. De gran valor.
Great addition!
It did not affect me but I'm sure others found it useful.
Absolutely essential!
Even if I am bilingual, I know interested people who cannot understand very well the English, so it is always helpful to have real time translations.
I think so. It helps the participation of Mexican colleagues.
Didn't notice
I think it made the event more widely accessible and was an acknowledgement of the multi-lingual communities associated with the SCR.
I didn't need the translation, so I'm not sure I'm qualified to answer this question.
I loved, loved, loved this. Please keep it up!

Was this essential for your participation?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
6	31	5

COMMENTS -

not as an English speaker, but I REALLY appreciated it being available for Spanish speakers
Subtitles would be fine as well but the real time is great for when you need to leave the screen briefly.
Because I'm English speaking and most talks were in English; but I appreciate that this will enable more talks in Spanish in which case I would need translation!
I understand some Spanish, but appreciated the translations!
I am bilingual, but glad to see others accommodated his way.
Pero yo creo que es necesario tener traducción.
Making this available was incredibly respectful of the history and heritage of the Santa Cruz River valley and should really help increase your outreach. (and in grant writing, too)
Spanish to English.
Although I am bilingual, I selected English, but occasionally listened in Spanish. Both are essential for a deep ecological understanding of the river.
No pero es un plus
I am not a fluent Spanish speaker, so yes, very helpful. And being a binational organization with binational research makes it imperative to present in both languages.
I speak English, and that's the default; I speak Spanish well enough to follow non-technical talks with good visuals.

Anything else you would like to share about Interpretation?

No
Nope, great job, very seamless!
Game Changer...great job
very good.
They were AMAZING-- thanks much for doing this!
Amazing translators, kudos.
Always impressed with these on-the-fly translations.
The translator was pretty accurate. Consider involving her in the next SCRRD.
It worked very well and can serve as a model for other presentations.
Since I have both languages i found it a bit discerning/distracting when I could hear both going on at once I had no problem after I figured out what I was doing
Having translation is more accessible for everyone, and the more we make it a common thing, the more we can do actual community building. This is not a monolingual community.

New Collaborations

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>
4	34	4

COMMENTS –

Elia Tapia in Mexico, Justin Clark will be contacting her for more data
Yes, actually several connections leading to projects have occurred over the years since SCCRDs has been happening.
Francisco Lara
There are lots of vibrant and long-term partnerships, collaborations, and sounding boards going on among the University, Pima County, Sonoran Institute, members of the public, and non-profits!
Could arise: More collaboration between the new Museum at the Court House, Mission Garden, the Presidio, and many other entities to further cement the Santa Cruz River as a centerpiece attraction.
Menlo Park Neighborhood Association. Menlo Park borders the river and many vecinos are active in clean-up, water planning, etc. Contact people are Zach Yentzer, President, Wendy Stern and Raul Ramirez, Vice Presidents. email, menloparktucson@gmail.com Website: https://menloparktucson.org/
It might be a little soon after the event to determine this

Has any new conservation funding resulted from this project or collaboration?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
1	25	16

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 similar sessions. This was well done. Liked the diversity of information and perspectives
The same
I thought the event was great! More data and information is always welcome and maybe having the conference twice a year or mini events that include hands-on learning with the public (when safely able to do so).
3D Results, everything like a videogame.
Hopefully a hybrid format to facilitate both in person and remote participation-- and keep up the same blend of science, management, culture, and art! Plus keep engaging Mexico and the Tohono O'odham nation
Continuance of translations.

Update in some of the on going projects
Updates on the Corazon Reach progress, any cultural/heritage news that has developed with the Santa Cruz Heritage Area, any new collaborations.
Like the broad subject matter of the presentations.
Real people! More hugs!
I don't know if this is an accurate observation, but to me it seemed the presentations heavily favored activities specific to the lower reaches of the Santa Cruz River, in Pima County. I would like to have heard/seen more on the upper reaches in Santa Cruz County.
Perhaps a presentation on the threats the proposed Rosemont Mine presents to the Santa Cruz River and Tucson's public water supply. This could include the Tribe(s), the county, and the city, plus non-profit groups.
Update on restoration of flows.
Update on El Rio preserve.
More cross-border research projects.
Same old same old is good
Me gustaría ver mas proyectos de involucramiento comunitario y citizen science.
the presentations given by artists were very interesting, a focused section encouraging the melding of art and science would be interesting
None at this time
Maybe different sessions can have different themes or approaches. Maybe technical, data-driven presentations can be together. Maybe you could solicit more visionary or values-based presentations and have them together.
More of the same. Longer presentation times. 2-days is a good length of overall symposium. Please bring back the special session presentations. The cultural, social, humanities perspective of the Santa Cruz River is important.
Early settlers of the region
The format was great, and I also found the programming very complete.
mostly updates on ongoing and new projects
Continue to follow up current research and monitoring of pollutants.
Pandemic allowing... it might be really cool to visit some of the different sites discussed in the talks.

Additional Meeting Feedback

Thanks
Gratitude to all who worked to make this presentation available WATER MATTERS MORE
Thank you. Very well organized
Just a big thank you to everyone involved and I can't wait to see more improvements of the quality of our ecosystem in the Sonoran Desert!
Very cross-disciplinary. One of the best Arizona Conferences I have ever been to, like the AHS Tucson in 2008.
Kudos to all! (SI, Steering Committee, presenters, and all participants. Great questions too.
Always so informative, you set the bar high for pulling together a virtual two day conference of this caliber. Thanks to all!
Great job pulling this off with virtually no glitches!
I look forward to future in-person events, but you stay may want to include the ability to attend virtually.
Look forward to an "in person" SCR Researcher Days next year!
Thank you for inviting me. I look forward to being more active
Hope the next SCR RD would be in person.
Would like access to recorded sessions

Good job.
We need to make sure we give some for the "human/historical" history of this amazing river
I wasn't able to tune in for some of the parts I wanted to watch - would it be possible to watch a recording?
Well done and very enjoyable.
I just appreciate all the work behind it. Thank you!
I missed the personal interactions at breaks and lunch, but thoroughly understand the situation.
You did a great job! See you next year.
Great job on this conference. I was really happy to see a lot of different cultures represented and I hope that tradition will continue.
Zoom makes everything harder.
Some Native American speakers were difficult to hear.
Great in every aspect. Luke did a fantastic job of keeping the energy level high and lively!!
Great work creating and chaperoning a professional and streamlined experience (and enjoyable!).
I participated in the lightning round presentations. It was a great experience.
I hope this program recording will be widely available. I was only able to participate afternoon of March 25 and I was VERY impressed with presentations and the technology to present. Well done!
I had meetings during the day for work which I had to attend. I'm so sorry that the presentations weren't recorded. I was sad to miss a lot of it. Would've been so exciting to hear it all. Is there a chance you'll at least send out slide decks?
will watch the others on video, couldn't fit other sessions into my schedule
Claire & Luke, you did a great job, way beyond any expectations. This was a HUGE success!
Good pacing.
I wish I could have come back on Friday, but "life intervened"
The presentations were very informative. It's amazing seeing the application of methods commonly used in my organization.
I wanted to attend all sessions, but got busy unfortunately.
Was mostly during my working hours--would have liked to listen to more.
I was at work so I did check out a few times-i was glad that the format was such that I could do this
I would've definitely wanted to be more present and not miss a single one of the presentations, but I tried multitasking with not much success. I look forward to review all the information that will remain shared with the public! Congratulations to all the organizers!
I had to bow out early on Friday afternoon, but I saw most of the talks.
I thought you did an excellent job of keeping to schedule and dealing with the complex Zoom structure.

Oral Presentations - Submitted Abstracts

(Listed in program order)

Welcome presentation: A Living River – Charting Santa Cruz River Conditions

LUKE COLE AND CLAIRE ZUGMEYER | Sonoran Institute

The Santa Cruz River has long been the backbone of the region’s natural and cultural heritage. Although the river has changed since humans have first arrived in the region 12,000 years ago, the river still exists and is a “living” entity that continues to support wildlife and communities along its course. Throughout Arizona, the release of effluent maintains flows of many river reaches. The Santa Cruz River is fortunate to have two stretches with effluent flows—one near Nogales in Santa Cruz County and one near Tucson in Pima County. The major facilities releasing effluent into the river have undergone significant upgrades and 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?

The *Living River* annual reports chart the status of these two stretches of the Santa Cruz River by presenting data on indicators of wetland health with easy-to-follow text and engaging graphics. Notable findings include the following: improved water clarity and quality, reductions in nutrient pollution, contraction of flow extent with higher infiltration rates, and improvements in aquatic wildlife. This long-term monitoring program has made use of diverse data sets collected by multiple agencies and serves as an important baseline of scientific information for river management decisions. The *Living River* reports are a critical tool in demonstrating to diverse audiences that although effluent flows are not “natural”, they provide numerous benefits including habitat for wildlife, aquifer recharge, and important recreation opportunities.

Culturally important riparian trees in southern Arizona: a behind-the-scenes look at ethnobotanical collaboration and research methods

DAWN ROCHA | Tonto National Forest Tribal Monitor Program/WestLand Resources

DANIEL MCNAIR | WestLand Resources

The Tonto National Forest Tribal Monitor Program was started in 2018, primarily with the purpose of identifying and reporting on cultural resources in Arizona from a tribal viewpoint. From the program's beginning, tribal voices have championed the perspective that plants and living landscapes are as important for conservation as artifacts and ancestral sites. As we developed workshops and trainings focused on culturally important plants, we realized that the research process was as important as the results, especially in a state with over 4,200 plant species. We are excited to share some of our ethnobotanical research processes and findings along the way, including what we have identified as the most helpful set of tools in terms of databases, available literature, and traditional ecological knowledge for studying plants and their traditional uses in Arizona. We will focus our examples on important riparian tree species that occur in the Santa Cruz and San Pedro watersheds in Southern Arizona, such as western soapberry, velvet mesquite, and others.

Bird community structure within three distinct reaches of the lower Santa Cruz River***PABLO ROCHA | School of Natural Resources and the Environment, University of Arizona***

Olya Phillips | Community Science Coordinator, Tucson Audubon

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

Riparian areas are important for many bird species and act as stopovers for migrating birds. Unfortunately, these areas are disappearing due to groundwater pumping, urbanization, and climate change. However, the discharge of treated effluent into dry riverbeds has the potential to restore habitat and benefit bird communities. A new effluent discharge point, at the Santa Cruz River Heritage Project in Tucson, presented a unique opportunity to investigate how bird communities respond to the sudden reappearance of water. In this study, we compare bird communities in the Heritage Project with those in two other reaches of the Santa Cruz: (1) a reach with effluent flow and dense, established riparian vegetation (Tangerine Road) and (2) a reach that's usually dry and is dominated by desert scrub vegetation (Irvington Road). Two-kilometer transects were established at each reach, with 9 survey points spaced 200 meters apart at each. Surveys occurred twice a month between August 2020 and January 2021, began at dawn, and consisted of a 9-minute survey at each of the 9 points within each. Bird community composition differed among the three sites, with some overlap between Starr Pass and Irvington, but generally lower species richness levels at Irvington. Additionally, community composition was relatively stable through time at Irvington, but varied widely across months at the two sites with water. Indicator species for Irvington included rock doves, verdins, and Gila woodpeckers. In contrast, killdeer and vermilion flycatchers were indicators for the Heritage Project, and song sparrows and warblers were indicators for Tangerine. Consistent with these observations, eBird data and Tucson Audubon community science monitoring at the Heritage Project showed dramatic increases in killdeer and vermilion flycatcher sightings after flow began in 2019. Together, our results highlight how the addition of effluent to otherwise dry streambeds quickly supports diverse and distinct bird communities.

Patterns of dragonfly diversity and recolonization along the effluent-dependent Santa Cruz River***MICHAEL BOGAN | School of Natural Resources and the Environment, University of Arizona***

Jeffrey Babson | Pima County Natural Resources

Rich Bailowitz | Naturalist

Doug Danforth | Naturalist

Pierre Deviche | Arizona State University

Laurens Halsey | Desert Harrier Guiding Service

Fred Heath | Naturalist

Rick Overson | Arizona State University

Laura Steger | Arizona State University

Due to their strong dispersal abilities, many species of dragonflies and damselflies (odonates) can rapidly colonize new aquatic habitats. This trait has allowed odonates to return to the lower Santa Cruz River after the discharge of treated effluent restored flow to three reaches of the river. In the past four years, we have documented a total of 58 dragonfly and damselfly species from these reaches of the river—an impressive count considering the source and recent history of effluent flows. In this talk, we will (1) present the results of an

odonate bio-blitz that we conducted at nine sites along the lower Santa Cruz River and (2) discuss ongoing colonization patterns in the newest flowing reach of the river (Tucson Water's Heritage Project). In the last weekend of September 2020, we conducted standardized 90-minute visual surveys for odonates at nine sites along the river, with each site being visited by one team in the morning and another team in the afternoon. In total, we observed 37 odonate species that weekend, with the most diverse sites at Tangerine Road in Marana and the Heritage Project in Tucson. We also documented differences in species that were active in the morning versus the afternoon. In addition to this bioblitz, we have been conducting monthly surveys at the Heritage Project since flow began in June 2019. Odonates rapidly colonized this new habitat, reaching high levels of diversity (>25 species) within 4 months of flow initiation. Although flow cessation, drying, and riverbed sediment removal 'reset' the community in May 2020, odonate diversity recovered within 4 months of flow resuming in June 2020. These results demonstrate the importance of effluent in supporting biodiversity along the Santa Cruz River and the resilient nature of our regional odonate fauna.

Gila topminnow expansion into the effluent Santa Cruz River highlights the importance of 'managed' waters for native fish conservation in southern Arizona

IAN MURRAY | Pima County Office of Sustainability and Conservation

Julia Fonseca | Pima County Office of Sustainability and Conservation

The Santa Cruz River in the Tucson area is a verdant ribbon of green with relatively large flows of water that are not as prone to the vagaries of drought compared to other natural waters. This is due to the use of highly treated effluent (treated wastewater) discharged into the river. Wastewater treatment facility upgrades in 2013 greatly increased water quality, including reducing ammonia to levels more amenable to aquatic life. The endangered Gila topminnow recolonized this section of the river in 2017 after decades of absence, and has since maintained a viable population, despite the presence of several species of predatory nonnative fish. Native fish species in Arizona have been hard hit over the last century due to a myriad of stressors ranging from exotic species to habitat alterations. The future for native fish in our area is fraught with uncertainty due to expected warming and drying trends, as well as all of the same historic threats. Managers are faced with challenges of how to ensure viable native fish populations remain on the landscape. Across Pima County conservation lands, most natural waters are small and subject to drought and other stochastic factors. Here we explore the substantial contributions that the effluent Santa Cruz River and other managed waters make for topminnow conservation on Pima County lands. This is a reflection of the increasingly important role that managed waters will play for native fish conservation moving forward. The success of the topminnow population in the effluent Santa Cruz River also prompts a variety of questions that address identifying key habitat features that promote this success and as well as their ability to coexist with predatory, invasive fish species.

Using effluent water to preserve the Gila Topminnow habitat in the Santa Cruz River

ELEANORA DEMARIA | Pima County Regional Flood Control District

Evan Canfield | Pima County Regional Flood Control District

Diminished flow extent in the Santa Cruz River starting in 2014 has impacted the survival chances of the Gila topminnow since its return to the Santa Cruz river in 2017. To maintain the established habitat of this endangered species, Pima County has requested that a portion of the Conservation Effluent Pool (CEP) be used

to maintain wet conditions in a stretch between the Agua Nueva Wastewater Reclamation Facility and, at a minimum, the river's confluence with the Cañada del Oro Wash in the Corazón area. Using flow extent measurements and daily effluent deliveries from the Agua Nueva plant, Pima County was able to estimate the amount of effluent flow needed to keep this stretch of the river wet year round. This CEP request will ensure that a minimum flow of 5 MGD, on a weekly average, will keep water flowing in the river during times of increased demand for off-channel diversions. Sensors and drone surveys in the channel will be used to monitor the flow extent and to measure the project's success.

Lower Santa Cruz River flow intermittence: discharge fluctuations, stream drying, and fish death

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

Brandon Enger | School of Natural Resources and the Environment, University of Arizona

Anton Ebenal | School of Natural Resources and the Environment, University of Arizona

Pablo Rocha | School of Natural Resources and the Environment, University of Arizona

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

Portions of the flowing Santa Cruz River have been recreated with effluent discharge from wastewater treatment plants. This effluent supports aquatic habitat, but it is poorly understood how fish have responded to an artificial flow regime where diurnal fluctuations often result in daily stream drying and rewetting. We documented daily flow intermittence and resulting fish mortality over a 12-week period during Spring 2020 on the Agua Nueva reach of the lower Santa Cruz River in Tucson, AZ. We hypothesized that fish mortality would be a function of recolonization and could therefore be predicted by time and distance. Specifically, we hypothesized that fish death would be positively correlated with time (duration of flow) and negatively correlated with distance from recolonization source. Using 5 trail cameras, we monitored drying duration and extent along a 2+ km stretch of river known to experience flow intermittence. Once a week during the period of daily drying, we visually counted fish mortalities due to stranding. Drying extent varied widely (range: 0-1.88 km) and averaged $0.79 \text{ km} \pm 0.14 \text{ SE}$. Observed fish mortalities also varied widely (range: 0-74 individuals per day; mean: $26.9 \pm 8.3 \text{ SE}$). Ninety-nine % of observed fish mortalities were Poeciliidae (63% of which were fry). We tested our hypothesis by using a generalized linear model with a variance adjusted Poisson distribution to predict Poeciliid deaths with duration of flow and distance from stable water ($R^2 = 0.614$). Our hypothesis was partially supported: duration was a positive predictor ($p = 0.035$), but distance was not significant ($p = 0.398$). As urban development continues, discharge of effluent into rivers and streams will become more common throughout the world. Continued research is needed to understand the unique benefits and challenges presented by these artificial effluent flows including their impacts on aquatic taxa.

Santa Cruz Food Sources: Regional Plant Education for a More Sustainable Future

JARED RENAUD AND REBECCA SHAW | College of Architecture, Planning and Landscape Architecture, University of Arizona

For several millennia, the Santa Cruz River Watershed has been an ongoing center of human activity; its indigenous populations have adapted and relied upon the region's flora for various food and medicinal uses.

While a wealth of knowledge exists on the ethnobotanical resources found within the diverse ecologies of the watershed, this information is often buried in academic literature and is not easily accessible to the public at large.

Since the beginning of European colonization in the southwest, local understanding of these nutritional resources has eroded. Over the past several centuries forced assimilation, ongoing conflict with, and the removal of indigenous populations has exacerbated the displacement of regional plant knowledge. The aforementioned events, along with historical droughts and Anglo-American reliance on and introduction of non-local plants further marginalized information on traditional plant use. With increasing aridification, food insecurity, and water shortages brought on by both climate change and population increases, landscape level planning needs to work within the confines of the environment and its resources in order to achieve sustainability.

This study aims to compile and synthesize literature on historic plant use into a compendium of information available across disciplines. Identification keys, photographs, and information about growing conditions and growing regions will make up the greater part of the document, which will also include suggestions for contemporary use and propagation – of particular interest to K-12 educators and to the general public. The resulting guide will be available to the public through the Drachman Institute at the University of Arizona.

Reconciliación en El Rio / Reconciliation on the River

ANGELANTONIO ENRIQUEZ BREault | Ironwood Tree Experience

In 2019 the Santa Cruz River Heritage Project restored flow to a stretch of river at the heart of our urban community. The effort has demonstrated how simple actions renew life, even our most degraded ecosystems. Miracles are possible – water is life. Unfortunately, rivers face challenges that they did not a century ago. Anthropogenic and violent changes to ancestral lands and the natural world have left our rivers incredibly vulnerable. Since November 2020, we have taken on the personal practice of cleaning up the reach of the Santa Cruz River that runs between Mission Wash and Congress St. Bridge. If we hope to continue to sustain life and connection along our river we must reimagine how we engage with one another and the land that holds us. To this end, this project has three objectives: Reconciliation - Restoration is a fallacy. However, removing anthropogenic waste and invasive species can help us begin a process of reconciliation. Learning - Outreach and education about our shared ecological and cultural systems through storytelling and citizen science. Justice - Addressing issues of equity and justice throughout our urban ecosystem and wild spaces is necessary to sustain life. At this moment, our reconciliation efforts along the Santa Cruz include the removal of trash and invasive plant species from the river bed and surrounding tributaries. Unfortunately, because invasive plant species like tamarisk and buffelgrass reproduce so rapidly, pulling them from the river bed is only a temporary “band-aid” solution. To implement more systemic healing, we have begun to repopulate the river’s native seed bank using a native grass blend provided by Pima County. All waste disposal resources and PPE are currently self-financed. We are interested securing partnerships so that we can continue providing high quality gear for volunteers, please reach out.

A low-tech method to quantify trash in the Santa Cruz River and identify its sources

LUKE COLE | Sonoran Institute

Kimberly McKinzie | Tucson Clean and Beautiful

Evan Canfield | Pima County Regional Flood Control District

Stakeholder and resident engagement efforts were a central component of the Pima County Regional Flood Control District–led Santa Cruz River Management Plan effort in 2019 and 2020. These meetings consistently tread upon a recurring question: can anything be done about the trash in the Santa Cruz? Sonoran Institute, in partnership with Tucson Clean and Beautiful and Pima County RFCD, has begun including on-site trash assessments during volunteer river clean-up events. Using a simple method of recording every item of trash in a fixed area (often 10m x 10m), volunteers can build a database while cleaning up the riverbed. Preliminary data show that food packaging and cups constitute 48% of all items of trash in the river. Single-use plastic bags and clothing each account for 10% of the items removed from the Santa Cruz. Over time, the trash database will grow, providing data that will help identify the sources of trash and to aid in designing solutions that can sequester trash before it reaches the river.

The Sonoita Creek Watershed

CAROLYN SHAFER | Town of Patagonia Flood & Flow Committee

Robert Proctor | Friends of Sonoita Creek

The Sonoita Creek Watershed, an important tributary to the upper Santa Cruz River, runs from the unincorporated area of Sonoita through the Town of Patagonia, joining the Santa Cruz River in Rio Rico, AZ. The Sonoita Creek Watershed encompasses the western Canelo Hills, the eastern and southern Patagonia Mountains, and the southern Santa Rita Mountains.

This sensitive biodiverse area includes a number of migratory wildlife corridors necessary for many species including some that are endangered. The area is seriously threatened by industry, population growth and climate change. The Sonoita Creek Watershed is sadly lacking in long term research and data that is essential in determining the present and future ramifications of the demands of its most precious resource - WATER.

A concerned group of stakeholders have joined together as the Town of Patagonia Flood and Flow Committee. Members include the Borderlands Restoration Network, Tucson Audubon, the Nature Conservancy, Patagonia Area Resource Alliance, Deep Dirt Institute, and Friends of Sonoita Creek.

In 2016 the town of Patagonia was designated a municipal watershed by the US Forest Service (USFS). The USFS has been working on legacy mine mitigation and erosion control and restoration in some areas of the Sonoita Creek Watershed. The Patagonia Flood and Flow

Committee with assistance from the USGS and the USFS has recently defined the area of the Patagonia Municipal Watershed within the Sonoita Creek Watershed. The town of Patagonia Flood and Flow Committee is collaborating with the USFS to establish a Watershed Restoration Action Plan.

Interested organizations and stakeholders want to establish a Watershed Management Coalition in order to combine education, restoration, and protection efforts and acquire research essential to understanding the hydrology and geology of the Sonoita Creek Watershed.

Citizen Artist™ a new participatory science research opportunity to study the Santa Cruz River

LEE ANN WOOLERY | Ph.D., Citizen Artist™ Founder and Director of Research

Environmental issues in the 21st century, including loss of biodiversity, habitat loss, species extinction, and the effects of climate change are at a critical juncture. Citizen Artist™ uses an art-based research methodology to study environmental change in tandem with western science methods, reaching broader audiences, including many underrepresented populations.

Citizen Artist™ is a new participatory science research opportunity that uses art-based research methodologies to study environmental change, including biodiversity and habitat loss in support of conservation efforts. Citizen Artist™ works with individuals and communities as creative co-collaborators in scientific field research projects to address local environmental issues that are community driven.

Citizen Artist™ participants enrolled in the Santa Cruz River participatory research project reviewed current aquatic ecosystem research that focuses on the detection of broad-scale changes in stream health. Participants then engaged in art-based research methods at the Tubac and Tumacacori, AZ sites focusing on data collection of streamflow, channel morphology, acoustic ecology, and riparian vegetation.

What participants learned:

- How art-based research methods engage in multi-modal learning which has been shown to garner great results for those who learn best with visual, audio, gestural, tactile, and spatial learning modalities.
- How the arts can act as a catalyst for change, give us empathy and help us understand places and people.
- How the ethics/values behind Citizen Artist™ help participants achieve a deep ethic of caring about the environment.

Citizen Artist™ engages a broad audience, providing an alternative methodology for ecological field research empowering individuals and communities who may have been overlooked by conventional science to get involved with the potential of positively transforming our current environmental issues.

Bi-National Santa Cruz River Río Compartido/Shared River Exhibition

RICARDO SANTOS HERNÁNDEZ | Visual artist, protector of the Santa Cruz River

Lee Ann Woolery | Ph.D. EcoArt Expeditions

The binational Santa Cruz River, a waterway shared by both the United States and Mexico, is the focus of the Río Compartido/Shared River exhibition. The exhibit features the creative work by artists from both sides of the International border and has been three years in development.

The exhibition is intended to expand awareness of our nation's waterways as an environmental necessity and an important cultural element. The Río Compartido/Shared River exhibit brings the message home of the significance of the regional waterway and unique shared responsibility for the Borderlands cultural and environmental heritage.

The Santa Cruz River with headwaters in the US, flows south into Mexico crossing the International Border, makes a U-turn and returns to the US making a reentry at Mascareñas near Kino Springs and flows through the Santa Cruz Valley towns and communities, including, Rio Rico, Tubac, Amado, Green Valley, and Tucson along its northerly 185-mile route.

Exhibiting Río Compartido/Shared River artists were encouraged to participate in educational programming at locations along the river including hikes and tours of the river ecosystem, public parks, museums, and the Nogales International Wastewater Treatment Plant. The educational programming was conducted by members of the Friends of the Santa Cruz River, Lowe House Project, property owners and volunteers familiar with the riparian cultural and environmental characteristics. The immersion program afforded artists the opportunity of experiencing firsthand the habitat, humanity, history, and cultural heritage of the Upper Santa Cruz River basin. Over 25 artists from Mexico and the US developed creative works.

The Río Compartido/Shared River exhibition was co-curated by Barbara Kuzara of Tubac, Arizona and Ricardo Santos Hernández of Nogales, Arizona and Chicago, Illinois. The exhibit first showed at the Lowe House Project in Tubac, Arizona in September 2019 and later at the Hilltop Gallery in Nogales, AZ in January 2021.

PFAS in Biosolids: A Southern Arizona Case Study

JAMES G. BROWN | Pima County Regional Wastewater Reclamation Department

Jeff Prevatt | Pima County Regional Wastewater Reclamation Department

Barbara Escobar | Pima County Regional Wastewater Reclamation Department

This study was done to determine the potential for land-applied biosolids to contaminate underlying groundwater with PFAS compounds northwest of Tucson, Arizona. PFAS compounds have been used since the 1940's in firefighting foams and in a wide variety of household products, and have contaminated groundwater in the study area. The concentration of PFAS in agricultural soils to which biosolids have been applied is unknown. Pima County had been applying biosolids derived from treated wastewater to agricultural fields since 1984, but discontinued the practice at the start of 2020 until more was known regarding the occurrence, transport and fate of PFAS in those fields. For this study, soil samples were taken at depths of 1, 3 and 6 feet in irrigated fields that received biosolids, irrigated fields that had not, and undisturbed desert soils that had never been farmed. No PFAS were found in samples taken from undisturbed soils. PFAS concentrations in soils to which biosolids had been applied were slightly higher but statistically comparable to those that never received biosolids. PFOS and PFOA, the most commonly found PFAS compounds, were detected at low levels. PFAS concentrations decreased with depth and were 90 to 97 percent attenuated at a depth of 6 feet below land surface. Based on these findings, it is extremely unlikely that these compounds will reach groundwater in the area, which ranges in depth from 150 to 250 feet below land surface. PFAS concentrations in the groundwater used for irrigation were slightly higher than those in the agricultural fields. Good correlation existed between the specific PFAS

compounds found in the groundwater and the fields, and it is likely that groundwater is the major source of PFAS in agricultural fields in the area. On the basis of these findings, the County plans to resume land-application of biosolids in 2021.

Microplastic pollution in the effluent-dependent lower Santa Cruz River during baseflow and post-flood conditions

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

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

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

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

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

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

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

Microplastics are an emerging contaminant of potential ecological concern in waterbodies across the world. One important point source of microplastic pollution is treated wastewater; after treatment, this effluent is often discharged directly into streams. In southern Arizona, effluent discharge supports perennial flow and riparian habitat in the Santa Cruz River but also brings microplastic pollution and its potential ecological challenges. In this project, we examined microplastic concentrations in the water column and benthic sediment, and microplastic consumption by mosquitofish (*Gambusia affinis*) at 10 sites along a ~40 km stretch of the lower Santa Cruz River. We quantified these factors across two time periods: baseflow (effluent only) and post-flood (effluent baseflow immediately following urban runoff). We found four types of microplastics in the Santa Cruz River: fibers, fragments, film, and beads. In total, across both sampling periods, we detected microplastics in 95% of water column samples, 99% of sediment samples, and 6% of mosquitofish stomachs. Flow status (baseflow vs post-flood) was the only significant predictor of microplastic presence and concentrations in our models. Across all sites, microplastic concentration in the water column was ~33% higher during post-flood, with most pieces (≥80%) being fibers in both seasons. However, microplastic concentrations in the benthic sediment were 55% lower in post-flood vs baseflow samples, with fibers and fragments being the most common types. During baseflow, only 1.5% of mosquitofish sampled had ingested microplastics (all fiber), while post-flood 10% did (85% fiber, 10% film, 5% fragment). This project provides the first evidence that microplastics are common in the water column and sediment of the lower Santa Cruz River, and that resident mosquitofish are more likely to ingest microplastics post-flood. Future studies should assess the long-term impacts of these microplastics on the health and populations of aquatic species.

Seasonal and longitudinal water quality dynamics in three effluent-dependent rivers in Arizona

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

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

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

The seasonal and longitudinal water quality dynamics across different geographic and climatic factors were investigated across six reaches of three effluent-dependent rivers in Arizona. We observed water quality

deterioration (e.g. elevated temperature and low dissolved oxygen) in some reaches during the hottest summer months and significantly greater natural remediation of water quality in longer reaches for several factors (temperature, dissolved oxygen and ammonia). Nearly all sites met or exceeded water quality conditions needed to support robust assemblages of native species (except Tres Rios reach during elevated ammonia in summer and fall measurement). However, this study also indicates that conditions based on temperature, oxygen level and ammonia may be stressful for the most sensitive taxa at sites closest to effluent outfalls, especially in summer. Overall, effluent-dependent streams have the capacity to serve as refuges for native biota, and they may become the only aquatic habitat available in many urbanizing arid and semi-arid regions.

Identifying Projects to Improve the Santa Cruz River Northwest of Tucson

EVAN CANFIELD | Pima County Regional Flood Control District

Scott Altherr | CMG Drainage

Luke Cole | Sonoran Institute

Rebeca Field | Kimley Horn

Cy Miller | JE Fuller

Since 2014, when effluent quality released to the Santa Cruz River improved, the conditions along the river have become more welcoming to both humans and wildlife; so the Pima County Flood Control District has developed plans to capitalize on these better conditions by implementing improvement projects. The odor issues that plagued the river, have become a thing of the past, the water is clearer, and aquatic wildlife has become more abundant and diverse. The endangered Gila topminnow has returned to this part of the river, and the Santa Cruz River has become a dragonfly viewing destination. Working with Sonoran Institute, and a team of consultants led by CMG Drainage, the Flood Control District identified and assessed concerns and opportunities identified by reach-focused stakeholder workgroups. From this initial assessment, potential alternatives were identified to address these concerns and opportunities with a series of projects that would reduce flood risk, improve public safety, reduce maintenance, improve habitat, optimize water resources, and provide recreational opportunities. This initial list was further winnowed to twenty selected alternatives using the Multi Criteria Decision Analysis (MCDA) protocol with scoring done by the stakeholder workgroups. The Consultant Team then developed concepts that provide a basis for implementation of the alternatives. Over the past six months, the public has had an opportunity to provide feedback on these projects using an on-line survey developed by Sonoran Institute. This presentation will describe the river assessment, the alternatives selection process, the public survey results, and the path forward for implementing the selected alternatives.

The Multiple Uses of a Modeled Terrain in the Lower Santa Cruz River

SCOTT ALTHERR AND RACHEL NOCK | CMG Drainage Engineering, Inc

As technology increases our ability to capture the earth's surface, better known as terrain, improves. Our discipline of work utilizes terrain as input for multiple exercises and evaluation in the Lower Santa Cruz River. We'll explore how we generate a terrain from LiDAR and what components of LiDAR are used for different scenarios. We'll show how it has been used for flood hazard modeling, assessment of infrastructure, design and parameterization of our hydraulic models in the Lower Santa Cruz River corridor.

Santa Cruz River Corazon Reach Stream Restoration***EVAN CANFIELD | Pima County Regional Flood Control District******KEVIN PAYNE | Kimley-Horn******WILL WILHELM | Kimley-Horn***

The Santa Cruz River, and specifically the areas near the confluences with the Rillito River and Cañada del Oro Wash was historically considered the heart, “El Corazon” of the Santa Cruz River in the Tucson Basin. Pima County’s ongoing efforts are restoring this reach to once again be the heart of Tucson’s ecology. The Santa Cruz River through this reach is Arizona’s longest effluent-dependent river. The 2013 Regional Optimization Master Plan (ROMP) upgraded two major regional wastewater treatment plants resulting in improved quality of the effluent discharged into the river. Pima County Regional Flood Control District’s (District) ongoing Santa Cruz River Management Plan identified the need for stream restoration / natural channel design within the Corazon Reach of the river. Kimley-Horn is leading the planning and conceptual design efforts, with assistance from technical experts throughout the community, to prepare a restoration plan for the Corazon Reach of the Santa Cruz River. The team is working on identifying the ecological objectives of the stream restoration and identifying degraded areas in need of restoration as well as stable, reference areas. The project team will ultimately prepare design concepts to allow the District to build natural channel design projects to continue the County’s restoration of the heart of Tucson.

El Corazon Bank Protection and River Park***KEVIN PAYNE | Kimley-Horn******JOHN SPIKER | Town of Oro Valley (formerly Pima County Regional Flood Control District)***

Pima County Flood Control District recently completed a project to address one of their more significant hazards. The El Corazon Bank Protection and River Park project stabilized the banks of the Santa Cruz River, Rillito River, and Cañada del Oro Wash (CDO) along the perimeter of the Orange Grove Sand and Gravel Pit, thus preventing capture of the pit by one or more of the adjacent rivers. Capture of the pit would have likely resulted in significant headcutting upstream and potentially catastrophic failure of upstream infrastructure, including Interstate-10. The District selected Kimley-Horn to lead the design of the project and the Ashton Company completed construction in 2019. The project includes nearly two miles of new soil cement filling a gap in the bank protection between the Rillito River and CDO Wash; new pedestrian bridges over both the Rillito River and CDO Wash; and connections from the new bridges to the Chuck Huckelberry Loop. The new bridges allowed the Loop to be rerouted off the Interstate-10 frontage road, providing a much safer, more scenic, and more user-friendly route. The District’s design and construction teams also addressed environmental and groundwater concerns along the effluent portion of the Santa Cruz River as well as ongoing and historical hazards related to the operation of the adjacent Orange Grove Sand and Gravel Pit.

El Santa Cruz River Heritage Managed Recharge Project at 18 months

MAYA TEYECHEA | *Tucson Water*

DICK THOMPSON | *Tucson Water (retired)*

This managed reclaim water recharge project has been in operation for 18 months now and has brought some answers, questions, acclaim. With flows for Over 1590 AF of water has now been recharged in a part of the Santa Cruz River that has not seen perennial flow in nearly a century. Dragonflies showed up one day one and since then frogs, coyotes, as well as the introduction of the Gila Top Minnow. The foliage along the recently dredged areas is bounding back to life setting up a backyard research area for biologists at the U of A. Tucson Water has maintained daily flows of 90 percent during 2020 and is currently working on a plan to have an alternate supply system to cover maintenance interruptions in the future. The nearly continuous flow has had a profound effect on this part of Santa Cruz riparian area created by the Heritage Project. Knowledge and lessons learned will hopefully pay off with similar projects by Tucson Water.

Survey results from resident engagement for the Pima County Santa Cruz River Management Plan

LUKE COLE | *Sonoran Institute*

Evan Canfield | Pima County Regional Flood Control District

Angela Melendez | Sonoran Institute

Residents of Pima County responded to a Sonoran Institute online survey that gauged their opinion and preferences around the sixteen structural and four non-structural project concepts that were developed by the Flood Control District, its consultants, and reach-specific stakeholder work groups for the Santa Cruz River Management Plan. 1,400 responses were provided from 39 area codes in Pima County between October 1 and December 31, 2020. All individual projects were net favorable and collectively 84% of respondents supported to the statement that the project is important and should be prioritized (65% agree, 19% somewhat agree). Respondents were asked to consider six categories of projects applicable across the entire river management plan and to respond with the benefits they would want to see with each project. Collectively, environmental benefits were the priority (70%) with the other benefit categories representing 35%–52% of the responses. The output from this survey will be used by Pima County Flood Control District to tailor design and implementation phases of the Santa Cruz River Management Plan to reflect public concerns and priorities.

Competing Visions for Capital Investment on the Tucson Reach

KENDALL KROESEN | *Mission Garden*

For most of the known history of the Santa Cruz River's Tucson reach, it trickled through shallow, sandy channels in a wide, riparian (and then agricultural) floodplain. Much of Tucson's history took place on or near that floodplain and was made possible because of its resources. The floodplain is now covered by a fresh and very recent history of commercial and residential development, and is riven by a deep, eroded channel. This reach is now the site of two conflicting visions for honoring the past. One, embodied in the Santa Cruz River Heritage Project, emphasizes the return of flowing water in the channel as the conveyor of our heritage. The other, Mission Garden and the not-yet-realized Tucson Origins Heritage Park, places our heritage on, and in, the

historic floodplain. Both these visions have the potential to influence how significant capital is spent to develop remaining open space in the area.

Borderless solutions for a bordered river: Green infrastructure in Ambos Nogales

FRANCISCO LARA-VALENCIA | Arizona State University

Ambos Nogales experience environmental challenges resulting in public health risk, ecological degradation, urban vulnerability, and threats to regional growth with adverse effects on communities on both sides of the international border. We all know that the solutions to these challenges demand better transboundary coordination and management of shared hydrological and ecological networks. The objective of this presentation is twofold. First is intended to advance the idea that establishing a green infrastructure network in the Ambos Nogales catchment area is the most practical and sustainable way to solve the environmental challenges faced by the Santa Cruz River and the communities that rely on it for water, recreation, and ecological services. The second objective is to present a plan to create such a network to reconnect Ambos Nogales -- and each city individually -- with its common natural foundation. The presentation is based on ongoing research work conducted by an interdisciplinary, interinstitutional, and binational team supported by the EPA's Border XXI Program and the NADBank.

A Water Balance Model for the Santa Cruz River Aquifer in Mexico

ELIA M. TAPIA VILLASEÑOR | Universidad de Sonora, Hermosillo, México

Eylon Shamir | Hydrologic Research Center

Sharon B. Megdal | Water Resources Research Center

The U.S.-Mexico border region is highly vulnerable to climate uncertainties. The high population growth rate, semi-arid to arid climate conditions, high ecosystem sensitivity, and institutional asymmetries between the two countries, are some of the reasons for such vulnerability. Climate uncertainties are currently affecting groundwater reserves, water availability, and water quality relevant for different border communities. Global climate models project a decrease in mean precipitation, punctuated by extreme events of flooding and drought. In this border region and elsewhere, tools such as water budget models that can assess the impact of climate uncertainties and water management schemes, are key to the development of water management strategies. For this study, we developed a modeling framework to assess the impact of climate uncertainties and different water management schemes in the Santa Cruz River Aquifer in Mexico. The modeling framework was carried out using readily available historical datasets and completing a comprehensive literature review. While the projections in this study did not show clear directional trends, it provides uncertainty bounds that can be useful for future planning of water resources. This study enhances the existing understanding of aquifer recharge and storage in the Santa Cruz River Aquifer in Mexico by characterizing the spatial and temporal aspects of the region.

Incorporating Climate Change on Flood Magnitude and Frequency Analysis in the Upper Santa Cruz River

JENNIFER G. DUAN | Department of Civil Engineering and Engineering Mechanics, University of Arizona

Yang Bai | Department of Civil Engineering and Engineering Mechanics, University of Arizona

F. Dominguez | Department of Atmospheric Sciences, University of Illinois

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Thomas Meixner | Department of Hydrology and Water Resources, University of Arizona

Hourly precipitation for one historical (1991-2000) and two future periods (2031-2040 and 2071-2079) were generated using the Weather Research and Forecasting (WRF) Regional Climate Model (RCM). The climate simulations were conducted for the Southwest region of the United States using an hourly temporal and 10 km spatial resolution grid. The boundary forcing for the WRF model was developed by the Hadley Centre for Climate Prediction and Research/Met Office's HadCM3 model with A2 emission scenario. The precipitation from the RCM-WRF model was bias-corrected using the observed data, and then used to quantify the impact of climate change on the magnitude and frequency of flood flow in the upper Santa Cruz River watershed (USCRW) in southern Arizona. The Computational Hydraulics and River Engineering two-dimensional (CHRE2D) model, a two-dimensional hydrodynamic and sediment transport model, was adapted for surface flow routing. The CHRE2D model was first calibrated using a storm event on July 15th, 1999, and then applied to the watershed for three selected periods. The simulated annual maximum discharges in two future periods were added to the historical records to obtain the flood frequency curve. Results indicate the peak discharges of 100-year, 200-year, and 500-year flood only increased slightly, and the increase is within the 90% confidence interval limits. Therefore, the flood magnitude and frequency curve will not change with the inclusion of projected future climate data for the study watershed.

Projected Changes to the Lower Santa Cruz River Hydroclimate – Results of Collaborative Study between the Bureau of Reclamation and Local Partners

EVE HALPER | Reclamation Phoenix Area Office

Lindsay Bearup | Reclamation Phoenix Area Office

The goal of the Lower Santa Cruz River Basin Study is to identify future supply-demand imbalances and develop strategies to improve water reliability within the Tucson Active Management Area. The Study is a partnership between Reclamation, the Southern Arizona Water Users Association, the Pima Association of Governments, the Central Arizona Project, the Arizona Department of Water Resources, the University of Arizona, and the Cortaro-Marana Irrigation District.

Reclamation developed a technical memorandum on how future temperature and precipitation may impact flows in the Lower Santa Cruz and its tributaries. The analysis used two greenhouse gas emissions scenarios and developed estimates for changes in temperature and precipitation for two future thirty-year periods. Changes were evaluated for the winter wet, dry fore-summer and monsoon seasons. The study also used a statistical "weather generator" to explore patterns of daily rainfall that replicate the natural variability of the southeastern Arizona climate.

One unique aspect of this study is the partnership with the University of Arizona to use physically-based (dynamic) downscaling to model regional-scale atmospheric processes. Previously, Reclamation's Basin Studies used statistically based downscaling which limits the range of events to the historical record.

Modeling results identify increases in temperature for all emissions scenarios and time periods, with larger increases under the higher emissions scenario. Precipitation changes are more variable than temperature. The lower emissions scenario had relatively minimal change in seasonal precipitation. In the higher emissions scenario, precipitation decreases significantly in the monsoon and winter wet seasons. Precipitation also becomes increasingly variable under future conditions.

Changes in runoff and streamflow were estimated using the Sacramento Soil Moisture Accounting Model. The lower emissions scenario showed increasing streamflows for the monsoon and winter wet seasons, while the higher emissions scenario featured substantially reduced streamflows, more days without flow in the modeled streams and reduced soil moisture.

ADWR Groundwater Modeling in the Santa Cruz River Basin: International Boundary to Picacho Peak

JUSTIN CLARK, OLGA HART, AND DIANNE YUNKER | Arizona Department of Water Resources

The Arizona Department of Water Resources (ADWR) has been working to develop a more complete understanding of the groundwater systems along the Santa Cruz River within the Santa Cruz and Tucson Active Management Areas (AMAs). The groundwater flow models constructed to this end improve our scientific understanding of the basins, particularly in areas previously lacking coverage, and facilitate more informed management of water resources. Although groundwater-centric, the models necessarily incorporate the impacts of flood recharge, and simulate the effects of riparian transpiration and groundwater discharge.

In this talk, we will highlight the recent progress made to the latest conceptual understanding of the interaction of stream and aquifer along the River from the international boundary to just south of Picacho Peak. Using the Tucson AMA model alongside the Santa Cruz AMA model (released in 2020) ADWR has made significant efforts made to improve historic simulations, thus promoting better long-term forecasting.



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Microplastic pollution in the effluent-dependent lower Santa Cruz River during baseflow and post-flood conditions

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

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Zach Nemec | University of Arizona, School of Natural Resources and the Environment
Larissa Lee | University of Arizona, School of Natural Resources and the Environment
David Quanrud | University of Arizona, School of Natural Resources and the Environment
Michael Bogan | University of Arizona, School of Natural Resources and the Environment

Microplastics are an emerging contaminant of potential ecological concern in waterbodies across the world. One important point source of microplastic pollution is treated wastewater; after treatment, this effluent is often discharged directly into streams. In southern Arizona, effluent discharge supports perennial flow and riparian habitat in the Santa Cruz River but also brings microplastic pollution and its potential ecological challenges. In this project, we examined microplastic concentrations in the water column and benthic sediment, and microplastic consumption by mosquitofish (*Gambusia affinis*) at 10 sites along a ~40 km stretch of the lower Santa Cruz River. We quantified these factors across two time periods: baseflow (effluent only) and post-flood (effluent baseflow immediately following urban runoff). We found four types of microplastics in the Santa Cruz River: fibers, fragments, film, and beads. In total, across both sampling periods, we detected microplastics in 95% of water column samples, 99% of sediment samples, and 6% of mosquitofish stomachs. Flow status (baseflow vs post-flood) was the only significant predictor of microplastic presence and concentrations in our models. Across all sites, microplastic concentration in the water column was ~33% higher during post-flood, with most pieces (=80%) being fibers in both seasons. However, microplastic concentrations in the benthic sediment were 55% lower in post-flood vs baseflow samples, with fibers and fragments being the most common types. During baseflow, only 1.5% of mosquitofish sampled had ingested microplastics (all fiber), while post-flood 10% did (85% fiber, 10% film, 5% fragment). This project provides the first evidence that microplastics are common in the water column and sediment of the lower Santa Cruz River, and that resident mosquitofish are more likely to ingest microplastics post-flood. Future studies should assess the long-term impacts of these microplastics on the health and populations of aquatic species.

Seasonal and longitudinal water quality dynamics in three effluent-dependent rivers in

Arizona

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

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

The seasonal and longitudinal water quality dynamics across different geographic and climatic factors were investigated across six reaches of three effluent-dependent rivers in Arizona. We observed water quality deterioration (e.g. elevated temperature and low dissolved oxygen) in some reaches during the hottest summer months and significantly greater natural remediation of water quality in longer reaches for several factors

(temperature, dissolved oxygen and ammonia). Nearly all sites met or exceeded water quality conditions needed to support robust assemblages of native species (except Tres Rios reach during elevated ammonia in summer and fall measurement). However, this study also indicates that conditions based on temperature, oxygen level and ammonia may be stressful for the most sensitive taxa at sites closest to effluent outfalls, especially in summer. Overall, effluent-dependent streams have the capacity to serve as refuges for native biota, and they may become the only aquatic habitat available in many urbanizing arid and semi-arid regions.

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