

Santa Cruz River Research Days

Proceedings

April 15 and 16, 2013

Fifth Annual
Arizona-Sonora Desert Museum, Education Annex



Santa Cruz River near Camino Del Cerro Road, Pima County, Arizona (photo courtesy of Matt Weber)



**Pima County Regional
Wastewater Reclamation
Department**



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Introduction

On April 15 and 16, 2013 Arizona State Museum, Friends of the Santa Cruz River, Pima County Regional Flood Control District, Pima County Regional Wastewater Reclamation, Tumacácori National Historical Park, and Sonoran Institute hosted the fifth annual “Santa Cruz River Research Days”. 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. Though past meetings have included presentations of work that could be viewed as “cultural”, this year was the first attempt to officially expand the scope of the meeting and include cultural resource work. This was accomplished by inviting several researchers and organizations to share cultural research that pertained to the Santa Cruz River. 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 all five Researchers’ Day events can be found at:

Sonoran Institute www.sonoraninstitute.org - links to Researchers’ Day events and information are provided in the ‘resources’ side-bar of the pages describing the Institute’s Santa Cruz River work (go to “WHERE WE WORK” > “Southwest” > “Santa Cruz River” or use the following [Link to Santa Cruz River Project on Sonoran Institute website](#)).

Event Sponsors and Planning Committee

Funding for this year’s event was generously provided by Friends of the Santa Cruz River, Pima County Regional Flood Control District, Pima County Regional Wastewater Reclamation Department, and Southwestern Arid Grassland Ecology.

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

Emily Brott, Sonoran Institute

Paul Fish, Arizona State Museum

Suzy Fish, Arizona State Museum

Akitsu Kimoto, Pima County Regional Flood Control District

Jeremy Moss, National Park Service, Tumacácori National Historical Park

Sherry Sass, Friends of the Santa Cruz River

Forrest Sherman, Friends of the Santa Cruz River and Southwestern Arid Grassland Ecology

Jason Welborn, National Park Service, Tumacácori National Historical Park

Claire Zugmeyer, Sonoran Institute

Special Thanks To:

Arizona-Sonoran Desert Museum – who provided a great venue for this event

Our esteemed panelists – who provided great fodder for the synthesis discussion (see page8)

Program

Monday April 15 9:00 – 5:00	9:00	Welcome	
	9:20	James Vint	<i>Early agricultural site of Las Capas</i>
	9:40	Emily Brott	<i>Living River - Lower Santa Cruz River</i>
	10:00	Frank Postillion	<i>Hydrologic evaluation of the Canoa Ranch area</i>
	10:20	Julie Stromberg	<i>Riparian vegetation response to effluent discharge</i>
	10:40	BREAK	
	11:00	Barnet Pavao-Zuckerman	<i>18th Century ranching, rendering, and regional economies</i>
	11:20	Alandra Kahl	<i>Trace organics as organic tracers</i>
	11:40	David Quanrud	<i>Fate of estrogenic activity</i>
	12:00	Poster Introductions (rapid fire - 2 minutes each)	
	12:20	BREAK LUNCH	
	1:20	Interactive Poster Session (all both days)	
	2:00	Evan Gwilliam	<i>Monitoring results: Tumacácori National Historical Park 2011-12</i>
	2:20	Mickey Reed	<i>Mapping Arizona wetlands</i>
	2:40	Thomas Sheridan	<i>Landscapes of fraud</i>
	3:00	BREAK	
	3:15	Day's Synthesis	<i>Tahnee Robertson, facilitator (summary of synthesis)</i>
	4:00	Posters/Networking	
Tuesday April 16 9:00 – 5:00	9:00	Welcome	
	9:20	Suzy Fish	<i>Traditional approaches for productivity and sustainability</i>
	9:40	Jacob Prietto	<i>Impacts of flow diversion on effluent infiltration</i>
	10:00	Tyson Swetnam	<i>Airborne laser swath mapping of vegetation and channel characteristics</i>
	10:20	Jennifer Duan	<i>Vegetation impacts on flow and sediment transport</i>
	10:40	BREAK	
	11:00	Jessica Gwinn	<i>Acid mine drainage impacts to invertebrate communities & food webs</i>
	11:20	Peter Reinthal	<i>Bioaccumulation of inorganic contaminants from past mining activity</i>
	11:40	Michael Lester	<i>Heavy metal accumulation in song sparrows</i>
	12:00	Poster Introductions (rapid fire - 2 minutes each)	
	12:20	BREAK LUNCH	
	1:20	Interactive Poster Session (all both days)	
	2:00	Laura Norman	<i>Can watershed models guide riparian restoration efforts?</i>
	2:20	Roy Petrakis	<i>Estimates of yellow-billed cuckoo habitat</i>
	2:40	Candice Rupprecht	<i>Conserve to Enhance</i>
	3:00	BREAK	
	3:15	Day's Synthesis	<i>Emily Brott, facilitator (summary of synthesis)</i>
	4:00	Posters/Networking	

Posters – posters up both days	
Elijah Allan	<i>Riparian ecosystem services: Akimel O'otham ethnomedicinal use of plants in the Salt and Santa Cruz Rivers</i>
Vanessa Bechtol	<i>Santa Cruz Valley National Heritage Area</i>
Carianne Campbell,	<i>Santa Cruz River at Cortaro Road – A volunteer restoration project</i>

Posters – posters up both days	
Marilyn Hanson	
Paul Fish	<u>Two villages on Tumamoc Hill</u>
Leila Gass	<u>A test of methods to measure vegetation change adjacent to gabions in Sonora, Mexico using Landsat imagery</u>
Josh Gormally	<u>Plants found along the effluent dominated stretch of the Middle Santa Cruz River</u>
Floyd Gray	<u>Nogales, Sonora flood warning and modeling network</u>
Pankaj Jamwal	<u>Using aerial photography and GIS for vegetation analysis of flood detention features in the Arizona borderlands area</u>
Akitsu Kimoto	<u>Historical Conditions Report for the Lower Santa Cruz River Living River Project – Predicting change in an effluent-dependent stream</u>
Hannah Moore	<u>Algae as bioindicators of stream function in acid mine drainage systems: Qualitative analyses of algal communities in Santa Cruz Watershed</u>
Koiya Tuttle	<u>Occurrence and fate of human and indicator viruses in the discharge from the Nogales Wastewater Treatment Plant in the Santa Cruz River</u>
Claire Zugmeyer	<u>Santa Cruz River conservation inventory mapping</u>

Summary of Synthesis Sessions

This is the first year that Santa Cruz River (SCR) Research Days incorporated a “synthesis session” at the end of each day of presentations. The purpose of the synthesis was to highlight common themes that emerge from this year’s event. To help us make this synthesis session most interesting and useful for participants, the Research Days planning committee invited a handful of people, with expertise in archaeology/history, riparian health, water quantity/quality, or restoration, to join a panel.

April 15 - Panel members:

Julia Fonseca, Pima County Office of Sustainability and Conservation

Kelly Mott Lacroix, University of Arizona, Water Resources Research Center

Pat O’Brien, National Park Service, Desert Southwest Cooperative Ecosystem Studies Unit

April 16 - Panel members:

Paul Fish, University of Arizona, Arizona State Museum

Hans Huth, private citizen

Ben Lomeli, Friends of the Santa Cruz River

Laura Norman, U.S. Geological Survey

Panel members were asked to attend the full day of presentations and think about the following questions:

- 1) What are 2-3 of the most interesting or compelling ideas you heard today?
- 2) Emerging issues/common themes
 - a. What emerging threats or challenges do you see in the SCR watershed?
 - b. What new opportunities for conservation and collaboration do you see in the SCR watershed?
 - c. What are implications for management?
 - d. What additional critical research questions or data gaps could help us better understand and address these issues?

During each day’s synthesis, panel members were asked to start the discussion by speaking for 5 minutes about the above questions and their “take home” message. After each of the panelists shared their thoughts, a facilitated discussion was held with the larger group. Below is a brief summary of the ideas (listed in no particular order) discussed by the group during the two synthesis sessions.

Most Interesting and Compelling Ideas:

- Water is central to both natural and cultural landscapes.
- Incorporating cultural resource work was not only interesting and compelling, but very useful for both research and management of natural resources.
- Though presentations covered very diverse topics, there was a strong interrelatedness among themes.
- Broad perspectives are important for managing a system; you can’t focus on only one part.

- How do we define the baseline or visions for the state of the river that we aim to conserve and or restore? This will vary by perspective, whether you're looking at the past or current state. The condition of the river has been a moving target over time; we likely can't define it as a single place/point in time. This would be an interesting discussion to have with this group.
- Interdisciplinary research can provide very compelling results – such as isotopic analysis to identify sources of pollution that are impacting aquatic communities.
- The past/present/future seems interrelated; ex. a historical pond at Canoa Ranch could be restored and serve as recharge.
- The rivers in this region are easily impacted by changes in flows.
- We'll never have all the science we need and will always have gaps in our knowledge. However, we might be overly cautious in terms of implementation. We need to balance these gaps while still trying to do good conservation work.
- We need a confidence to take more chances. How to reduce risk? Doing what we're doing during this annual event, learning from each other. To try and capture the art and feel from what others have done, and to mesh with the science. Listen to the land and learn to read the land. That's the bottom line of how we can successfully move forward.

Emerging Issues and Data Gaps:

- We need to understand how Arizona/Sonora economy impacts the natural and cultural landscapes.
- Need to understand the potential impacts of the El Pilar Mine along the river in Sonora.
- Many of the presentations focused on the river north of Mexico; we need to invite and encourage participation and networking with our colleagues in Mexico.
- Water pollution related to mining.
- The Santa Cruz River is unique because of the role that effluent plays; this needs to be further explored.
- Need to understand if improved infiltration rates along the Upper Santa Cruz River, in Santa Cruz County, are impacting the health of riparian areas.
- Using lidar technology, we could map how gabions are functioning on a regional scale.
- This region is a patchwork of jurisdictions; the current synergies should be analyzed and maximized.
- Interdisciplinary discussions pertaining to history, hydrology, and riparian resources would be helpful.
- There is a lack of natural recharge to many "shoe-string" aquifers – Long, narrow and shallow alluvial aquifers that are surrounded by bedrock. These types of aquifers are quickly replenished but also drain down very quickly.
- Emerging contaminants – ecologists and chemists studying these need to work together.

Other Discussion points:

- There are many stakeholders and groups missing from this event, including agencies, industry, regional non-profits, community groups etc.
- There are many "successes" that we didn't hear about, including projects like Kino wetland, run-off catchments, wiping out of bullfrogs and tamarix in certain parts of the watershed.
- New opportunities could include working with effluent owners and mines – potential water increases that could happen, more emerging contaminants work

- New opportunities for conservation/collaboration – only limited by imagination, groups that are not “conservation oriented” need to be brought into the conversation.
- Regarding possible cross-watershed network, AZ Riparian Council is going to try and coordinate all the Friends groups; still being determined, but at a minimum there would be a website with information about the various river groups.
- Management and collaboration in the watershed – should bring what was done in the Sonoran Desert Conservation Plan into this discussion. This is likely the only regional conservation planning that brought so many stakeholders together.
- The final presentation about the Conserve to Enhance program was a perfect capstone to the day and the event. This is one way to bring watershed/river awareness back into our culture, as it was for the Hohokam.
- Problems with regional models – may not work well for the local scale. Though they will help make a good first shot, follow-up and modification will be necessary.
- Bring people to the river – perhaps a short film could be made that comes from the Research Days group that would present the information discussed at the annual event. This could be a powerful messaging tool.
- There is such passion in the people working in the watershed; so many young people doing great work.
- Bureau of Reclamation plans to conduct research and mapping pertaining to the geohydrology of the Upper Santa Cruz River, including diversion and recharge basins, positive/negative impacts, Nogales area water storage.

Meeting Impact and Evaluation Results

This year we developed the first evaluation of Santa Cruz River Research Days to do two things – 1) try to assess and begin tracking the impact of this annual gathering on conservation efforts, and 2) get feedback from meeting participants to help with planning of future events. This represents a new section in the annual proceedings.

Quick Summary measures

OVERALL ATTENDANCE – 81 attendees over the course of 2 days; 43 of which were there both days. This is the largest attendance to date for this event.

UNIQUE AFFILIATIONS – attendees listed 37 different organizations, groups, agencies, university departments, local government, state/federal government, and community members as their affiliation.

Evaluation Results

TOTAL EVALUATIONS RECEIVED - 34

Of these 34 evaluations:

- Each affiliation option was selected at least once. Options included local government, state/federal government, organization, university, community group, interested individual, and other.
 - o Suggestions for additional affiliations included – private consulting, industry/business, landowner, watershed resident, business
- 15 were completed by attendees who attended/participated in both days

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

- The breadth of studies and research involving all aspects of the river and its inhabitants.
- The diversity of topics; networking opportunities to learn about research being conducted; cross-fertilization of disciplines in presentations, discussions
- The broad array of research and conservation work presented by different groups, university to government, nonprofit . . .
- The cultural/historical aspects - the talks from the Fishes and Thomas Sheridan were really terrific
- Very nice historical perspective and incorporation of chemical/microbial monitoring in place/planned
- All talks really nice blend of cultural and natural resource research, history and management activities
- Hearing presentations outside my field
- The high quality of all the presentations
- Breadth of participants expertise and experience
- Bringing together people and projects from the same area that may not know each other or be aware of other, similar work in the same geography
- Historic presentation and linkages with current management challenges
- Listening to diverse presentations vs only one theme
- Everything: talks, posters, synthesis, networking

- The range of the presentations
- The history and cultural info
- The presentation on mining
- Water quality data near patagonia lake
- Learning more about sources of water pollution from mining

QUESTION 2 - Facility

Was the space comfortable?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
20	8	6

COMMENTS - Generally the facility was viewed as comfortable. The most frequent comment - the chairs were too hard and uncomfortable. Other comments included – the space was a little small, temperature inconsistent, poor acoustics in the poster room.

Could you hear the presentation?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
33	1	0

COMMENTS - Comments regarding acoustics ranged from “very good”, to “mostly good”, to “ok”. One comment noted that acoustics were fine, but quality of projector was not ideal for some colors/text (note - this referred to day 1, and day 2 used a better projector)

Was the drive too long?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
4	28	2

COMMENTS - The majority of responses indicated the drive was not too long to attend the meeting. There were a few responses indicating the distance was “fair”, “100 miles round trip”, and likely far for people who don’t live close-by.

Other comments about the venue?

SUMMARY - The majority of the responses offered support, citing the beautiful location, quiet, ability to be outside, and ease of parking as positive attributes to hosting this event at this venue. A couple responses indicated desire to have more time to explore outside, including the museum, and perhaps having a tour with a museum docent during the lunch break. One response indicated a lack of presence from the Desert Museum host and that the location was great, but a different room, such as the Baldwin education would be preferred. There was also a suggestion to organize carpools for attendees.

QUESTION 3 - Content

Were the presentations useful?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
34	0	0

COMMENTS - Responses that included comments cited the great breadth of information presented, the usefulness of hearing all presentations, the high quality of presentations made, and the appreciation of learning new information. There were a couple comments regarding use of too much jargon and technical language that made it hard for people working in other fields to understand some presentations.

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

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
32	1	1

COMMENTS - A couple suggestions were made that 30 minutes might provide more time for questions. Alternatively, a couple comments said presentations should not be any longer, but more time made within the 20 minutes for questions. There was also a request to include speaker affiliations in the program.

Were the posters useful/interesting?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
32	1	2

COMMENTS - The majority of respondents found the posters and the poster session to be both useful and interesting. One response found the posters to not be very helpful or interesting and suggested not including posters in the future. One response stated a “neutral” opinion of the posters while another response indicated they didn’t view the posters and could not comment.

Were the 2 minute poster introductions helpful?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
26	2	6

COMMENTS - The majority of the responses indicated this new feature was very helpful and appreciated. A couple responses did not find the introductions essential, but liked getting to see presenters associated with the different posters. Suggestions for improvements were to: include images from the poster in the slide show, asking presenters to share major conclusions, asking presenters to not share the results and thus “give away the ending”, allow time for a little more depth, keep introductions to 2 minutes each, and maybe split the introductions over the two days.

QUESTION 4 – Synthesis and Networking

Was the day's synthesis useful?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
22	2	10

COMMENTS – Responses indicated that the synthesis was very useful as this was a time for greater interaction and the panelists had an opportunity to share their thoughts. There were several comments that this wasn't as useful as it could have been because many attendees left prior to the synthesis, a pattern reflected in several evaluations that did not answer this question. Suggestions for improvement included indentifying tangible action items and priorities, and integrating the synthesis more into the program to increase attendance.

Was the networking time useful (too much, too little, etc.)?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
26	1	6

COMMENTS – The majority of responses indicated the there was a good amount of networking time provided, though it was noted that the last networking/poster session of the day was not really attended. A suggestion for improvement was to choose a venue that could accommodate a nearby happy hour, as this would permit continued networking and discussion.

QUESTION 5 – New Collaboration

Research Days is designed primarily as a forum for learning. However, we hope this can galvanize new projects and collaborations, and help avoid duplication. The following two questions are helping us understand 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>
6	16	12

COMMENTS – Many responses indicated either no knowledge or being unsure. However, there were five unique projects or collaborations identified:

- Laura Norman (U.S. Geological Survey) working with Ron Pulliam (Borderlands Habitat Restoration Initiative)
- Blue Evening Star writing an article about Jess Gwinn/Peter Reinthal research on mining pollution in the Patagonia Mountains for Patagonia Regional Times and The FLOW (a Friends of the Santa Cruz River newsletter)
- New collaboration partners for USGS gabion monitoring project
- Pima County and Sonoran Institute partnership to bring the Living River report concept to the Lower Santa Cruz River as it flows through Tucson

- Results of USGS-UA interdisciplinary Sonoita Creek contaminant study are good enough to advance networking, re-present findings, etc. to stakeholders who didn't attend the SCRDR.

Has any new conservation funding resulted from this project or collaboration? If yes, was the funding new, existing, in-kind, or all of these?

<u>Yes</u>	<u>No</u>	<u>Other/No Response</u>
2	12	20

COMMENTS – The majority of evaluations did not respond to this question or did not know of any new conservation funding. One response listed both new and in-kind funding as the source of new conservation funds. The other yes response indicated “all of these”.

QUESTION 6 – **New Directions**

Since Santa Cruz River Research Days has been evolving over the years, this question was aimed at measuring the interest to expand and include potential new topics at future meetings. The following three topics were proposed:

	<u>Very Interested</u>	<u>Moderately Interested</u>	<u>Not Interested</u>	<u>No answer</u>
Expansion from river to watershed	21	10	2	1
Policy and planning implications of research	17	11	3	3
Trans-border issues	23	9	0	2

COMMENTS – The majority of evaluation responses indicated high interest in all three topics. However, there was some caution regarding adding more topics. There is the need to balance new directions with time to present valuable research. Adding topics would likely increase the length of the event; keeping the event to a max of two days was important to many.

Though some feel there is a need for greater watershed collaboration, others felt that expanding the scope to the watershed could diminish the networking focused on the river and would likely necessitate longer meetings. To address the subwatershed groups and address policy issues, perhaps a separate meeting/workshop would be of help. This workshop could be held annually, on a weekend, and marketed to a lay audience to include updates from the subwatershed groups, successful projects, successful approaches, research synthesis, and policy.

One suggestion was made to provide an additional option of “unsure”; perhaps those that did not answer would have chosen this option. Other suggestions were to expand on these topics only as they pertain to the river, as well as adding management to the policy/planning implications, because linking research and practice is very important. Additional topics suggested were focusing on the use of the river by different species and highlighting successful programs, grassroot efforts, and opportunities to engage.

Things people liked:

- the no-frills, informal character, low-/no-cost, and especially the brevity of the conference
- the synthesis - great idea
- great moderating of sessions and organizing of conference
- ordering of presentations
- incorporating the posters in the lunch hour

Suggestions for improvement:

GENERAL ORGANIZATION/LOGISTICS

- keep it free and brief
- invite more of the stakeholders (private land owners, ranchers, Native peoples, developers)
- make time for 10 min of participant introductions;
- invest in real nametags
- develop a map that shows the areas discussed
- add "turn off phones" to housekeeping
- add a "Call to Action" discussion, maybe as a wrap up
- keep attendance free but approach agencies/others to sponsor the break treats/drinks etc
- move it back to the library for 2014; the venue worked well in general, but the library is just a little more comfortable, spacious, ASDM is wonderful and was good overall

CONTENT

- researchers should discuss: what we are aiming for (for the watershed) and how could this be accomplished
- suggest communication ethos to presenters - communicate to broad range of expertise, important to communicate to non-specialists, including non-scientists ; less jargon, more meaning, and less methods (unless introducing new tool)
- have less modeling data and more results
- maybe posters should be more technical and presentations geared for broad audience
- incorporate take away points from previous meetings at beginning of event
- have the conclusions/next steps slides from each presentation compiled and shared
- prioritize actions based on one/two take-away messages from each presentation
- appreciate the cultural connections provided by invited speakers at a high level; this does not need to be a venue to report on every salvage archaeology project - already venues for that

OTHER IDEAS

- develop a video that explains: status of the river, history, global context, specifically identify polluters, how to stabilize landscape for watershed restoration

Presentation Abstracts

(Listed in alphabetical order by presenter)

A Living River: Charting wetland health of the Lower Santa Cruz River

BROTT, EMILY M., Sonoran Institute

Claire A. Zugmeyer, Sonoran Institute

Evan Canfield, Pima County Regional Flood Control District

Akitsu Kimoto, Pima County Regional Flood Control District

James Dubois, Pima County Regional Wastewater Reclamation Department

Ed Curley, Pima County Regional Wastewater Reclamation Department

Julia Fonseca, Pima County Office of Sustainability and Conservation

Brian Powell, Pima County Office of Sustainability and Conservation

The Lower Santa Cruz River (LSCR) in northeastern Pima County is Arizona's longest effluent-dependent river and provides the County's principal wetland habitat. Significant steps are underway to improve wetland health along the river, most notably Pima County's \$660 million wastewater treatment plant upgrade (Regional Optimization Master Plan, ROMP) to improve the quality of municipal effluent discharged into the river. Currently, no comprehensive monitoring strategy and reporting tool exists to track changes of wetland conditions. This EPA-funded project, a Living River: Charting Wetland Health of the LSCR, will develop a monitoring strategy and reporting tool using the successful *Living River* series created for the Upper Santa Cruz River as a model. With the assistance of a Technical Committee of experts and stakeholders, this project will develop a monitoring strategy, select indicators, determine baseline conditions, and assess the effect of effluent upgrades on wetland health. The expected outputs of the project include, 1) a historical conditions report that summarizes past conditions of the LSCR, 2) a monitoring strategy with quantifiable indicators that track changes of wetland health, 3) a selection process report that summarizes the process of selecting monitoring indicators, 4) three annual *Living River* reports that summarize wetland conditions for the selected indicators, and 5) numerous outreach efforts including a project website and public presentations. To date, the historical conditions report has been prepared and will be available on the Pima County Regional Flood Control District website. The report summarizes the historical stream discharges and loss, channel geomorphology, vegetation, water quality, macro invertebrate, and anticipated changes due to the ROMP upgrades. When completed, this project will provide numerous environmental outcomes including improved wetland protection, increased understanding of wetland conditions, and improved public understanding of wetland values.

Vegetation impacts on flow and sediment transport in the Santa Cruz River

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

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

The lower Santa Cruz has established stable vegetations in both main channel and floodplain due to long-term drought and nutrient-rich effluent flow. Those vegetations affect both flow hydrodynamic properties and in-stream sediment transport. As a consequence, channel morphologic changes are also affected by vegetation pattern, density, and flexibility. The resistance to flow through vegetated areas is increased by an additional

drag exerted by vegetation. Because of this additional drag, flow through vegetated areas decelerates and the mean velocities reduce comparing to unvegetated areas. Vegetation characteristics, such as vegetation-type, distribution, density, flexibility, and degree of submergence, affect flow hydraulic properties including flow depth, velocity, area, hydraulic radius, and energy slope. Vegetation roughness can be the dominant component of flow resistance in vegetated waterways.

This paper presents a one-dimensional unsteady flow and sediment transport model for simulating flood routing and sediment transport over mobile alluvium in vegetated channel network. The modified St. Venant equation together with the suspended sediment and bed load transport equations are solved simultaneously to obtain flow properties and sediment transport rates. The Godunov-type finite volume method is employed, and the flux terms are discretized by using the upwind and the HLLC schemes. Then, the Exner equation is used to solve for bed elevation changes. Vegetation in the channel is considered by incorporating a vegetation module to calculate flow roughness and bed shear stresses for sediment transport. At river confluences, water surface elevations are kept the same, and the law of mass conservation is used as the internal boundary conditions. An unprecedented flood event occurred in the Santa Cruz River, Tucson, Arizona, in July 2006, is used to test the performances of the model. Simulated results of water surface elevation and bed elevation changes with and without the vegetation module are compared with the measurements, and showed the vegetation impact is important for simulating river morphologic changes in the lower Santa Cruz River.

Traditional approaches to modifying the environment for productivity and sustainability along the Santa Cruz River

FISH, SUZANNE, University of Arizona
Paul Fish, University of Arizona

Hohokam ancestors of today's O'odham were farmers in the Tucson Basin by 4000 years ago. Unlike Hohokam living in the broader, flatter Phoenix Basin who constructed the most massive canal networks north of Peru and filled them from the perennial Salt and Gila rivers, the Tucson Hohokam relied on more diversified agricultural techniques. In the narrower valley of the intermittent Santa Cruz River, they too irrigated fields along the floodplain from canals of lesser magnitude. They harvested additional crops across basin slopes by diverting floodwaters from tributaries and by capturing overland runoff. Such varied Tucson agricultural strategies and their environmental effects are examined from the perspective of case studies in the Marana and Tumamoc Hill sectors of the Santa Cruz River.

Aquatic and riparian system monitoring results: Tumacácori National Historical Park 2011-12

GWILLIAM, EVAN, National Park Service, Sonoran Desert Network
Kara Raymond, National Park Service, Sonoran Desert Network

The presenters will present the results from NPS I&M monitoring at Tumacacori during water years 2011 and 2012, focusing on water quantity, channel morphology, water quality including data from extended deployments of logging multiparameter water quality sondes, macroinvertebrates and riparian vegetation. These results will be used make assessments of the current status of the aquatic and riparian systems at Tumacacori and possible implications of short term changes in stream discharge and long term impact of land use and climate change on these resources.

Comparative invertebrate community structure and food web dynamics in an upland acid mine drainage–impacted watershed, Patagonia Mountains, Santa Cruz County

GWINN, JESSICA E. , University of Arizona Department of Ecology and Evolutionary Biology

Floyd Gray, U. S. Geological Survey

John Chesley, University of Arizona, Department of Geosciences

David Dettman, University of Arizona, Department of Geosciences

Emily Washburne, University of Arizona, Department of Ecology and Evolutionary Biology

Peter N. Reinthal, University of Arizona, Department of Ecology and Evolutionary Biology

Abandoned mine sites within the Santa Cruz watershed can cause disturbance of aquatic biota assemblage on both small and large scales. Mine drainages in the Patagonia Mountains are of concern because acidic, metal-laden water periodically discharge into Sonoita Creek and Patagonia Lake, and may eventually reaches the Santa Cruz River near Rio Rico, AZ. Sonoita Creek has a rich native fish assemblage and Patagonia Lake has a popular sport fishery. Aquatic macroinvertebrate communities are excellent indicators of water quality, and as such, the stream community structure along various stretches of the upper Santa Cruz tributary system was determined. In addition we examined water quality and food web dynamics using stable isotopes in three streams with varying degrees of abiotic impairment; (1) Alum Gulch with elevated metal levels and low pH, (2) Humboldt Canyon with lower metal levels and low pH, and (3) Middle Harshaw Creek with low metal levels and neutral pH. Impaired stream reaches had macroinvertebrate community structure alterations and food web disruption, indicating an overall increase in predatory invertebrates. Alum Gulch had a decrease in both abundance and diversity of macroinvertebrates, especially pollution sensitive taxa. Harshaw Creek had the greatest diversity of macroinvertebrates and increased food web complexity. Humboldt Canyon was intermediate in diversity. Carbon and nitrogen isotopic results indicate a loss of lower trophic levels in metal impaired streams.

Trace organics as organic tracers: modeling fate and transport in the Santa Cruz River, Tucson, Arizona

KAHL , ALANDRA, University of Arizona, Department of Chemical and Environmental Engineering

Leif Abrell, University of Arizona

Jon Chorover, University of Arizona

David Quanrud, University of Arizona

Bob Arnold, University of Arizona

A suite of organic compounds that are commonly found in municipal wastewaters were measured as a function of distance/time of travel in US streams in the vicinities of Boston, MA; Austin, TX; and Tucson, AZ in order to determine the degree to which in-stream processes such as photolysis, adsorption and biochemical transformations attenuate trace contaminants that survive conventional wastewater treatment. Mass balances were developed for each compound based on streamflow and treatment plant effluent data for each location assuming that each compound was conserved. Predicted and measured values were then compared to indicate degree of attenuation with distance or time of travel. The mechanisms responsible for compound losses were investigated by comparing fractional loss to parametric indications of chemical hydrophobicity and biochemical degradability across the suite of chemicals selected for study. The most likely mechanism for attenuations of compounds with in-stream half times of hours to days (e.g. 9 hours in the Tucson basin) was biodegradation, based on correlations between fractional removal over a fixed interval of time/distance and compound-specific

biodegradation rate constants. Compounds expected to be biorefractory (Fluoxetine, triclosan, ibuprofen) were reduced in concentration during in-stream travel times of days to weeks. Responsible mechanisms could not be reliably assigned.

The distribution and extent of heavy metal accumulation in song sparrows of the Upper Santa Cruz River Watershed, Arizona

LESTER, MICHAEL B., University of Arizona, School of Natural Resources and the Environment

Charles Van Riper III, University of Arizona, School of Natural Resources and the Environment, and U.S.

Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station

Riparian ecosystems in arid environments provide critical habitat for breeding, migratory, and wintering birds, yet are often at risk of contamination with heavy metals. Birds and other animals living in contaminated areas are susceptible to adverse health effects as a result of long-term exposure and bioaccumulation of heavy metals. Our study took place as part of a collaborative effort to quantify the level of contaminants in the upper Santa Cruz River watershed. We chose to examine six sites that reflect different potential sources of contamination. We investigated the extent of heavy metal accumulation in blood and feathers of Song Sparrows (*Melospiza melodia*) over two breeding seasons. Body mass residuals and blood leukocyte (white blood cell) counts were used to assess Song Sparrow condition. Between 5 and 16 metals showed significant differences among sites, although most metals were below background concentrations. Cadmium, copper, mercury, nickel, and selenium in Song Sparrows did exceed background levels found in other studies but were lower than the levels found prior to an upgrade of the sewage treatment plant on the Santa Cruz River. Individuals captured in both years of this study generally showed higher concentrations in 2012 for 14 and 7 metals in blood and feathers, respectively, indicating that birds may be accumulating metals over multiple years. We found no major condition effects as a result of metal exposure, yet trends suggest that exposure to higher concentrations induces an immune response through increased leukocyte numbers. Continued monitoring of heavy metal concentrations in birds in the upper Santa Cruz watershed is recommended, as well as future studies examining how heavy metal contamination affects avian health and productivity.

Can watershed models guide riparian restoration efforts in the Borderlands?

NORMAN, LAURA, U.S. Geological Survey, Western Geographic Science Center

Ron Pulliam, Borderlands Habitat Restoration Initiative

Valer Austin, Cuenca los Ojos

David Seibert, Borderlands Habitat Restoration Initiative

In the headwaters of the Sonoita Creek, just outside of the little town of Patagonia, AZ, Borderlands Habitat Restoration Initiative (BHRI) are beginning to install rock gabion detention features in select streams and arroyos in an attempt to create a more appealing atmosphere to wildlife and humans alike. BHRI is using lessons learned from the San Bernardino Watershed, where Cuenca los Ojos (CLO) are restoring habitat through an ancient tradition of slowing erosion and harvesting water. The USGS is providing watershed model support to explore how remote sensing and virtual models can support restoration efforts; specifically, to optimize the placement and type of structures to slow flow, retain sediment, stabilize erodible channels, and increase water infiltration. At Deep Dirt Farm Institute: over 100 small rock erosion control structures will be built to stabilize channels; 10 large wood and rock post vanes will protect banks and grow native vegetation; and 3 large gabions will be

installed in strategically chosen eroding areas. Watershed analysis provides a template to help restoration practitioners prioritize restoration activities. In the first iteration of field work, a small channel, referred to as Bone Creek, is being remediated. It is the land-owner's contention that the Bone Creek was not a natural arroyo, and instead is the culmination of years of downcutting subsequent to the failure of a headwaters stockpond pre-1990. The landowner would like to stabilize the channel using a series of rock gabions or trincheras.

USGS visited the site to acquire a high-resolution Lidar dataset and derived a bare-earth DEM from these data. The high-res DEM was superimposed on the existing 10-m DEM to visualize changes incurred due to headcutting, and approximate source sediment load and hydrologic characteristics. A sub-watershed was created at the location of the stock pond, and rainfall-runoff models were employed to simulate volumes of runoff and trapped sediment. This presentation will take you step by step through the watershed modeling process to demonstrate how gabion structures respond to sediment loads and identify best management practices.

Ranching, rendering, and regional economies in the 18th-Century Pimería Alta

PAVAO-ZUCKERMAN, BARNET, University of Arizona

Spanish colonial missions were critical to the expansion of European economic institutions in the sixteenth through nineteenth centuries. Native American labor in mission contexts was recruited in support of broader programs of colonialism, mercantilism, and resource extraction. Animals and animal products were often important commodities within colonial-period regional exchange networks and thus, zooarchaeological data is crucial to the reconstruction of local economic practices that linked Native labor to larger-scale economic processes. Zooarchaeological remains from Mission San Agustín de Tucson, located in the Santa Cruz River Valley, and Mission Nuestra Señora del Pilar y Santiago de Cocóspera, located on a tributary to the Magdalena River to the south, demonstrate that Native labor supported broader colonial economic processes through the production of animal products.

Estimates of yellow-billed cuckoo habitat in the Upper Santa Cruz Watershed and the state of Arizona

PETRAKIS, ROY E., University of Arizona

Miguel L Villarreal, U.S. Geological Survey

Charles V. Riper, U.S. Geological Survey

Lowland riparian woodlands within the state of Arizona have limited distributions and in some areas are diminishing at a rapid rate due to modification of river systems for human uses. The Neotropical migrant yellow-billed cuckoo (*Coccyzus americanus*), which breeds in southwestern riparian areas, has faced recent population declines related to habitat loss and is a candidate for federal listing under the Endangered Species Act. To determine the most suitable breeding habitat in Arizona for the cuckoo we developed environmental niche models using freely available geospatial data sets and two years of presence/absence observations (n = 479). Riparian vegetation is often insufficiently mapped in land cover classifications, a result of classification scheme, intended audience, and geographic scale. Therefore we examined the influence of data accuracy, related to both thematic content and scale, on habitat estimation by developing habitat maps from vegetation/land cover data sources representing different geographic extents: national, regional, and state-wide. We also developed

aggregate vegetation maps based on the degree of agreement between these data sets which were defined as conservative (agreement between all, smallest areal extent), moderate (agreement between two or more, medium extent), or liberal (no agreement, largest extent). An independent validation conducted using high-resolution aerial photography proved that the aggregate data had higher map accuracy than the original source data alone. Original data sources and aggregate classes were used to develop multiple yellow-billed cuckoo habitat models, which when compared illustrate the effects of data quality on model accuracy, and the potential use of multi-source vegetation data for accurate species habitat models. We discuss the amount and distribution of yellow-billed cuckoo habitat in the Upper Santa Cruz watershed and compare it to other watersheds in the State of Arizona.

Hydrologic evaluation of the Canoa Ranch area

POSTILLION, FRANK, Pima County Regional Flood Control District

David Scalero, Pima County Regional Flood Control District

Mark Krieski, Pima County Regional Flood Control District

Pima County Regional Flood Control District has conducted a hydrologic evaluation of the Canoa Ranch, just north of the Santa Cruz/Pima County Line, with a focus on the historical and current water balance and how it has affected local groundwater-level conditions, and the potential impacts on the hydro- and meso-riparian vegetation of the Ranch. Freeport McMoran Mine pumps groundwater from large extraction wells spaced along the floodplain of the Santa Cruz River (SCR) on the Pima County Canoa Ranch property. Other wells include ranch and municipal wells in the vicinity. Pumping in the study area ranged from a low of 14,075 AF in 1992 to a peak of 24,990 AF in 2010. Average pumpage from 1984-2010 is 19,610 AF/yr. of which 83% is from the six mining wells on Canoa Ranch. Well water-level hydrographs confirm ground-water level decline due to the large pumping, beginning in the 1970s, can only be offset by large flood flows along the SCR similar to the 1978-94 period. The large declines experienced since 1995 will continue unless a sustained wetter climatic period occurs, a supplemental source of water is introduced, or groundwater pumping is significantly reduced. The future outlook for water resources and groundwater-level recovery on Canoa Ranch is mixed. Cyclic trends of climate suggest Canoa Ranch could transition into a wet period, based on relatively dry years from 1960-1976, wet years from 1977-1994, and dry years from 1995-2012. Climate models show a different outlook. SCR effluent will probably not reach Canoa Ranch due to better water quality, enhancing recharge, and diversion of a portion to the Alisos Treatment Facility. Canoa Ranch mine well field from 2014-2025 will pump 24% of the earlier 1984-2010 amount. From 2025-2042 (end of the mine plan of operation) pumping would increase to 44% of the 1984-2010 average.

Impacts of flow diversion on effluent infiltration

PRIETTO, JACOB, University of Arizona, Department of Hydrology & Water Resources

Evan Canfield, Pima County Regional Flood Control District

Akitsu Kimoto, Pima County Regional Flood Control District

Frank Postillion, Pima County Regional Flood Control District

David Scalero, Pima County Regional Flood Control District

In May and June of 2012, Pima County Regional Flood Control District (RFCD) conducted two bank protection repair projects on the effluent-dependent Santa Cruz River downstream of Cortaro Road and upstream of Twin Peaks Road, which resulted in decreased surface flow downstream. To prepare the site for the first project,

completed on May 4, 2012, water was diverted away from the bank protection into a parallel channel excavated in fine-grained sediment to the east. For the second project, downstream of the first, water was diverted into an abandoned, low flow channel to the east from May 21 to June 4, 2012, while the soil cement bank protection was repaired. RFCD became aware of the projects' effect on infiltration, as the downstream USGS Trico Road stream gauge recorded no flow conditions from May 21 to June 8, 2012. To better isolate the effects on infiltration, RFCD measured stream flow near the Twin Peaks Road Bridge on June 4, 6, 13, 20 and 29, 2012. Discharge rates during the high flow part of the day, consistently increased from 28 cfs to 50 cfs, demonstrating a reduction in losses over the observation period. Based on the timing that the USGS Trico Road gauge experienced no flow, it appears that the second diversion, which diverted flow into an existing channel resulted in the greater infiltration, assuming evapotranspiration to be constant and negligible. The results of the study indicate that the existing channels were effective conduits for infiltration, but over time the physical, biological, and chemical clogging processes ensued and losses were reduced. In contrast, the first diversion into a newly excavated channel did not noticeably impact downstream flows which indicated that some of the sediment is not as conducive to infiltration, even without the clogging layer.

Fate of estrogenic activity along the Lower Santa Cruz River, Arizona

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

Bingfeng Dong, Long Cheng, Alandra Kahl, Hao Vo, Stephanie Ruehl, Andrew Keller, Robert Arnold, and Eduardo Saez - University of Arizona, Chemical and Environmental Engineering

Many trace organic contaminants (TOrcs) that enter municipal wastewater through domestic use are only partially removed during conventional wastewater treatment. Many of these are innocuous in character (e.g. cholesterol) but they also include endocrine disrupting compounds (EDCs), such as estrone and other estrogenic compounds, at concentrations that are potentially deleterious to continuously exposed aquatic organisms residing downstream from discharge points of municipal effluent. In addition, EDCs and other TOrcs may accumulate in riverbed sediments via deposition of suspended solids or sorption of liquid-phase TOrcs during effluent infiltration/percolation in the riverbed. We evaluated the occurrence and fate of EDCs, measured as estrogenic activity, along a 25-mile reach of the Lower Santa Cruz River (SCR) as a function of distance downstream from municipal wastewater reclamation facilities in Tucson. River water, suspended solids, and riverbed sediments (top 2 cm) were sampled to establish the persistence of toxicity in river/sediments. Sampling was performed before and after the summer monsoon rainstorm season to assess associated impacts on sediment-bound endocrine disruption activities as consequence of increased streamflow rates during runoff events. Liquid-phase and suspended solid concentrations of estrogenic activity decreased by more than 99% during in-stream transport along the 25-mile reach of the SCR. Estrogenic activity concentrations in near-surface sediments were found to be highest in the pre-monsoon riverbed samples. Presumably, these sediments were scoured and transported downstream during high runoff events in summer, replaced by newly deposited (upstream) sediments possessing little or no estrogenic activity. This would thus represent an annual cycle of scour of "contaminated" sediment followed by deposition of relatively cleaner sediment in the riverbed along the effluent-dependent study reach.

Mapping Arizona wetlands

REED, MICKEY, University of Arizona, School of Natural Resources and the Environment, Advanced Resource Technology

L. Campbell, L. Mexicano, U. Nguyen, L. Perry, C. Wissler, D. Yeasmin - University of Arizona, School of Natural Resources and the Environment, Advanced Resource Technology

Under contract to AZDEQ, Advanced Resource Technology (ART) was charged with the development of an integrated geospatial database to support the monitoring and protection of wetlands in the State of Arizona, which will be added to the USFWS National Wetlands Inventory. A major requirement was the identification, delineation, and classification of wetlands to the class level of the Cowardin (1979) system, and their presentation in a series of spatial datasets representing seventy 8-digit hydrological units. Using a combination of existing vector layers from various agencies, we compiled a single composite raster layer that expressed rankings of likelihood of finding a wetland. Comparison with 2007 4-band 1-meter NAIP imagery revealed a close match between the raster predictor and objects on the ground. Visual inspection of the imagery at 1:10,000 also revealed many sites that had not been recorded previously by any agency. The acquisition and attribution of wetland polygons was undertaken by a crew of six analysts and took about two years. Each watershed contained an average of about 1000 polygons. QA/QC protocols were developed to insure seamless integration of features and attributes across watershed boundaries, logical and geometric consistency between datasets, and the development of metadata standards. Of the 1635 polygons drawn in the two units of the Santa Cruz River watershed, 444 directly characterized the river itself. In the Upper unit, 841 ha. were classified as palustrine areas, either forested, scrub-shrub, or unconsolidated shore. Of the 1646 ha. of riverine areas, there were 602 ha. of intermittent streambed and 1044 ha. of perennial unconsolidated bottom or shore. In the Lower (downstream) unit, 294 ha. were classified as palustrine wetlands. A total riverine area of 1494 ha. was comprised of 1113 ha. of intermittent streambed and 380 ha. classified as perennial bottom, shore, or emergent.

Inorganic contaminants from past mining activity: bioaccumulation in fish and aquatic macro-invertebrates, Santa Cruz Watershed, Arizona.

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Floyd Gray, U.S. Geological Survey

Jessica E. Gwinn, University of Arizona, Department of Ecology and Evolutionary Biology

The Patagonia Mountains in the Santa Cruz watershed have a long history of mining activity which has left many tainted aquatic systems. Identifying extent, sources and transportation methods of metal contaminants in these aquatic systems is paramount to understanding function of acidic and heavy metal laden ecosystems. We collected fish and aquatic macroinvertebrates from 2007-2012 from a variety of lakes and streams in the Santa Cruz basin (Patagonia Mountains, Sonoita Creek, Patagonia Lake and Pena Blanca Lake) to examine bioaccumulation of heavy metal contamination. High Resolution Inductive Coupled Plasma Mass Spectrometry (HR-ICP-MS) was used to analyze fish and aquatic macroinvertebrate tissues for 59 inorganic contaminants. In addition, we used lead isotopic analysis to examine soil, water, and aquatic biota to determine possible point source pollution locations in relation to known mine locations. Numerous contaminants are found in very high levels in both invertebrates and fish which are geographically near past mining areas. Lead (Pb) and mercury (Hg) were elevated in predatory invertebrates when compared to detrital feeding invertebrates. Of the five species of fish tested, the predatory sport fish, largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*) had the highest levels of Hg and Pb. Elevated Hg and Pb in predatory fish from these lakes are of special concern because they are consumed by humans.

Conserve to Enhance: A tool for linking consumer water efficiency and urban wash enhancement in Tucson

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Aaron Lien, University of Arizona Water Resources Research Center

Sharon Megdal, University of Arizona Water Resources Research Center

Emily Brott, Sonoran Institute

Claire Zugmeyer, Sonoran Institute

Karilyn Roach, Watershed Management Group

Lisa Shipek, Watershed Management Group

The University of Arizona Water Resources Research Center (WRRC) is exploring ways to meet the challenge of water for the environment in Arizona. The Sonoran Institute, Tucson Water, Watershed Management Group, and WRRC have partnered to engage Tucson Water customers as pilot program participants to voluntarily conserve water and contribute the value of their savings to the Conserve to Enhance (C2E) fund. From January 2011 through December 2012, 58 pilot participants engaged in a variety of water conservation actions, including water harvesting workshops and pledged donations based on monthly water savings to a C2E fund. C2E pilot participants saved 2.2 million gallons of water and donated over \$2,000 in donations during the pilot. Simultaneously, C2E has gained political support through a voluntary check box on the Tucson Water utility bill that was approved by City of Tucson Mayor and Council and provides thousands of dollars in additional funding for local C2E projects annually. Check box funds and participant donations were invested in a riparian enhancement project adjacent to Atturbury Wash in Lincoln Park, on the south side of Tucson in October 2012. A one-acre passive rainwater harvesting site that includes three rock-lined basins, over 25 native trees and shrubs and a raised viewing path was designed and completed by Tucson Audubon with the help of over 30 volunteers. In 2013 C2E will be funding new urban wash and neighborhood enhancement projects throughout Tucson.

Landscapes of Fraud: Mission Tumacácori, the Baca Float, and the betrayal of the O'odham

SHERIDAN, THOMAS, University of Arizona

This paper examines the production and destruction of space in the Santa Cruz Valley from late pre-Columbian times to the bankruptcy of the Rio Rico development in 1975. Independent O'odham communities occupied the upper Santa Cruz Valley in the late 1600s when Spaniards and Jesuit missionaries first settled what they called the Pimería Alta. Jesuit missions attempted to transform O'odham conceptions of both space and time but also protected a mission land base which became a Spanish land grant vested in the O'odham community of Tumacácori in 1807. Beginning in 1845, however, real estate speculation and land fraud destroyed two land-based communities of small rancher-farmers---the O'odham in the late 1840s and homesteaders in the early 1900s---as the U.S. Supreme Court threw out a legitimate land grant and confirmed the fraudulent Baca Float No. 3. Land in the Santa Cruz Valley was transformed from an extension of community to a factor of reproduction, then production, and finally into fictitious capital, bought and sold for its speculative value in Santa Fe, Dallas, and the East Coast.

Nitrogen and nitrophiles: Riparian vegetation response to effluent discharge

Stromberg, Juliet C., Arizona State University, School of Life Sciences

Margaret White, Arizona State University, School of Life Sciences

In riparian ecosystems of southwestern United States, declines in stream flows coupled with release of treated municipal wastewater have resulted in the emergence of effluent-dominated waterways. The combined effects of increased water availability and nutrient concentrations on these ecosystems are not well understood. Through greenhouse and field studies, we asked: Do elevated nutrient concentrations cause shifts in species composition? And, does water table of the receiving stream influence riparian forest development? We examined plant response in a greenhouse fertilization experiment and by sampling vegetation at field sites along the effluent-dominated Santa Cruz River and the San Pedro, a reference river. The greenhouse experiment and natural field experiment both indicated that nutrient enrichment alters community composition, producing shifts toward nitrophiles (species with strong response to nitrogen addition). Patterns of exotic vs. native species were more complex, with differing responses in the field and greenhouse. With respect to forest abundance, the forested area differed at least 2-fold between shallow and deep water table reaches. Patterns of change in composition and area with distance from effluent outfall varied between study reaches owing to unique landscape contexts.

Airborne laser swath mapping of vegetation and channel characteristics along the Lower Santa Cruz River

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Brian Powell, Pima County Office of Conservation Science & Environmental Policy

D. Phillip Guertin, University of Arizona, School of Natural Resources and Environment

For part of the EPA's Reviving River Project along the Lower Santa Cruz River, Pima County is tasked with evaluating the effects an effluent water quality upgrade will have on 1) the channel characteristics and 2) the vegetation within the existing waterway. The Pima Association of Governments (PAG) began commissioning aerial laser swath mapping (ALSM), also called airborne Light Detection and Range (LiDAR), flights over the Santa Cruz River valley and Metropolitan Tucson in 2005, with a complete re-flight in 2008, and a partial re-flight in 2011. Currently PAG expects a three-to-four year return interval, with the next planned re-flight in 2015. The purpose of this report is to summarize the utility of the previous LiDAR collections and to develop recommendations for the future 2015 acquisition. Here we report on a step-by-step procedure for how the 2005, 2008, and 2011 LiDAR characterizes associated changes in the channel morphology and vegetation structure with a particular focus on the 2005-2006 flood events. Additionally we propose a method for classifying vegetation from LiDAR with multi-spectral orthophoto imagery.

Recent research at the early agricultural site of Las Capas, Pima County, Arizona

VINT, JAMES M., Desert Archaeology, Inc.

Desert Archaeology, Inc., conducted intensive and extensive archaeological excavations at the site of Las Capas from August 2008 through September 2009. This Early Agricultural irrigation community is located on the Santa Cruz River floodplain where the modern Ina Road Regional Waste-water Reclamation Facility (IRRWWF) currently

operates. These excavations were carried out under Pima County Cultural Resource legislation as part of this large County bond-funded regional waste-water upgrade project.

The site of Las Capas dates from circa 1250 BC to 800/750 BC, and has several well-documented serial occupations preserved in floodplain deposits. Las Capas was first identified in the late 1970s, but not investigated in detail until work conducted in 1998 by Desert Archaeology, Inc., and in 1999 by SWCA, Inc. These two projects provided important base-line information about the site, including stratigraphic and radio-carbon based chronology, material culture, and documentation of maize agriculture sustained by canal-fed irrigation. This paper presents a summary of Desert Archaeology's 2008-2009 field season, which had the luxury of exploring over 60 acres within the IRRWRF campus and intensively excavating nearly 7 acres. Field work documented an extensive irrigation system that was initiated around 1250 BC and persisted, with modification and adaptation to changes in the floodplain, until around 800-750 BC when a major flood apparently caused significant and irreparable damage to the canal intake and across the farmed floodplain surface in general. Details are presented on the canal and field system, which at this time is the best documented and most intensively studied example of a system this age in the American southwest. Results of ongoing analyses of paleoenvironmental and material culture data are also summarized. This work has greatly increased our understanding of Early Agricultural settlement, subsistence, and community organization.

Poster Abstracts

(Listed in Alphabetical order by presenter)

Riparian ecosystem services: Akimel O’otham ethnomedicinal use of plants in the Salt and Santa Cruz Rivers

ALLAN, ELIJAH, Arizona State University, School of Life Sciences

Juliet Stromberg, Arizona State University, School of Life Sciences

Semi-arid riparian zones in the Southwest U.S. provide habitat for many native and introduced plants. Several riparian areas are being restored by planting native species and clearing introduced species, tasks that require funding and labor to complete. Plants are a primary source of medicinal compounds, and National Institute of Health sponsored surveys indicate that use of Complementary and Alternative Medicine (CAM) has increased in recent years. The Phoenix metro area’s minority population, major users of CAM, also has increased. We asked: Does the number of potential medicinal and food sources differ between native and introduced plants in the Salt River and Santa Cruz riparian zones? We directly inventoried study sites for plant composition and also queried SEINet (a regional plant database) to determine the names of trees and shrubs growing along the river. To determine medicinal uses (particularly ethnomedicine of Akimel O’otham (AO) people) we queried several ethnobotany/medicine databases, and accessed prior information from AO elders. Of 52 woody plants, 40 native and 12 introduced, 29 had CAM uses. One introduced plant had actual AO CAM use, while the greatest CAM potential (20 medicinal applications) was found in an introduced tree species. We conclude that native and introduced woody plants in the Salt Rivers do provide potential for plant-centered CAM use. Consideration of the plants’ ethno-functional roles could be used as a basis to determine whether or not to weed plants from restoration sites.

Santa Cruz Valley National Heritage Area

BECHTOL, VANESSA, Santa Cruz Valley Heritage Alliance

The Santa Cruz Valley Heritage Alliance is a non-profit organization that has been working towards designation of the Santa Cruz Valley National Heritage Area since 2003. With broad and bi-partisan representation and support, the Heritage Alliance developed a feasibility study for the National Heritage Area in 2005. The Heritage Alliance is the local coordinating entity for the Santa Cruz Valley National Heritage Area and will be responsible for promoting the Heritage Area and coordinating heritage education, preservation, and promotion projects, with extensive public input and participation.

Telling America’s Story - National Heritage Areas are designated by Congress as a place where natural, cultural, historic and recreational resources combine to form cohesive, nationally distinctive landscapes arising from patterns of past and present human activities shaped by geography. These patterns make the regions representative of the national experience through the physical features that remain and the cultural traditions that have evolved in the areas. Distinctive Stories of the Santa Cruz River: Sky Islands and Desert Seas, Streams in the Desert, Bird Habitat and Migration Routes, Native American Lifeways, Desert Farming, Ranching Traditions, Spanish and Mexican Frontier, Mining Booms, U.S. Military Posts on the Mexico Border, and U.S.-Mexico Border Culture.

Congressional designation as a National Heritage Area supports local heritage preservation, promotion, and education projects, such as promotion of heritage destinations and historic sites, heritage education programs, heritage foods promotion and education, riparian restoration, rehabilitation of historic buildings, and more. The proposed boundary of the Santa Cruz Valley National Heritage Area was selected because it marks an area that is a source of identity for residents, is a coherent natural and cultural landscape, and contains sufficient nature and heritage resources of national significance to support a National Heritage Area designation and promote heritage tourism. The boundary does not impose any additional local, state or federal regulations.
www.SantaCruzHeritage.org

Santa Cruz River at Cortaro Road – A volunteer restoration project

CAMPBELL, CARIANNE, Arizona Native Plant Society, Tucson Chapter and RECON Environmental, Inc.
MARILYN HANSON, Arizona Native Plant Society, Tucson Chapter

The Tucson Chapter of the Arizona Native Plant Society (AZNPS) has coordinated with the Pima County Regional Flood Control District and the Town of Marana to restore an approximate 5-acre disturbance along the Santa Cruz River that resulted from repairs to the low flow bank protection of the river at that location. AZNPS designed a site-specific planting and seeding palette, and was able to obtain donations of restoration-quality plant materials and DriWater irrigation supplement. Installation began in August of 2012 and AZNPS has maintained monthly volunteer days to: construct water harvesting basins; install plants and herbivory protection; water and mulch plants; remove invasive, non-native plants including buffelgrass (*Pennisetum ciliare*), Mexican paloverde (*Parkinsonia aculeata*), and buttongrass (*Dactyloctenium radulans*). Volunteer interest has been high, with many volunteers returning for multiple events. AZNPS is seeking other opportunities to conduct volunteer restoration projects in southern Arizona.

Two villages on Tumamoc Hill

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A prominent Tucson land Mark, Tumamoc Hill has an extensive complex of stone *trincheras* features. It is the only such hill site in southern Arizona with substantial, well-documented occupations dating to the Early Agricultural (Cienega phase, 500 to 300 B.C.) and Early Ceramic (Tortolita phase, A.D. 475 to 600) periods. Massive walls and terraces encircling the hilltop represent one of the earliest communal-scale constructions in the U.S. Southwest. A diversity of other stone features are concentrated on the summit. Using current mapping techniques, augmented by excavations, recent University of Arizona investigations have generated data that allow an organizational assessment of Tumamoc's Tortolita phase in Santa Cruz valley settlement at the beginning of the Hohokam sequence.

A test of methods to measure vegetation change adjacent to gabions in Sonora, Mexico using Landsat imagery

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In the southwestern United States and northern Mexico, climate and land use change have resulted in lowered water tables, reduced vegetation cover, and increased erosion. In Nogales, Sonora, flood detention gabions have been installed in tributaries where flooding is a problem. In other borderland watersheds, gabions of various sizes and design are being installed to control erosion, restore habitat and improve surface and groundwater conditions. The work presented here is a subset of a project aimed at quantifying potential impacts of gabion structures in this region. We are exploring methods to measure changes in vegetation associated with different types of gabions, in watersheds with various types of hydrologic regimes. Results may help guide future construction and maintenance of gabions. We mapped the locations of known flood detention gabions in the upper Nogales watershed, and created random (control) points on stream beds in the same area. We created buffers around gabion and random locations, 60 m on each side of the stream and 150 m upstream and downstream. These buffers approximated the expected riparian area of influence of the gabions, and for the random locations. We obtained Landsat Thematic Mapper images (30 m) from May/June (a generally dry period), for the years 1984-2010, and calculated mean Normalized Difference Vegetation Index (NDVI) values, for the buffer areas. This allowed us to track changes in vegetation greenness around the gabions and control points. Results show little difference in NDVI for areas with and without dams, in the Nogales area. By contrast, erosion control structures installed in northeast Sonora on the San Bernardino Ranch have been associated with an increase in vegetation. We are currently exploring methods for detecting vegetation response to gabion emplacement, and for determining the driving factors for differences in vegetation response. We request feedback from the audience on these issues.

Plants found along the effluent dominated stretch of the Middle Santa Cruz River

GORMALLY, JOSH , Orascom

During thesis work in the spring of 2002 60 plant species were identified by the author along the lower effluent dependent stretch of the Santa Cruz River. In the fall of 2011 an additional 43 plant species were identified by the author in the field or noted as existing in the area using the UA Herbarium's database, for a total of 103 existing effluent dependent plant species. An article was written and published by the author describing these plants in "Desert Plants", Volume 27, Number 1, June 2011. This poster will present and describe these plants to interested viewers. It will include photographs of some of the predominant and more notable species.

Nogales, Sonora flood warning and modeling network

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The University of Arizona Water Resources Research Center (WRRRC) is exploring ways to meet the challenge of water for the environment in Arizona. Conserve to Enhance (C2E) is an innovative financial mechanism that links voluntary water conservation actions to environmental enhancement projects and the first pilot of this concept has been underway in Tucson, Arizona since January 2011. The Sonoran Institute, Tucson Water, Watershed Management Group, and WRRRC have partnered to engage Tucson Water customers as pilot program participants that will conserve water and contribute the value of their savings to the C2E fund; this fund will support restoration work at Atturbury Wash (southeast Tucson), as well as smaller scale neighborhood projects. C2E has gained local support and a voluntary check box on the Tucson Water utility bill was approved by City of Tucson Mayor and Council that provides additional C2E funding for local projects. Forty-five of the 60 participants are receiving subsidies provided by the US EPA to implement rainwater harvesting practices, designed to increase household water savings and improve backyard environments. Monthly water use is tracked by Tucson Water and provided to participants on a quarterly basis, along with a suggested donation for the value of water conserved. In the first year of the C2E pilot, program participants saved over 1.1 million gallons of water and donated \$1,074 to the C2E fund. This poster details outcomes from the first year of the Tucson pilot and explores the idea that programs like C2E that connect water conservation to environmental enhancement, provide a new, unique motivation for water conservation and raises awareness about water resources-related environmental benefits. Lessons learned during program development in Tucson will help inform implementation of C2E in other communities.

Using aerial photography and GIS for vegetation analysis of flood detention features in the Arizona borderlands area

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A vegetation mapping system for change detection was tested at the borderlands areas between southern Arizona and northern Sonora, Mexico to examine the impact of flood detention features on riparian vegetation. Gabions (rock dams) are present in the Nogales watershed and multiple agencies have tried using gabion and other detention features to help restore vegetation and habitats to native conditions, however, little is known about the impact of these features on riparian vegetation. The objective of this study was to analyze vegetation changes through time from before and after gabion construction by integrating aerial photography and geospatial analysis tools. We identified fifteen dams/gabions and riparian vegetation around these gabions was

digitized manually using a series of aerial photographs or high-resolution satellite images. The data used in this study was acquired in 2003, May 12, 2011 and October 23, 2012 in Arizona and northern Sonora, Mexico and accessed via Google Earth. Polygons of digitized vegetation were compared over time. The data was compared through the same season over the year. In addition, precipitation data during these periods will be analyzed to evaluate its impact on vegetation. Results show that in the Nogales watershed there is little significant vegetation change related to gabion installation. Future studies could be done to compare areas showing some change over time with vegetation indices derived from satellite imagery for the same location. We also promote more monitoring efforts to map potential changes in the future.

Historical conditions report for the Lower Santa Cruz River Living River Project – Predicting change in an effluent-dependent stream

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Pima County has collected and analyzed historical data on the conditions of the effluent-dependent Lower Santa Cruz River as part of the county's 4-yr EPA-funded grant. The project aims to understand the effect of treatment plant upgrades on the health of this large wetland system. The project will ultimately convey information about current conditions of the river to the public in a series of annual Living River reports. Pima County will also use results to develop a Lower Santa Cruz River Management Plan, fulfilling a recommendation of a recent Pima County/City of Tucson initiative to better manage all available water sources, including effluent. The Historical Conditions Report compiles and interprets existing data on water quantity, flow regime and geomorphology; vegetation; water quality; and macroinvertebrates. The report also discusses likely changes we expect to see from improvement in water quality of the discharge to the stream. The most dramatic impacts are likely to result from decreased nutrient load. Infiltration rates are expected to increase as biofilms forming the clogging layer become less pervasive. Because biofilms provide cohesion to streambed sediment, the sediment transport dynamics and associated morphology of the flow channel may change as well. Vegetation distribution may change in response to changes in infiltration, as more water percolates to groundwater closer to the treatment plants, and less water is available to downstream reaches. In addition, some plants, such as nitrophobic forbs, may become more abundant as water quality improves. Finally, treatment plant upgrades are expected to improve aquatic habitat and conditions for birds and wildlife. In summary, the Historical Conditions Report gives us a better understanding of current river dynamics by reviewing existing data, and anticipates some significant changes in river functions for the Lower Santa Cruz River in response to imminent water quality improvement.

Algae as bioindicators of stream function in acid mine drainage systems: Qualitative analyses of algal communities in Santa Cruz Watershed

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Acid Mine Drainage (AMD) alters stream characteristics usually via an input of acidic and metal-laden water from abandoned mines and tailings. In the Santa Cruz watershed, many geologic workings, tailings, and mine drainages periodically discharge metal-rich, acidic water and leachates into surrounding streams. These impacted aquatic systems are characterized by increased acidity and metal levels. Algae communities can be used as bio-indicators of stream function as indicated through decreased biodiversity and primary production. Here we examined algal communities in two sites in the Patagonia Mountains: Harshaw Creek, with neutral pH and low metal content and Alum Creek, with inputs from mine tailings and adits, which has relatively low pH and elevated metals content. We qualitatively analyzed the algae community structure during pre- and post-monsoon seasons, February 2011 and July 2011, respectively. Harshaw Creek had higher algae generic richness (14 total genera present with five of those being Chrysophyta, six Chlorophyta, and three Cyanophyta/ Dinoflagellates) than Alum Gulch (seven genera present with four being in Chrysophyta and three Chlorophyta) in both seasons. Based on these preliminary findings, we will investigate algae diversity of both sites using quantitative techniques. We will use a Sedwick rafter slide to determine the relative abundance of the algae, as indicated by average cell counts, present at each location. Fluorometric techniques will be used to examine the amount of chlorophyll A, a key biochemical component in photosynthesis, in each stream. Both measurements will be compared to a light-dark test to determine the productivity of each site. Such information is crucial to understand the impacts of abandoned mines on aquatic resources and biotic communities in the Santa Cruz drainage.

Occurrence and fate of human and indicator viruses in the discharge from the Nogales Wastewater Treatment Plant in the Santa Cruz River

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Human enteric viruses are believed to be the major case of recreational waterborne illness. The goal of this project was to assess the removal of enteric viruses and an indicator plant virus during treatment at the Nogales International Wastewater Treatment Plant (NIWTP) and their fate after discharge into the Santa Cruz River. The NIWTP uses three treatment steps (i.e., activated sludge, sand filtration, and ultraviolet light disinfection) and discharges approximately 15 to 17 million gallons of treated wastewater into the Upper Santa Cruz River daily. The river maintains an in-stream flow for approximately 23 to 27 miles before receding underground near Amado, Arizona. The presence of viruses known to persist during wastewater treatment was determined using an HA negatively charged membrane filter method to concentrate the viruses followed by quantitative PCR (qPCR) (polymerase chain reaction) analysis. The concentrations of pepper mild mottle virus (PMMV), Aichi

virus, enteroviruses, and adenoviruses were between 10^4 and 10^5 genomic copies per ml in the untreated wastewater. Aichi virus, enteroviruses, and adenoviruses were reduced by 90~99% by wastewater treatment, whereas PMMV was reduced by less than 90%. Norovirus was not detected in either the pretreatment or post-treatment samples. Human enteric viruses were not present in the river, although the river had exceeding high concentrations of total coliforms and *Escherichia coli* during the monsoon months. Nevertheless, PMMV was present at the same levels detected in the NIWTC effluent throughout the sampling range from Rio Rico, AZ to Amado, AZ (approximately 27 miles). During the monsoon season The apparent lack of influence on the water quality of viruses in the river from the NIWTP is likely the result of effective wastewater treatment and dilution during the monsoon season.

Santa Cruz River conservation mapping

ZUGMEYER, CLAIRE, Sonoran Institute

Emily Brott, Sonoran Institute

Attendees of the annual Santa Cruz River Research Days (SCRRD) have identified a need to expand collaboration, partnership, and sharing of lessons learned across the watershed. To help guide this interest, Sonoran Institute organized a symposium on 2 May 2012 entitled “Santa Cruz River Conservation”. The symposium was held within the Madrean Archipelago III conference and included a binational mapping session to inventory current knowledge of natural resource conservation efforts in the watershed. Updated maps displaying the results will share the 2012 inventory and provide an opportunity for SCRRD attendees to identify and update conservation efforts. In particular a mapping activity at this year’s SCRRD could identify efforts focused on cultural resources, part of the expanded focus of the annual event. If successful this activity could recur annually and serve as a helpful tool to track diverse and widespread efforts, identify and guide future projects, and help increase collaborations and partnerships in both natural and cultural resource conservation.

Additional Research

Not everyone conducting research, monitoring, or restoration on the Santa Cruz River were able to attend this year's conference. Therefore we have included the following additional abstracts to provide a more comprehensive record of current conservation efforts.

Conservation and mitigation program: An overview and progress update of Arizona's newest conservation program

LASHWAY, Sharon, Arizona Game and Fish Department

The Conservation and Mitigation Program (CAMP) was created in 2011 to reduce and offset impacts of the Arizona Game and Fish Department's (AGFD) Sportfish Stocking Program as identified through the ESA and NEPA process as the result of Section 7. The CAMP is responsible for fulfilling conservation and mitigation measures for threatened and endangered (T&E), Candidate, and sensitive species that may be affected by the AGFD sportfish stocking program. There are 45 mandatory measures that CAMP will be responsible for fulfilling within the next ten years. The Tucson Region of the Arizona Game and Fish Department is currently working towards meeting these measures through various projects specifically working with the Chiricahua Leopard frog (*Rana chiricahuensis*) and the Northern Mexican gartersnake (*Thamnophis eques megalops*).

Santa Cruz River restoration – San Lázaro, April 4-7, 2013

MORRIS, Christopher, Sky Island Alliance

Erosion issues stemming from human manipulation of the waterways for agriculture, ranching and a burgeoning urban population have impacted the Santa Cruz River throughout the region. However, near San Lázaro, Sonora, the river still flows naturally most of the year. Applied restoration techniques, including reforestation and cattle fencing, are expected to increase water flow and habitat benefit for migratory birds in this reach of the river by providing seasonal rest from grazing pressure that encourages recruitment of riparian trees. Over the course of a dozen or so visits during the previous few years, Sky Island Alliance (SIA) and key partners at Sonoran Institute met with local ranchers, including Ventura Rivera from Arroyo Milpillias, to discuss local concerns about water and possible opportunities for collaboration. On April 4-7, 2013 a group consisting of seven binational volunteers, restoration guru Van Clothier of Stream Dynamics, and two SIA staff members conducted a workshop to initiate reforestation on a stretch of the river near San Lázaro. Over the course of a long weekend the workshop successfully engaged local youth and planted an estimated 500 saplings. The saplings were dispersed along the river in sites managed by five different local ejido (communal lands) members. An increase in woody plants along the banks will help anchor soils, allow water to better infiltrate, and provide enhanced wildlife habitat.

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