



Southwest Biological Science Center Updates

As a unit of the U.S. Geological Survey (**USGS**), the mission of the Southwest Biological Science Center (**SBSC**) is to provide quality scientific information needed to conserve and manage natural and biological resources, with an emphasis on the species and ecosystems of the southwestern United States. The SBSC has two research branches: *Terrestrial Dryland Ecology* and *River Ecosystem Science*, which includes the Grand Canyon Monitoring and Research Center (**GCMRC**). Both branches conduct research on the biology, ecology, and natural processes of the Southwest. SBSC has two research stations in Arizona (Flagstaff and Tucson) and one in Moab, Utah. You can find the SBSC online at: <https://usgs.gov/centers/sbsc>.

WELCOME

Below are recent products and activities coming from the SBSC, and **SBSC personnel have an asterisk after their names**. If you would like more information about the SBSC or with anything in this month's update contact Todd Wojtowicz (twojtowicz@usgs.gov).

IMAGE OF THE ISSUE



Water from Glen Canyon Dam's four jet tubes during the November 2018 High-Flow Experiment (HFE) on the Colorado River. For more information on Colorado River HFEs:

https://www.usgs.gov/centers/sbsc/science/high-flow-experiments-colorado-river?qt-science_center_objects=0#qt-science_center_objects

(Photo credit: Mike Moran, USGS)

OUTREACH

Media, Broadcasts, Books and Films

Find us on Twitter

Look for us on Twitter (<https://twitter.com/usgsaz>). We post photos depicting field work, restoration approaches, arthropods, wildlife, flowers, and beautiful natural areas. We also provide links to our website and highlight some of our recent science.

Where Have All the Turtles Gone, and Why Does It Matter?

1) National Geographic published an article about a recently published paper with SBSC's Jeff Lovich* as the lead author. The article focuses on the global status of turtles and the ecological roles they play. Jeff and one of the paper's co-authors, Whit Gibbons, were interviewed for the article. The National Geographic article is titled **What if There Were No More Turtles** and can be found here:

<https://www.nationalgeographic.com/animals/2018/09/turtles-endangered-biodiversity-ecology-tortoise-terrapin-animals/?user.testname=none>. The paper the article is based on is titled **Where Have All the Turtles Gone, and Why Does It Matter?** and can be found here: <https://academic.oup.com/bioscience/advance-article/doi/10.1093/biosci/biy095/5079873>.



Moroccan turtle (Photo credit: Jeff Lovich, USGS)

2) Anthropocene Magazine recently published an article also featuring Jeff Lovich's* **Where Have All the Turtles Gone, and Why Does It Matter?** manuscript. The article discusses the global status of turtles and their ecological roles. Lovich was quoted in the piece and the article, titled **The missing turtles of the Anthropocene**, can be found here: <http://www.anthropocenemagazine.org/2018/10/anthropocene-missing-turtles/>.

Using Criollo Cattle to Develop More Sustainable Grazing Strategies

1) SBSC's Mike Duniway* and Matt Redd, the director of the Canyonlands Research Center, were interviewed by John Hollenhorst from the NBC affiliate in Salt Lake City, KSL TV. The interview involved a field trip and a discussion of a new Criollo cattle research project, as well as USGS drought experiments and dust studies. The new Criollo study will evaluate if using these cattle can yield more sustainable grazing strategies in the Southwest. The interviews were incorporated into a video titled **Criollo cows could be savior for Utah Ranchers** (<https://ksltv.com/406949/criollo-cows-savior-utah-ranchers/>).

2) The Deseret News published an article that quoted SBSC's Mike Duniway* and Matt Redd, the director of the Canyonlands Research Center. The article also discussed Criollo cattle, and how this breed might be used to develop more sustainable grazing strategies in the Southwest. The title of the article is **Are cows that were good enough for Columbus good for Utah?** and can be found here: <https://www.deseretnews.com/article/900052482/are-cows-that-were-good-enough-for-columbus-good-for-utah.html>.



Criollo cattle in the American Southwest.
(Photo credit: Mike Duniway, USGS)

Aquatic Insects in Grand Canyon and Experimental Bug Flows on the Colorado River

1) Scientific American published an article titled **Re-engineering the Colorado River to save the Grand Canyon: Can dam releases that mimic natural flows restore the Grand Canyon ecosystem?** The article focuses on the effects of Glen Canyon Dam on the Grand Canyon. Much of the article is about the experimental flows from Glen Canyon Dam that occurred this past summer (dubbed “bug flows”), which attempted to increase the reproductive success of aquatic insects, prey that native fish species and the economically important rainbow trout in the Colorado River downstream of Glen Canyon Dam rely on. SBSC’s Ted Kennedy*, Jeff Muehlbauer*, and Ted Melis* were quoted in the article and the reporter joined Muehlbauer and David Goodenough* on an insect sampling trip. The article can be found here:

<https://www.scientificamerican.com/article/re-engineering-the-colorado-river-to-save-the-grand-canyon/>. A published paper that was important in the initiation of the summer bug flows was mentioned in the article and it can be found here: <https://academic.oup.com/bioscience/article/66/7/561/2463266>.



Insect eggs (white material on rock at water level) in the Colorado River during the first week of the experimental bug flows
(Photo credit: Ted Kennedy, USGS)

2) The Arizona Republic published an article exploring many biological and ecological aspects of the Colorado River in Grand Canyon. In addition to text, the article contains videos and slideshows. The article repeatedly refers to research on aquatic insects in the Colorado River and SBSC’s Ted Kennedy* and Megan Daubert* were quoted in the piece. Additionally, Brece Hendrix* and Chyenne Szydlo* were photographed handling insect traps. The experimental bug flows that occurred from May to August of this year was discussed in the article, and Kennedy’s paper on aquatic insects was a major motivator in initiating the bug flows. The Arizona Republic article is titled **Unnatural wonder: A journey into the heart of a river forever changed by human hands** and can be found here: <https://www.azcentral.com/in-depth/news/local/arizona-environment/2018/10/21/grand-canyon-rafting-fishing-trip-shows-colorado-river-challenges/757278002/>. Kennedy’s paper about Glen Canyon’s effects on aquatic insects can be found here: <https://academic.oup.com/bioscience/article/66/7/561/2463266>.

3) Ted Kennedy* and Anya Metcalfe* were quoted in a recently published book titled **Downriver: Into the future of water in the West** by Heather Hansman. Additionally, a manuscript published by the Kennedy lab was cited in the book. The manuscript is titled **Flow management for hydropower extirpates aquatic insects undermining river food webs** and can be found here: <https://academic.oup.com/bioscience/article/66/7/561/2463266>.

Methane in Icelandic Lakes

Dickson College interviewed Kristin Strock about her Icelandic lakes methane project. SBSC’s Bridget Deemer* is a collaborator on the project. The researchers are measuring methane production, consumption, and emission in Icelandic lakes with the ultimate goal of understanding the effects of increasing temperatures on methane, a strong greenhouse gas, being liberated from lakes.

In a recent research trip, Bridget and other members of the research team sampled physical, chemical, and biological components of nine Icelandic lakes. The all-female research team have the official label of “National Geographic Explorers”. The interview can be found here:

http://www.dickinson.edu/news/article/3399/podcast_dickinson_college_team_explores_icelands_lakes_on_national_geographic_research_trip.



Lake Djupavatn, one of the lakes sampled by the research team in Iceland.
(Photo credit: Bridget Deemer, USGS)

High-Flow experiment on the Colorado River

1) Mike Moran*, Deputy Chief of SBSC's Grand Canyon Monitoring and Research Center (GCMRC), was quoted in an Arizona Republic article about the High-Flow Experiment that began on November 5 at Glen Canyon Dam on the Colorado River. High-Flow Experiments are used to move sediment from the bed of the Colorado River to build and maintain sandbars and beaches in Grand Canyon. The experiments also provide GCMRC scientists opportunities to study the effects of this strategy in Grand Canyon. The Arizona Republic article can be found here:

<https://www.azcentral.com/story/news/local/arizona-environment/2018/11/05/grand-canyon-flooded-high-flow-experiment-colorado-river-federal-officials-glen-canyon-dam-lake-mead/1861287002/>.



Glen Canyon Dam's Jet tubes during the high-flow experiment on November 5, 2018. (Photo credit: Todd Wojtowicz, USGS)

2) Scott VanderKooi*, Chief of SBSC's Grand Canyon Monitoring and Research Center, was quoted in an

Arizona Republic article about the elevated flows from Glen Canyon Dam that occurred from November 5-8. The article can be found here: <https://www.azcentral.com/story/news/local/arizona-environment/2018/11/19/fat-fish-after-grand-canyon-flood-isnt-all-good-news-colorado-river/1954378002/>.

Beyond the Rim

An Arizona PBS documentary titled **Beyond the Rim: The Next 100 Years of the Grand Canyon** aired on February 26 and quotes SBSC's Ted Kennedy* and Anya Metcalfe* (from about 17:30 to 20:35). The 40-minute documentary focuses on Grand Canyon National Park, its volunteers, its visitors, Native Americans associated with Grand Canyon, the Colorado River, historical scientific explorations of Grand Canyon, the flora and fauna of Grand Canyon, and more. The documentary can be found here: <https://azpbs.org/2019/02/beyond-the-rim-the-next-100-years-of-grand-canyon-national-park/>.

Vegetation Recovery on Abandoned Oil and Gas Well Sites

1) A USGS press release was published on February 12 highlighting a recent manuscript that describes the use of satellite data to assess vegetation changes on abandoned oil and gas sites and presents results on vegetation recovery on those well sites on the Colorado Plateau. The manuscript was written by scientists from the Western Geographic Science Center and Southwest Biological Science Center scientists Mike Duniway* and Travis Nauman*. The title of the press release is **Vegetation recovery on abandoned oil and gas well sites is variable: after five years, one-third of sites recover more than 50 percent** and can be found here:

<https://www.usgs.gov/news/vegetation-recovery-abandoned-oil-and-gas-well-sites-variable-colorado-plateau>. The paper the press release based on can be found here:

<https://www.sciencedirect.com/science/article/pii/S0303243418303027>.

2) SBSC's Mike Duniway* and Western Geographic Science Center's Miguel Villarreal were interviewed by KRCC, a Colorado Springs public radio station about a paper that presents results on vegetation recovery on abandoned oil and gas well sites on the Colorado Plateau. The paper the interview was based on can be found here:

<https://www.sciencedirect.com/science/article/pii/S0303243418303027>.



Active well pad on near Canyonlands National Park, Utah. (Photo credit: Mike Duniway, USGS)

Future of the Colorado River Symposium

The Moab Times-Independent published an article about the Future of the Colorado River public symposium that was held last October. The article described the event and its speakers including the presentations given by SBSC's Sasha Reed* and Paul Grams*. Reed talked about riparian plant communities and the nonnative tamarisk. Grams discussed the effects of dams on river channel characteristics, sandbars, sediment movement, and experimental flows. The title of the article is **River symposium: Let's figure out how to do a good job** and can be found here: <https://moabtimes.com/2018/10/26/river-symposium-let-s-figure-out-how-to-do-a-good-job-38767/>.

Spotted Owls and Barred Owls

A press release put out by the journal Ecological Applications titled **Owls against owls in a challenge for survival** is about a recently published paper with SBSC's Charles Yackulic* as the lead author. The press release discusses the findings of Yackulic and his co-authors who were trying to determine if controlling barred owls, managing habitat, or both would support northern spotted owl populations most. Here is the press release:

<https://www.esa.org/esa/owls-against-owls-in-a-challenge-for-survival/>. Here is the paper the press release is based on: <https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1861>.

Colorado River Delta and Minute 319 Pulse Flow

Pamela Nagler* was interviewed by the Mexican-based PMD Comunicación SC while in Mexicalia, Mexico from October 23-25 for a wrap-up meeting about the bi-national Minute 319 pulse flow that occurred in 2014. The interview focused on Colorado River Delta research conducted by Pamela's long-time collaborator who recently passed away. In addition, she was asked about other results regarding the 2014 pulse flow on native plant species and the history of Colorado River flows reaching the delta.

Drought on the Colorado Plateau

Alix Pfennigwerth* was interviewed for Science Moab, a weekly radio program that focuses on Colorado Plateau research. Alix spoke about the USGS **Colorado Plateau Extreme Drought in Grasslands Experiment** (EDGE), and about the general topics about drought and plant ecology on the Colorado Plateau. Here is the link to the interview: <https://www.kzmu.org/plant-resiliency-to-drought/>. For more information about EDGE:

https://www.usgs.gov/centers/sbsc/science/colorado-plateau-extreme-drought-grassland-experiment-edge?qt-science_center_objects=0#qt-science_center_objects.



EDGE rainout shelter in a dryland ecosystem
(Photo credit: Mike Duniway, USGS)

Citizen Science in Grand Canyon

Anya Metcalfe* is featured in the USGS Ecosystems Podcast Series – Outstanding in the Field podcast titled **Citizen Science—Your Data in Action**. In the podcast, Anya discusses aquatic insects in the Colorado River in Grand Canyon, the effects of Glen Canyon Dam on those insects, and the potential beneficial effects of experimental “bug flows” from Glen Canyon Dam on aquatic insects during the summer of 2018. To listen to the podcast:

https://www.usgs.gov/mission-areas/ecosystems/science/usgs-ecosystems-podcast-series-outstanding-field?qt-science_center_objects=0#qt-science_center_objects.

Soil Erosion in the West

Mike Duniway* was quoted by 91.5 KRCC, an NPR Station, in an article titled **Soil erosion in the West is getting worse and the air is getting dustier** and can be found here: <https://www.krcc.org/post/soil-erosion-west-getting-worse-and-air-getting-dustier>. The article referenced a recently published paper about wind erosion and dust in moisture-limited regions of the US. Duniway is the lead author and the paper is co-authored by SBSC's Alix Pfennigwerth*, Stephen Fick*, Travis Nauman*, and Jayne Belnap* as well as a collaborator from University of Colorado Boulder. The paper can be found here: <https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.2650>.

Students Learning about Plants and Soil in Utah

Ohio Wesleyan University published a video depicting undergraduate students learning about plants and soil outside of Moab, UT. Sean Hoy-Skubik* and Mike Duniway* are shown teaching students in the field. The link to the video is here: https://www.youtube.com/watch?time_continue=1&v=c2VnAgQWijU.

Food Drive in Moab, Utah

SBSC personnel in Moab, Ut, along with National Park Service and the Synergy Company were acknowledged by the Moab Sun News for the amount of food they collected during a local food drive. Collectively, the three organizations collected and donated over 3,700 pounds of food. SBSC's Hilda Smith* and Erika Geiger* organized SBSC's role in the Moab food drive. The article is titled **A Moab partnership bares fruit – and other food** and can be found here: http://www.moabsunnews.com/news/article_2ae5d6ca-c7e7-11e8-ab43-e78e2dcd764c.html.

Public, Partner, and Youth Outreach Activities

Upper Colorado River Commission

Scott VanderKooi*, Chief of SBSC's Grand Canyon Monitoring and Research Center (GMCRC), gave an invited presentation on GMCRC activities at the 283rd meeting of the Upper Colorado River Commission on December 12, 2018 in Las Vegas, NV. The Commission's meeting was held in conjunction with the annual meeting of the Colorado River Water Users Association. His talk focused on two experimental flows released from Glen Canyon Dam on the Colorado River in 2018 and the responses of key biological and physical resources downstream in Glen and Grand Canyons. Experimental bug flows to benefit aquatic insect abundance and diversity downstream of the dam were conducted from May through August 2018 and a High-Flow Experiment to manage limited sand resources occurred in November 2018.

National Park Service, Bureau of Land Management, Forest Service, and Tribal Partners

- 1) Jayne Belnap* gave a talk on the ecosystem role of biocrusts to the National Park Service employees and other interested people in the public in the Grand Junction, CO area on November 5. This talk was followed by a walk, where naturally occurring biocrusts were viewed and discussed.
- 2) Kirsten Ironside* gave a presentation to the superintendent of Bryce Canyon National Park and staff, the Bryce Canyon Natural History Association board, and representatives from the Dixie National Forest on the importance of wilderness areas in national parks for mountain lion reproduction.
- 3) Travis Nauman* and Mike Duniway* shared results from their recent Colorado River Basin salinity studies with staff of the Moab Bureau of Land Management on December 11. Travis gave a presentation on the work the USGS has been conducting to better understand where the high salt-contributing lands are located, including both irrigated agriculture and areas of rangeland and forest with high bare-ground exposure and highly saline soils.
- 4) On February 22nd, SBSC scientist Sasha Reed* helped host a Science-Management Day, bringing together scientists, managers, and stakeholders in the Southwest. Attendees included Althea Walker, Tribal Climate Science Liason, and Steve Jackson, Director of the USGS Southwest Climate Adaptation Science Center, Lance Porter, Bureau of Land Management's Canyon Country District Manager, Dana Witwicki and Rebecca Weissinger of the National Park Service, and Zach Low of the Manti-La Sal U.S. Forest Service, as well as many others from regional agencies, and 40 graduate students and professors from Utah State University. The event was a part of a Utah State University Climate Adaptation Science (CAS) graduate program Reed co-developed, which strives to give graduate students land management and policy experience during their formative graduate school years. Climate adaptation is a focus and a large part of this program is providing internships where graduate students spend their summer in agency settings. The program is supported by the National Science Foundation. For more information, look to the CAS program website (<https://climateadaptation.usu.edu/>) and/or contact Reed (screed@usgs.gov).

Glen Canyon Dam Adaptive Management Program

1) Scott VanderKooi*, Chief of SBSC's Grand Canyon Monitoring and Research Center (GCMRC), and GCMRC staff participated in a September 27 webinar to update Glen Canyon Dam Adaptive Management Program stakeholders on the possibility of conducting a High-Flow Experiment released from Glen Canyon Dam into Glen and Grand Canyons in early November. Tim Petty, the Assistant Secretary for Water and Science, also participated in the webinar. The objective of High-Flow Experiments is to maintain or enlarge sandbars and beaches along the Colorado River by managing limited sediment resources. VanderKooi, along with GCMRC staff members David Topping*, Helen Fairley*, and Jeff Muehlbauer* provided an overview on the status of resources including sand and sediment, native and nonnatives fishes including the endangered humpback chub, the aquatic foodbase, riparian vegetation, and archeological and cultural resources. Updates on water resources and hydropower were provided by the Bureau of Reclamation and Western Area Power Administration.



Glen Canyon Dam as seen from the Colorado River. (Photo credit: Todd Wojtowicz, USGS)

2) Scott VanderKooi* and Katrina Grantz from the Bureau of Reclamation briefed the Assistant Secretary for Water and Science, Tim Petty, and representatives from federal and state agencies involved in the Glen Canyon Dam Adaptive Management Program on October 16 concerning a potential High-Flow Experiment proposed to be released from Glen Canyon Dam in early November. The briefing provided an overview of the recommendation from a technical team, which reviewed Colorado River resources of concern, to proceed with a High-Flow Experiment.

3) Scott VanderKooi*, Dave Lytle* (SBSC's Center Director), and GCMRC staff attended the winter meeting of the Glen Canyon Dam Adaptive Management Program's Adaptive Management Working Group (AMWG) in Phoenix, AZ on March 6-7, 2019. The first day of the meeting was attended by Dr. Tim Petty, secretary for Water and Science and chair of the AMWG, and Kiel Weaver, Deputy Assistant Secretary for Water and Science. VanderKooi and GCMRC Deputy Chief Mike Moran* provided a preview of results to be presented at the March 12-13, 2019 Annual Reporting Meeting to AMWG stakeholders. In addition, VanderKooi presented on potential flow experiments that may be conducted in 2019 and future years in Glen and Grand Canyons and research and monitoring activities to be conducted in support of these experiments as well as budget considerations associated with a change in the budget model of the Glen Canyon Adaptive Management Program from support derived from Glen Canyon Dam power revenues to appropriated funding.

4) Personnel from GCMRC met with stakeholders for their annual reporting meeting on March 12-13, 2019 in Phoenix, Arizona. GCMRC scientists provided oral and poster presentations on recent findings regarding a wide variety of topics including water quality, nonnative and native fish, sediment, sandbars, archeological and cultural resources, recreation, riparian vegetation, and the aquatic food base. The annual reporting meeting this year included a session on March 13 entirely devoted to High-Flow Experimental releases and their effect on various resources.

5) Scott Vanderkooi*, Mike Moran*, and Helen Fairley* from the GCMRC attended a meeting of the Glen Canyon Dam Adaptive Management Program's Technical Working Group (TWG) in Phoenix, Arizona on March 14, 2019. Vanderkooi gave presentations on possible experimental actions for calendar year 2019 and the status of biological conservation measures from the Long-Term Experimental and Management Plan. Moran gave a presentation on the GCMRC Fiscal Year 2018 budget and expenditures.

Restoration Assessment and Monitoring Program for the Southwest (RAMPS)

1) Molly McCormick*, project coordinator for the Restoration Assessment and Monitoring Program for the Southwest (RAMPS), visited Flagstaff High School's pre-AP Biology classes and talked about arid ecosystems and restoration.

2) SBSC's Restoration Assessment and Monitoring Program for the Southwest (RAMPS) co-organized the Southwest Vegetation Management Association annual meeting in Tucson, AZ. The meeting included 22 oral presentations, four poster presentations, offered a class for herbicide applicators licenses, and offered continuing education credits for managers maintaining those licenses. There were 75 people in attendance over the three days, including land managers from federal and state organizations and academia across the Southwest.

3) The USGS Restoration Assessment and Monitoring Program for the Southwest (RAMPS) and project partners on the Navajo Nation were awarded a Bureau of Indian Affairs Tribal Resiliency grant for their project **Building Resiliency with Native Seeds: A Restoration Training Model for Southwest Tribes**. The project will build social and ecological resiliency by addressing harmful

environmental trends, such as drought and soil erosion, through a series of workshops and demonstration sites. The project will train at least 52 tribal members and staff from three tribes in six communities across the Little Colorado River and Verde River Valleys in effective restoration practices using native seeds. The project is an example of how RAMPS works with stakeholders within the Department of Interior, tribal governments, and state agencies to provide guidance and support for effective restoration strategies across the Southwest. The RAMPS consortium of over 100 entities works together to increase land productivity and to reduce threats posed by environmental hazards. RAMPS is coordinated by the SBSC and more information about this program can be found by contacting the program manager, Molly McCormick* (mmccormick@usgs.gov), or by going to the RAMPS website: www.usgs.gov/SBSC/RAMPS.

4) Seth Munson* and Molly McCormick* from RAMPS went on a tour with the Arizona Public Service (APS) natural resource specialist to discuss research questions regarding right of way maintenance in desert chaparral vegetation communities.

5) Molly McCormick* from RAMPS gave a presentation at the Central Arizona Conservation Alliance (CAZCA) restoration lab. Members of CAZCA are looking to build some experimental gardens as part of the USGS RAMPS RestoreNet project. To get more information about RAMPS: www.usgs.gov/SBSC/RAMPS. For more information about the RestoreNet project: https://www.usgs.gov/centers/sbsc/science/restorennet-distributed-field-trial-network-dryland-restoration?qt-science_center_objects=0#qt-science_center_objects.

6) Molly McCormick provided an update on the RestoreNet project to the partners at the Diablo Trust Cooperative Resource Operational Plan (CROP) meeting.

7) RAMPS helped facilitate a multi-day meeting with 40 USGS scientists and resource managers in southeast Utah. The objectives of the workshop included building a shared vision, identify research needs, and generating management options that address threats caused by increasing aridity. The group is now solidifying that vision in preparation for funding proposals that will support implementation.

8) RAMPS was recently mentioned in the National Seed Strategy Progress Report (https://www.blm.gov/sites/blm.gov/files/uploads/NationalSeedStrategy_MakingProgress_2018.pdf, page 8) for supporting the science needs of a multi-agency working group on the topic of plant materials development. RAMPS, along with SBSC scientist Rob Massatti*, helped supplement the Progress Summary Tables (Appendix 1) with ongoing research going on across the Southwest that supports the Seed Strategy.



Molly McCormick, RAMPS project coordinator, and National Park Service attendee at a multi-day meeting with 40 USGS scientists and resource managers in southeast Utah. (Photo credit: Mike Duniway, USGS)

9) The first workshop of the Bureau of Indian Affairs (BIA)-funded "**Building Resilience with Native Seeds**" was held on April 2 in Window Rock, AZ. Participants included twenty-three employees of tribal land management agencies of three tribes (Diné, Hopi, and Yavapai-Apache). In this workshop, participants reviewed restoration ecology and techniques for arid lands, learned about the newly-formed Diné Native Plant Program, and sowed native plant seeds in the greenhouse. The plants will be installed at an experimental plot and demonstration garden in a subsequent workshop. This was the first in a six-workshop series designed to "train the trainers". The participants will be given resources so that they can train their colleagues in techniques for restoring arid lands. Ramps assisted in the writing of the BIA-funded proposal.

10) The Ramps team, led by Mike Duniway*, is partnering with the Bureau of Land Management (BLM) national office to improve reclamation success on western public lands in seven states. The group is currently conducting a structured analysis of existing reclamation standards and practices, including scientific literature, reports, and policies. The next stage is to talk with BLM field office staff to better understand practices at the field-office level. The project will produce a practical technical reference or guidebook that can be used to inform management or policy decisions.

11) Ramps recently partnered with the National Park Service (NPS), Society for Ecological Restoration, and Strategic Habitat Enhancement, LLC (SHE) on techniques for restoring pollinator habitat in the Sonoran Desert. Participants included 30 NPS resource managers and field staff, private citizens, and organizations working on medium scale (1 acre or more) pollinator habitat projects. The workshop was held at NPS Desert Research Learning Center (DRLC) in Tucson. After learning about pollination ecology and techniques for supporting pollinators in arid lands, participants help install 20 native plant species as part of the DRLC pollinator demonstration garden.

12) On April 4, Molly McCormick* and Rob Massatti* participated in the research committee for the Institute for Applied Ecology's Southwest Seed Partnership. The committee is comprised of representatives from National Forest Service, Bureau of Land Management, National Park Service, U.S. Geological Survey, New Mexico State University, and University of Arizona. The group is working on sharing the latest research, identifying gaps in knowledge, and then making progress on filling those gaps on the topic of native plant materials development for arid land restoration.

Youth and Student Outreach

1) Erika Geiger* and Sasha Reed* were on the planning committee for the Moab, UT Festival of Science, which occurred from October 3-7. SBSC had a presence at every event and led three of them, including a plant and biological soil crust hike. The festival of science attracts people of all ages, including many young people.

2) Bridget Deemer* is part of an all-woman National Geographic Explorers research team exploring the potential effects of increasing temperatures on methane, a strong greenhouse gas, being liberated from lakes. As part of this project, an undergraduate student from Dickinson College visited SBSC's Grand Canyon Monitoring and Research Center and Northern Arizona University to run methane concentration samples at the Colorado Plateau Stable Isotope Laboratory in coordination with Deemer.

3) David Ward* spoke to 21 students at a Yavapai College aquaculture class in Chino Valley, AZ about ammonia cycling in a filtration and control of invasive aquatic species context.

4) Morgan Ford* conducted a comprehensive lab tour for approximately 20 Prescott College students conducting their Grand Canyon Semester. This included an explanation of aquatic insect research, a tour of the SBSC insect lab facilities, a discussion of some of the current issues surrounding Grand Canyon, and an exploration of potential internship opportunities for interested students.

5) David Ward* gave a lecture at Northern Arizona University to approximately 80 undergraduate students in a vertebrate zoology class about the conservation of southwestern native fish on February 4.



Icelandic lake sampled as part of the methane project.
(Photo credit: Bridget Deemer. USGS)

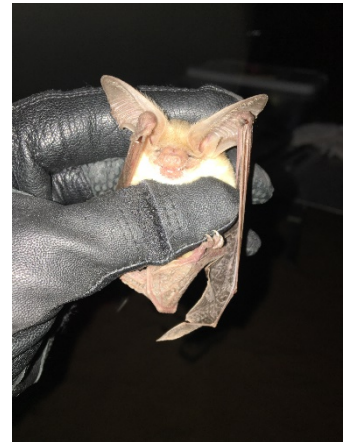
6) SBSC's Sasha Reed* and Lucretia Olson from the U.S. Forest Service will serve on a panel that was requested by the University of Montana's graduate students to field questions and share perspectives about federal science careers.

7) Ted Kennedy's* aquatic ecology research group hired an intern from a local high school to complete a project examining the effects of wildfire/ash flow on the macroinvertebrate community structure in Shinumo Creek in Grand Canyon. This internship is being conducted as part of a senior project to graduate with high honors from school.

8) Morgan Ford* brought microscopes and various other sample processing equipment to Northland Preparatory Academy and Sinagua Middle School to assist them with a water quality project both schools are working on. This included a brief discussion of water quality assessment principles, and then a hands-on lab where each student was instructed to sort and properly identify the invertebrates they collected from leaf-packs collected from a small stream in the area to assess its quality.

9) David Ward* held a fish show and tell for two 7th grade classes in a Flagstaff, Arizona middle school. 65 students attended the show and tell and the topic was native and invasive species of the Colorado River.

10) Kirsten Ironside* gave a presentation to the middle school students of Maine Consolidated School in Parks, AZ on bats last Thursday (2/28). The presentation showed students how to access USGS National Gap Analysis Project (GAP) models and use sciencebase.gov for finding information on bats. Kathryn Thomas* assisted with developing the presentation and Kathryn's vertebrate biodiversity and renewable energy project (https://www.usgs.gov/centers/sbsc/science/informing-renewable-energy-development-siting-decisions-vertebrate-biodiversity?qt-science_center_objects=0#qt-science_center_objects) was helpful for identifying bat species habitat at the school, and will also help the students design bat houses and roosts in support of their Natural Heritage grant to create a school yard bat sanctuary.



Bat captured by USGS researchers.
(Photo credit: USGS)

11) The SBSC was one of several Flagstaff science centers to participate in Flagstaff's 6th annual STEM Celebration Night at Northern Arizona University. Todd Wojtowicz* attended the event on behalf of SBSC, and Morgan Ford* and Shellie Puffer* helped Wojtowicz prepare for the event. The SBSC table contained a display of aquatic and terrestrial insects, images of turtles, and literature about SBSC science. The other Flagstaff USGS science centers that participated at Flagstaff's STEM Night were the Astrogeology Science Center; Geology, Minerals, Energy, and Geophysics Science Center; Western Geographic Science Center; and Arizona Water Science Center.

12) David Ward gave a guest lecture at the Yavapai College Aquaculture Class in Chino Valley on April 2 to about 20 students on reproduction and spawning in fish.

Grand Canyon River Guides Training Seminar

Scott VanderKooi*, Chief of the Grand Canyon Monitoring and Research Center (GCMRC), Helen Fairley*, David Ward*, Anya Metcalf*, and Paul Grams* attended the Grand Canyon River Guides Training Seminar on March 31. Ward and VanderKooi gave a hands-on presentation about native and non-native fish of the Colorado River, Metcalf spoke about insects and the experimental Bug Flows that occurred on the Colorado River during the summer of 2018, Grams spoke about sand bars and High-Flow Experiments on the Colorado River, and Fairley spoke about the relationship between dam-regulated flows, sediment supply, vegetation encroachment, and archaeological site preservation.

Restoration Meeting

Rebecca Mann*, Natalie Day*, Colin Tucker*, and Steve Fick* from SBSC, plus Kristina Young (University of Texas at El Paso and Science Moab) organized and hosted a working group meeting for Canyon Country Restoration researchers and practitioners in Moab, UT on March 19th. Approximately 35 people participated in the event, representing the local Moab area plus closely neighboring communities including Monticello, UT, and Grand Junction, CO. Restoration-oriented presentations were given by local experts, including Mike Duniway* (SBSC). These were followed by a group discussion how the local restoration community can build capacity for partnerships and networking. The meeting was sponsored by the Society for Ecological Restoration, Southwest Chapter.

Public Presentations

- 1) Sash Reed* and Paul Grams* gave presentations at a community symposium titled **The Future of the Colorado River**. Sasha talked about riparian plant communities associated with large rivers and Paul spoke about river sediment.
- 2) SBSC scientist Sasha Reed* gave an invited talk to the Moab, Utah community at a Science on Tap event. The talk was titled **The word on the street: NEW things we have learned about our desert ecosystems in the last 20 years**, and more than 160 people attended the talk. For more information about the talk or the event, please contact Reed (screed@usgs.gov).
- 3) David Ward* gave a presentation at the Museum of Northern Arizona about the fishes on Arizona to about 60 people.
- 4) David Ward* gave a presentation to the public in Flagstaff, AZ at their monthly Science on Tap event on April 18. His presentation was titled **Colorado pikeminnow: forgotten predator of the lower Colorado River** and 70 people were present to hear David's talk.

SCIENCE

Published Papers, Reports, Data Releases, etc.

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- Reed, S.C.* , 2018, The Future of Riparian Vegetation Communities along the Big Rivers [presentation]: The Future of the Colorado River: A Community Symposium.
- Reed, S.C.* , 2019, Exploring the structure and function of our U.S. drylands: stories of resilience and change [presentation]: University of Montana's Organismal Biology, Ecology, and Evolution program.
- Reed, S.C.* , 2019, Challenges and solutions for our global drylands: a biogeochemical perspective [presentation]: Stanford University, School of Earth, Energy, & Environmental Sciences.
- Sankey, J.B.* , Kapsrak, A.* , Caster, J.* , Sankey, T., Andrews, T.* , Solazzo, D., 2018, Integrating LiDAR and SfM data from ground-based, unmanned (UAV) and manned aerial platforms to estimate sediment budgets for aeolian dunefields [presentation]: American Geophysical Union meeting.
- Sankey, J.B.* , Kapsrak, A.* , Caster, J.* , Sankey, T., Andrews, T.* , Solazzo, D., 2018, Integrating LiDAR and SfM data from ground-based, unmanned (UAV) and manned aerial platforms to estimate sediment budgets for aeolian dunefields [presentation]: American Geophysical Union meeting.
- Tennant, L.* , 2018, Effects of body size on vulnerability to predation in juvenile roundtail chub stocked in the upper Verde River, Arizona [presentation]: Desert Fishes Council meeting.
- VanderKooi, S.* , 2018, Glen Canyon Dam Adaptive Management Program—science support and lessons learned [presentation]: Middle Rio Grande Endangered Species Collaborative Program workshop.
- Ward, D.* , 2018, Forgotten secrets of invasive fish eradication [presentation]: Desert Fishes Council meeting.

PUBLICATIONS HIGHLIGHTED BY OTHER SCIENTISTS & ORGANIZATIONS

River Bounces Back After World's Largest-Ever Dam Removal

The journal *Nature* highlighted a recently published paper with co-authors from the USGS and Bureau of Land Management (BLM). The authors of the paper are from the Pacific Coastal and Marine Science Center (Amy East (lead author), Joshua Logan, and Andy Richie), Washington Water Science Center (Mark Mastin), Arizona Water Science Center (Chris Magirl), and Southwest Biological Science Center (Joel Sankey*) from the USGS, and Jennifer Bounry from the BLM. The title of *Nature* article is **River bounces back after world's largest-ever dam removal** and can be found here: <https://www.nature.com/articles/d41586-018-07707-0>. The paper the article is based on can be found here: <https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JF004703>.

Global Conservation Status of Turtles and Tortoises (Order: Testudines)

The Chelonian Research Foundation published a press release about a paper that reviewed and analyzed the conservation status and threat categories of all recognized species of turtles and tortoises. SBSC scientist Jeff Lovich* is a co-author on that paper. The press release can be found here: <http://www.chelonianjournals.org/page/Global-Review-of-Turtle-and-Tortoise-Status-Reveals-Extent-of-Extinction-Crisis>. The paper that the press release is based on can be found here: <http://www.chelonianjournals.org/doi/full/10.2744/CCB-1348.1>.

Effectiveness of Ultrasonic Imaging for Evaluating Presence and Maturity of Eggs in Fishes in Remote Field Locations

A manuscript co-authored by SBSC's David Ward* along with two collaborators from the USGS Arizona Cooperative Fish and Wildlife Research Unit (including the lead author) was one of four papers highlighted in the November 2018 issue of Fisheries magazine. The highlighted paper describes an ultrasonic, nonlethal method to determine sex and maturity in fish species. The Fisheries magazine highlight can be found on page 548 of the November issue:

<https://afspubs.onlinelibrary.wiley.com/doi/epdf/10.1002/fsh.10011>. The manuscript the highlight is based on is titled **Effectiveness of ultrasonic imaging for evaluating presence and maturity of eggs in fishes in remote field locations** and can be found here: <https://afspubs.onlinelibrary.wiley.com/doi/full/10.1002/nafm.10200>.



Endangered humpback chub
(Photo credit: David Ward, USGS)

AWARDS

Bridget Deemer* was recently accepted for an editorial fellowship with the Limnology and Oceanography Letters journal. The two-year fellowship allows early-career scientists to gain experience in scientific publishing, peer-review, and scientific writing.

The USGS Restoration Assessment and Monitoring Program for the Southwest (RAMPS) was recently awarded a NASA Space Grant to support a Northern Arizona University undergraduate research intern for the 2019-2020 school year. The intern will assist with installing and measuring sites for **RestoreNet**, an ecological restoration field trial network designed to strengthen DOI land treatment outcomes across environmental gradients in the Southwest. For more information on **RestoreNet**: https://www.usgs.gov/centers/sbsc/science/restorennet-distributed-field-trial-network-dryland-restoration?qt-science_center_objects=0#qt-science_center_objects.

OTHER NOTABLES

Minute 319 Pulse Flow

Pamela Nagler* was in Mexicalia, Mexico from October 23-25 for a wrap-up meeting about the bi-national Minute 319 pulse flow that occurred in 2014. There were representatives from American and Mexican non-governmental organizations and universities, USGS, Bureau of Reclamation, Colorado River Commission of Nevada, Arizona Department of Water Resources, and the International Boundary and Water Commission (IBWC) present at the meeting. The meeting consisted of presentations about the results of the Minute 319 pulse flow of 2014 and fieldtrips.

Weed Management Meeting

Kathryn Thomas* attended the Sonoran Cooperative Weed Management Area meeting (So-CWMA) in Tucson November 7th. The So-CWMA is re-initiating after a multi-year hiatus. Thomas provided information on previous collaborative efforts in Arizona which she led or collaborated with: the Southwest Exotic Plant Mapping Program (SWEMP) and the Arizona Wildlands Invasive Plant Working Group.

Economics Workshop

Lucas Bair* attended a Department of Interior (DOI) Economics Training Workshop from September 25-27 in Washington, D.C. The objectives of the workshop were to provide training on new economic tool used for analysis and data visualization, discuss the DOI's current economics needs, share current DOI research, and develop a economics community of practice to leverage expertise across the DOI. Lucas also served on a panel and gave a presentation at the workshop.



Nonnative Russian thistle (*Salsola tragus*) growing on a sand dune in southern Arizona. (Photo credit: USGS)

Sediment Workshop in Flagstaff

The Sediment Transport Opportunities for Proposals (STOP) interdisciplinary workshop was held on October 24 on the USGS Flagstaff Science Campus (FSC), Flagstaff, AZ. Tim Titus from the Astrogeology Science Center led the workshop and personnel from Geology, Minerals, Energy, and Geophysics Science Center; Western Geographic Science Center; Astrogeology Science Center; Arizona Water Science Center; and Southwest Biological Science Center served on the program committee and as facilitators during the workshop. Representatives from all five science centers located on the FSC, several Northern Arizona University departments, and the National Park Service attended the workshop. Several interdisciplinary project ideas were developed in the workshop and those ideas are currently being developed into proposals.



Dust samplers at a site in Utah are being used to help understand the transport of sediment via wind.
(Photo credit: Erika Geiger, USGS)

Sesquicentennial Colorado River Exploring Expedition

SBSC's Paul Grams*, Joel Sankey*, Lucas Bair*, Helen Fairley*, Ted Kennedy*, Anya Metcalfe*, Charles Yackulic*, Bridget Deemer*, Maria Dzul*, Tom Gushue*, Emily Palmquist*, Pamela Nagler*, Sasha Reed*, Molly McCormick*, Todd Wojtowicz*, Mike Moran*, Scott VanderKooi*, and Ted Melis* met with organizers of the Sesquicentennial Colorado River Exploring Expedition (SCREE), of which the USGS is a partner. SCREE will celebrate the John Wesley Powell expedition that started in 1869 to explore the Green and Colorado Rivers by having their own expedition of the Green and Colorado Rivers starting in May 2019. This project will give rise to a diverse array of outreach and educational material highlighting USGS science, including SBSC science. SBSC personnel provided scientific information about the Colorado River to USGS's manager of Youth and Education Programs Eleanor Snow as well as Anne Scott (USGS), Bill Banks (USGS), and Tom Minckley (University of Wyoming).

USGS Drought Workshop

A number of USGS Southwest Region ecologists participated in an Ecological Drought Workshop in Denver, CO on April 11. The goals of the workshop were to advance the USGS Integrated Ecological Drought Strategy by discussing and developing interdisciplinary approaches for addressing ecological drought vulnerability in several basins across the United States. The working group brought together participants with expertise in surface water hydrology, aquatic biology, and terrestrial ecology to integrate data sources at the catchment level to improve monitoring and evaluation of ecological drought impacts. Southwest Region participants included John Bradford* (SBSC), Mike Duniway* (SBSC), Ellis Margolis (Fort Collins Science Center (FORT)), Jens Stevens (FORT), Pat Shafroth (FORT), and Greg Auble (FORT).

SBSC Photo Used on the Cover of Applied Vegetation Science

A photo by Laura Durning* was published on the cover of Applied Vegetation Science's most recent issue (volume 21, issue 4). The issue also contains a paper by SBSC's Emily Palmquist*, Barb Ralston (Office of Science Quality and Integrity), and Brad Butterfield (lead author, Northern Arizona University) titled **Hydrological regime and climate interactively shape riparian vegetation composition along the Colorado River, Grand Canyon** (page 572 of the issue). The link to the recent Applied Vegetation Science issue is here: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/avsc.12412>.

SBSC Scientists on Graduate Committees

1) Paul Grams* served on a graduate committee for a student at Northern Arizona University, and that student gave his thesis defense on November 30. The thesis presentation was titled **Estimating riverbed sand thickness using CHIRP sonar: case study from the Colorado River in Grand Canyon**.

2) Joel Sankey* also served on a Northern Arizona University graduate committee for a student who defended his dissertation on November 30. The title of the dissertation presentation was **Ponderosa pine forest health and ecohydrology monitoring via passive and active remote sensing: forest structure, snowpack dynamics and ecosystem moisture**.

Using Criollo Cattle to Develop More Sustainable Grazing Strategies

In a new study, SBSC (led by Mike Duniway*), USDA-ARS Jornada Experimental Range, New Mexico State University, and The Nature Conservancy have partnered to test new cattle breeds with the goal of identifying sustainable grazing strategies in a warming and drying Colorado Plateau. In this study, researchers are comparing the movements and behavior of ten typical Angus and ten Raramuri Criollo cows on both winter and summer range of the Canyonlands Research Center. The Criollo have a smaller frame and more diverse browsing behavior that may limit the heavy impact sometimes seen in poorly distributed grazing cattle. For more information on Criollo cattle see: <https://jornada.nmsu.edu/bulletin/production-criollo-southwest>.



Criollo cattle (Photo credit: Mike Duniway, USGS)

Predicting the Next High-Impact Insect Invasion

Kathryn Thomas* attended the joint Entomological Societies of America, Canada and British Columbia meeting in Vancouver, British Columbia November 11-14. At the conference, Thomas presented results from the USGS Powell Working Group '**Predicting the Next High-Impact Insect Invasion**' with a poster '**Traits and factors of non-native phytophagous insects in North America: The TRAFAC database**' and co-authored with other Powell working group members a virtual poster '**Do all great minds think alike? An assessment of expert perspective on the impacts of non-native insects in North America**'. Additionally, Thomas gave an invited session presentation titled '**Using evolutionary history to help identify high-impact, non-native herbivorous specialist insects prior to their arrival**'.

Meeting with the USGS Director

USGS scientists Jayne Belnap*, Jill Baron, and Sasha Reed*, as well as others from the USGS Council of Senior Science Advisors and Presidential Early Career Award for Science and Engineering award groups, met with USGS Director Jim Reilly in Washington, D.C. The group shared their ideas and perspectives and discussed a wide range of issues related to USGS science at the national, regional, and local scale.

Editorial Boards and Meetings

- 1) Joel Sankey joined the editorial board as an associate editor at Journal of Geophysical Research - Earth Surface
- 2) David Dean* was the primary convener and chair of the **Advancement in the measurement and understanding of sediment transport and bed form dynamics in sand bed rivers I** session at the recent American Geophysical Union meeting. David Topping* was a co-convener of the session.
- 3) Pamela Nagler* co-chaired the **Evapotranspiration: advances in remote sensing-based estimation, mapping, and evaluation I** and **Evapotranspiration: advances in remote sensing-based estimation, mapping, and evaluation posters** sessions at the recent American Geophysical Union conference.
- 4) Pamela Nagler* attended the Hydrological Processes Journal Editorial Board Meeting on December 13 and is the lead editor of an upcoming special issue titled **A tribute to Edward P. Glenn (1947-2017): a legacy of scientific environmental assessment and applications in hydrological processes**. Pamela completed much of the work that Ed was working on before he passed and invited others to contribute to his lines of research.
- 5) Pamela Nagler* convening a session at the European Geoscience Union General Assembly 2019 on April 12. The session is titled **Estimating evapotranspiration in extreme and sensitive environments using remote sensing, ground data and models**.

2nd State of the Carbon Cycle Report

The second State of the Carbon Cycle Report (SOCCR-2) held a number of sessions at the 2018 American Geophysical Union meeting celebrating the release of the continental synthesis. SBSC scientist Sasha Reed* was one of five scientific co-leads of the report, and the release of SOCCR-2 represents the culmination by work of hundreds of authors and numerous agencies and institutions. The report can be found here: <https://carbon2018.globalchange.gov>.

Pollinators and the Energy Sector Workshop

Kathryn Thomas* attended a two-day training workshop on pollinators and the energy sector on March 27-28 in Sacramento, CA. The workshop was sponsored by the Electric Power Research Institute (EPRI); the Xerces Society and Pollinator Partnership also contributed to the workshop. The workshop provided an opportunity for discussion of pollinator-focused studies and needs on grid corridors and infrastructure on public lands in the West.

High-Flow Experiment on the Colorado River

1) On November 5, the Department of the Interior initiated a 60-hour, high-volume water release from Glen Canyon Dam. Mike Moran*, Helen Fairly*, Tom Gushue*, Guillaume Dramais*, and Todd Wojtowicz* attended the beginning of the release. This High-Flow Experiment, the fifth since 2012, was conducted as part of an experimental strategy to manage limited sediment resources to build and maintain sandbars and camping beaches along the Colorado River through Grand Canyon National Park. Studies conducted in conjunction with previous High-Flow Experiments have allowed scientists to better understand the physical and ecological processes of the post-dam Colorado River. Scientists Nick Voichick*, Tom Sabol*, and Ron Griffiths* with SBSC's Grand Canyon and Monitoring Research Center (GCMRC) collected data on resource responses during the High-Flow Experiment. Monitoring of sandbars and beaches, the aquatic foodbase, native and non-native fish populations, and riparian vegetation will occur in the months following the High-Flow Experiment to quantify any effects of the experiment on these key resources.

2) In a joint effort, SBSC and Arizona Water Science Center (AZWSC) researchers collected data in the Colorado River throughout the High-Flow Experiment. AZWSC personnel Joel Unema and Michael Robinson were at Phantom (the Grand Canyon gage) collecting suspended sediment samples and discharge measurements. Jessica Anderson, Justine Mayo, Geoff DeBenedetto, and Joe Affinati collected water quality samples, suspended sediment, and measured discharge on November 5-6 at Colorado River at Lees Ferry, and Corey Sannes and Curt Crouch measured discharge at Colorado River above Diamond Creek on November 8. SBSC personnel Ron Griffiths* and Tom Sabol* collected suspended sediment samples and measured discharge at the Colorado River above National Canyon gaging station, and Nick Voichick* and Dave Dean* collected suspended sediment samples at the Lees Ferry gage. Additionally, SBSC's Tim Andrews* hiked to the Grand Canyon gage to conduct some repairs making it possible to download data from the instruments via satellite after the high-flow recedes.

**For more information about the
Southwest Biological Science Center:**

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<https://www.usgs.gov/centers/sbsc>

