

# Abstracts and Program

## The 4<sup>th</sup> Joint Symposium on the Natural History and Geology of The Bahamas



Photo: Olivia Walton, University of New Haven

June 8 - June 12, 2023  
Gerace Research Centre  
University of The Bahamas  
San Salvador, The Bahamas



# THE 4<sup>th</sup> JOINT SYMPOSIUM ON THE NATURAL HISTORY AND GEOLOGY OF THE BAHAMAS

June 8<sup>th</sup> to June 12<sup>th</sup>, 2023

GERACE RESEARCH CENTRE  
UNIVERSITY OF THE BAHAMAS  
SAN SALVADOR, THE BAHAMAS



## PROGRAM CO-CHAIRPERSONS:

**Dr. Dawn M. Ford**  
The University of Tennessee at  
Chattanooga  
Honors College and Master of Public  
Health Program  
Chattanooga, TN 37403

**Dr. Dan Kjar**  
Elmira College  
Department of Biology  
Elmira, NY 14901

## ORGANIZER:

**Dr. Troy A. Dexter**  
Executive Director  
Gerace Research Centre  
University of The Bahamas  
San Salvador, The Bahamas



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OF THE BAHAMAS

**PARTICIPANTS LIST**

**Lily Acierno**

Bayport  
New York  
United States of America

**Alyssa Anderson**

Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Laura Baker**

The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Kristin Bakkegard**

Samford University  
Birmingham  
Alabama  
United States of America

**John Barnes**

NOAA/ESRL/Global Monitoring  
Laboratory  
Boulder  
Colorado  
United States of America

**Mary Jane Berman**

Miami University  
Oxford  
Ohio  
United States of America

**Charles Breithaupt**

ExxonMobil  
Houston  
Texas  
United States of America

**Trevor Browning**

Elmira College  
Elmira  
New York  
United States of America

**Ken Buchan**

Dorset Council  
Weymouth  
Dorset  
United Kingdom

**Mario Caputo**

University of Nevada, Las Vegas  
Tujunga  
California  
United States of America

**Janelle Caputo**

Tujunga  
California  
United States of America

**Nicole Cardino**

University of San Diego  
Lindenhurst  
New York  
United States of America

**Eric Cathcart**

University of San Diego  
San Diego  
California  
United States of America

**Xinyan Chen**

School of Communication, Media  
and Journalism, College of Liberal  
Arts, Wenzhou-Kean University  
Wenzhou  
Zhejiang  
China

**Sydnei Cartwright**

University of Michigan  
Ann Arbor  
Michigan  
United States of America

**Renee Clary**

Mississippi State University  
Starkville  
Mississippi  
United States of America

**Katherine Clayton**

Hobart and William Smith  
Colleges  
Geneva  
New York  
United States of America

**Emily Clayton**

Blue Point  
New York  
United States of America

**Eric Cole**

St. Olaf College  
Northfield  
Minnesota  
United States of America

**Gyllian Cooper**

The University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Olivia Cunningham**

University of Louisiana at  
Lafayette  
Lafayette  
Louisiana  
United States of America

**Allen Curran**  
Smith College  
Northampton  
Massachusetts  
United States of America

**Gareth Davies**  
Vrije Universiteit Amsterdam  
Amsterdam  
The Netherlands

**Ancilleno Davis**  
The Bahamas National Trust  
Nassau  
New Providence  
The Bahamas

**Nancy Elliott**  
Siena College  
Greenlawn  
New York  
United States of America

**Ashley Ellis**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Alyssa Enevold**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Emory Evans**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Justin Fagnoni**  
Central Connecticut State  
University  
New Britain  
Connecticut  
United States of America

**Shelby Flint**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Dawn Ford**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Chris Fuhrmann**  
NOAA's Southeast Regional  
Climate Center  
Chapel Hill  
North Carolina  
United States of America

**Seth Gagnon**  
Central Connecticut State  
University  
New Britain  
Connecticut  
United States of America

**Yakun Gao**  
School of Communication, Media  
and Journalism, College of Liberal  
Arts, Wenzhou-Kean University  
Wenzhou  
Zhejiang  
China

**Kathy Gerace**  
Gerace Research Centre  
Grahams Harbour  
San Salvador  
The Bahamas

**Tobias Grun**  
University of Florida  
Gainesville  
Florida  
United States of America

**Lynn Gillie**  
Elmira College  
Elmira  
New York  
United States of America

**Bosiljka Glumac**  
Smith College  
Northampton  
Massachusetts  
United States of America

**Michael Godley**  
William Carey University  
Hattiesburg  
Mississippi  
United States of America

**Yunhan Gou**  
School of Communication, Media  
and Journalism, College of Liberal  
Arts, Wenzhou-Kean University  
Wenzhou  
Zhejiang  
China

**Mary Griep**  
St. Olaf College  
Northfield  
Minnesota  
United States of America

**David Griffing**  
Hartwick College  
Oneonta  
New York  
United States of America

**Elizabeth Griffith**  
Ohio State University  
Columbus  
Ohio  
United States of America

**Jason Gulley**  
University of South Florida  
Tampa  
Florida  
United States of America

**Andrew Hinrichs**  
Omaha's Henry Doorly Zoo and  
Aquarium  
Omaha  
Nebraska  
United States of America

**Daisymae Hunter**  
Port Howe  
Cat Island  
The Bahamas

**Patricia Ireland**  
Elmira College  
Elmira  
New York  
United States of America

**Caroline Ireland**  
Boston College  
Boston  
Massachusetts  
United States of America

**Amin Kabir**  
University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Rayan Kanfar**  
Stanford University  
Stanford  
California  
United States of America

**Daniel Kjar**  
Elmira College  
Elmira  
New York  
United States of America

**MacKenzie Klett**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Ronnie Knoll**  
University of South Florida  
Tampa  
Florida  
United States of America

**Edward Knowles**  
University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Michal Kowalewski**  
University of Florida  
Gainesville  
Florida  
United States of America

**Lee Kump**  
Penn State College of Earth and  
Mineral Sciences  
State College  
Pennsylvania  
United States of America

**Christana Landress**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Carol Landry**  
Ohio State University  
Mansfield  
Ohio  
United States of America

**Jessica Leesburg**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Hannah Lissner**  
University of San Diego  
San Diego  
California  
United States of America

**Elena Longan**  
University of New Hampshire  
Durham  
New Hampshire  
United States of America

**Trenton McEnaney**  
University of Missouri-Kansas  
City  
Kansas City  
Missouri  
United States of America

**Allan Meyers**  
Eckerd College  
Saint Petersburg  
Florida  
United States of America

**Maddox Miller**  
Louisiana State University  
Lafayette  
Louisiana  
United States of America

**PJ Moore**  
ExxonMobil  
Houston  
Texas  
United States of America

**Jenny Morris**  
Bahamas National Trust  
Nassau  
New Providence  
The Bahamas

**Tapan Mukerji**  
Stanford University  
Stanford  
California  
United States of America

**Joan Mylroie**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**John Mylroie**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Athena Nagel**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Tina Niemi**  
University of Missouri-Kansas  
City  
Kansas City  
Missouri  
United States of America

**Joseph Nolan**  
University of Missouri-Kansas  
City  
Kansas City  
Missouri  
United States of America

**Joanna Ostapkowicz**  
University of Oxford  
Oxford  
Oxon  
United Kingdom

**Elena Payne**  
University of Missouri-Kansas  
City  
Kansas City  
Missouri  
United States of America

**Sierra Petersen**  
University of Michigan  
Ann Arbor  
Michigan  
United States of America

**Cassandra Phillips**  
Girl Scouts of Louisiana  
Lafayette  
Louisiana  
United States of America

**Cecilie Phillips**  
University of Michigan  
Ann Arbor  
Michigan  
United States of America

**Roger Portell**  
University of Florida  
Gainesville  
Florida  
United States of America

**Alex Quizon**  
University of Michigan  
Ann Arbor  
Michigan  
United States of America

**John Rodgers**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**John Rollino**  
AECOM  
New York  
New York  
United States of America

**John Rucker**  
University of Missouri-Kansas  
City  
Jefferson City  
Missouri  
United States of America

**Ashawnt, Russell**  
The University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Natalie Salazar**  
University of South Florida  
Tampa  
Florida  
United States of America

**Jillian Saraney**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**John Saurer**  
St. Olaf College  
Northfield  
Minnesota  
United States of America

**Rick Schulting**  
University of Oxford  
Oxford  
Oxon  
United Kingdom

**Stephanie Schwabe**  
Rob Palmer Blue Holes  
Foundation  
Charleston  
South Carolina  
United States of America

**Charlie Shaeff**  
Central VA Community College  
(retired)  
Lynchburg,  
Virginia  
United States of America

**Nimmi Sharma**  
Central Connecticut State  
University  
New Britain  
Connecticut  
United States of America

**Sherilyn Smith**  
Le Moyne College  
Cazenovia  
New York  
United States of America

**Patricia Spellman**  
University of South Florida  
Tampa  
Florida  
United States of America

**Mark Stephens**  
University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Regan Truedson**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Grace Turner**  
Antiquities, Monuments and  
Museum Corporation (AMMC)  
Nassau  
New Providence  
The Bahamas

**Katelynn Urness**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**Jackson Vierstraete**  
Southwest Minnesota State  
University  
Marshall  
Minnesota  
United States of America

**John Wells**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Philip Weech**  
Nassau  
New Providence  
The Bahamas

**Ian Winkelstern**  
Grand Valley State University  
Allendale  
Michigan  
United States of America

**John Winter**  
Molloy University  
Rockville Centre  
New York  
United States of America

**Kim Wood**  
Mississippi State University  
Starkville  
Mississippi  
United States of America

**Maria Woodside-Oriakhi**  
University of The Bahamas  
Nassau  
New Providence  
The Bahamas

**Abbie Woodson**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Judson Wynne**  
Northern Arizona University  
Flagstaff  
Arizona  
United States of America

**Taylor Yates**  
The University of Tennessee at  
Chattanooga  
Chattanooga  
Tennessee  
United States of America

**Jessica Yesensky**  
Elmira College  
Elmira  
New York  
United States of America

**T. Emre Yildirim**  
School of Communication, Media  
and Journalism, College of Liberal  
Arts, Wenzhou-Kean University  
Wenzhou  
Zhejiang  
China

**Theodore Yoder**  
St. Stephen's & St. Agnes School  
Alexandria  
Virginia  
United States of America



## CONFERENCE PROGRAM\*

\*Unless otherwise noted, all conference activities are held in the GRC Conference Room

### Thursday – June 8<sup>th</sup>

- 4:00 PM     **Registration:** Receive your badges, collect your goodie bags, and get your room assignments.
- 4:30 PM     **Poster Setup/Presentation Upload:** Please upload your presentation to the conference computer and/or hang your poster in the poster hall.
- 5:30 PM     **Dinner in Cafeteria**
- 7:00 PM     Opening Remarks, **Troy Dexter**
- 7:25 PM     Introduction of Keynote Speaker, **Dawn Ford and Dan Kjar, Conference Co-Chairs**
- 7:30 PM     “Threats from the Land and Sea: Sediment Erosion and Deposition Vulnerability of Small (<5,000 km<sup>2</sup>) Islands,” **Trevor Browning, Keynote Speaker**

### Friday – June 9<sup>th</sup>

- 7:30 AM     **Breakfast in Cafeteria**
- 8:15 AM     **Announcements, Conference Room**

#### *Natural History of the Bahamas*

- 8:20 AM     “Irregular Echinoids of the Bahamas: Preliminary Bio-Inventorizing of Important Ecosystem Engineers,” **Michal Kowalewski**
- 8:40 AM     “*Cassiopea* Life History: It Takes 3 to Tango,” **Eric Cole**
- 9:00 AM     “Networks of Plant Pollinator Interactions in Coastal Communities on San Salvador Island, Bahamas,” **Carol Landry**
- 9:20 AM     “*Eleutherodactylus rogersi* (Bahamian Flat-Headed Frog) on San Salvador, The Bahamas with Comparisons to Other Islands,” **Kristin Bakkegard**
- 9:40 AM     “A Quarter Century of Observed Ecological Changes of Shallow Water Coral Patch Reefs of San Salvador Island, Bahamas: 1992-2019,” **John Rollino**
- 10:00 AM    **Coffee Break**

## **Friday – June 9<sup>th</sup> (continued)**

### ***The Value of Field Education (Natural History Focused)***

- 10:20 AM “Successful Teaching and Training Techniques of Tropical Nearshore Coastal Ecology for High School Students and Citizen Scientists,” **Ted Yoder**
- 10:40 AM “Lessons from Linked Courses in Biology and Art,” **Eric Cole**
- 11:00 AM “NSC1902/BIO3930 Marine and Island Ecology: 50 Years of Elmira College Students on San Salvador,” **Daniel Kjar**
- 12:00 PM **Lunch in Cafeteria**
- 1:00 PM **Island Field Trips:** Field trips TBD, Refer to sign-up sheets in Conference Room.
- 4:30 PM **Poster Hall Opens**
- 5:00 PM **Social Hour**
- 6:00 PM **Dinner in Cafeteria**
- 7:30 PM **Poster Lightning Session: Participating Poster Presenters:** *For poster presenters who choose to take part, you will have 5 minutes to describe the main points of your work. You may also project a digital copy of your poster online and in the conference room.*

## **Saturday – June 10<sup>th</sup>**

- 5:15 AM **Bird Watchers Field Trip:** *This free field trip will be led by the island's top birding guide! Hiking is involved, so wear appropriate footwear. If you have binoculars, please bring them as our supply is limited.*
- 7:00 AM **Breakfast in Cafeteria** (Please note the earlier start time)

### ***Archeology of the Bahamas***

- 8:00 AM “An Overview of Stone Celts from San Salvador,” **Rick Schulting**
- 8:20 AM “Identifying Historical Period Archaeological Sites on San Salvador Island Using Lidar Survey Data,” **John Rucker**
- 8:40 AM “The Power of Archaeology Field Schools: The Gerace Research Centre and Lucayan Archaeology,” **Mary Jane Berman**

## **Saturday – June 10<sup>th</sup> (continued)**

- 9:00 AM “Development of an Archaeology Program for the Government of the Bahamas,” **Grace Turner**
- 9:20 AM **Coffee Break**
- 9:40 AM “A Shift from Marine to Terrestrial Resources? New Radiocarbon Dates and Stable Carbon and Nitrogen Isotope Data on Pre-Columbian Human Remains from San Salvador,” **Rick Schulting**
- 10:00 AM “Fifty Years of Historic Archaeology,” **Kathy Gerace**
- The Value of Field Education (Archeology Focused)***
- 10:20 AM “Ten Years of the Cat Island Heritage Project: Community Archaeology and Field-Based Education,” **Allan Meyers**
- 11:00 AM **High Cay Excursion Day Trip Participants:** *Spend the afternoon snorkeling, hiking, and having lunch and drinks on High Cay! This trip is offered by a local company, not a part of the GRC. The cost is \$140 paid directly to them, and cash preferred. Transportation provided.*
- 12:00 PM **Lunch in Cafeteria (for those not going to High Cay)**
- 1:00 PM **Island Field Trips (for those not going to High Cay).** Field trips TBD, Refer to sign-up sheets in Conference Room
- 5:00 PM **Social Hour/Poster Session.**

### **Presenters should be available by their poster:**

1. “TI/TH and TI/ZR Variability within San Salvador Island Paleosols,” **Hannah Lissner**
2. “New Last Interglacial Paleoclimate Data from San Salvador and Great Inagua,” **Ian Winkelstern**
3. “Soil Metals Distributions Adjacent to the Dixon Hill Lighthouse, San Salvador, the Bahamas,” **Nicole Cardino**
4. “Spatial Statistical Analysis and Geomodeling of Banana Holes Using Point Patterns and Generative Adversarial Networks,” **Rayan Kanfar**
5. “The Electronic Beach and Cooperative Learning on San Salvador,” **Sherilyn G.F. Smith**
6. “The San Salvador Community Enrichment Initiative,” **Dawn Ford**
7. “Bahamian Field Experiences: Past, Present, and Future,” **Laura Baker**
8. “A Quick Look at the History of Elmira College Faculty and Student Research,” **Daniel Kjar**
9. “Was Sea Level Ever Higher Than Present on San Salvador Island in the Bahamas During the Mid-to-Late Holocene,” **Tina M. Niemi**
10. “Geomorphic changes to Sandy Point Beach from Analyses of Aerial Imagery and Implications for Sediment Transport and Storm Wave Direction on San Salvador Island, the Bahamas.” **Elena Payne**

## **Saturday – June 10<sup>th</sup> (continued)**

6:00 PM **Dinner in Cafeteria**

### ***Gerace Research Centre 50<sup>th</sup> Anniversary Celebration***

7:00 PM **Anniversary Talks**, Discussions about the history and impact of the station and where we are looking to bring the station into the future.

8:00 PM “Engaging the Bahamian Community for Education, Environment, and Health,” **Dawn Ford, Keynote Speaker**

## **Sunday – June 11<sup>th</sup>**

7:30 AM **Breakfast in Cafeteria**

### ***Geology of the Bahamas***

8:20 AM “Investigating the Relationship between Lake Connectivity and Genesis: Evidence from Basin Morphology and Lake Level Variability on San Salvador Island, Bahamas,” **Charles Breithaupt**

8:40 AM “The Bahamas as a Model for the Solar System,” **John Mylroie**

9:00 AM “The Wind-Blown Sedimentary Origin of Quaternary Calcareenites on San Salvador Island, The Bahamas: How We Know and What We Know So Far,” **Mario V. Caputo**

9:20 AM “Estimating the Causes of Lake Level Variability on a Low-Lying Carbonate Island,” **Natalie Salazar**

9:40 AM “Examination of Rainfall Variability on San Salvador Island Using Data from a Volunteer Rain Gauge Network,” **Chris Fuhrmann**

10:00 AM **Coffee Break**

10:20 AM “Remote Sensing of Nocturnal Atmospheric Aerosols in the Bahamas Using Camera Lidar and Star Photometry,” **Amin Kabir**

### ***The Value of Field Education (Geology Focused)***

10:40 AM “Virtual Field Excursions’ Potential for Public Access to Unique Karst Landscapes: Challenges and Opportunities in Geoheritage,” **Renee M. Clary**

11:00 AM “Confidence and Community: Achieving Critical Student Outcomes Through Field-Based Research Projects in a Faculty-Led Study-Abroad Experience,” **Shelby Flint**

## **Sunday – June 11<sup>th</sup> (continued)**

- 11:20 AM “From Beach Sand to Tabby Construction: Teaching Process Sedimentology and Cultural History in an Introductory Field Methods Course,” **Tina Niemi**
- 11:40 AM “‘Geojournalism’ Approaches for Field and Virtual Environmental Education,” **Mark Stephens**
- 12:00 PM **Lunch in Cafeteria**
- 1:00 PM **Island Field Trips.** Field trips TBD, Refer to sign-up sheets in Conference Room
- 5:00 PM **Social Hour**
- 6:00 PM **Dinner in Cafeteria**
- 7:00 PM **Closing Ceremony**

## **Monday – June 12<sup>th</sup>**

- 7:30 AM **Breakfast in Cafeteria**
- 8:30 AM **Free Time/Packing**
- 12:00 PM **Lunch in Cafeteria**
- 1:00 PM **Depart for Airport:** For those departing on the 12<sup>th</sup> or going on the post-conference field trip.

## **KEYNOTE PRESENTATIONS**

*Thursday at 7:30 PM*

### **THREATS FROM THE LAND AND SEA: SEDIMENT EROSION AND DEPOSITION VULNERABILITY OF SMALL (<5,000 KM<sup>2</sup>) ISLANDS**

Dr. Trevor Browning  
Elmira College  
Elmira, NY, USA

The tropics are naturally vulnerable to weathering and erosion. Rapid population growth (projected to be 50% of global population by 2050) in this region leads to land use changes which increase erosion and peak flows that transport sediment. The issue is particularly of interest on the many (~45,000) small tropical (<5,000 km<sup>2</sup>) islands, and their >115M residents, where ecotourism and sediment intolerant ecosystems such as coral reefs are the main driver of their economies. Vulnerability to erosion and deposition is poorly understood in these communities due to the misclassification or exclusion of small islands in coarse global models. This study utilizes the previously established EVI/EDVI methodology for St. John in the US Virgin Islands. We use the only vulnerability assessment method that connects watershed erosion and coastal deposition to compare locally sourced, high-resolution datasets (5 x 5 m) to satellite-collected, remotely sensed low-resolution datasets (463 x 463 m). We find that on the island scale (~52 km<sup>2</sup>) the difference in vulnerability calculated by the two methods is minor. On the watershed scale however, low-resolution datasets fail to accurately demonstrate watershed and coastal deposition vulnerability when compared to high-resolution analysis. Specifically, we find that anthropogenic development (roads and buildings) is poorly constrained at a global scale. Additionally, Category 5 Hurricanes Irma and Maria deposited ~25 cm over 1.28 km<sup>2</sup> of coastal ecosystems on St. John in 2017 such as seagrasses and corals. Using the EVI/EDVI methodology we corroborate that the layer was not delivered by the watershed. Overall, this highlights threats both from land use change and climate change.

*Saturday at 8:00 PM*

### **ENGAGING THE BAHAMIAN COMMUNITY FOR EDUCATION, ENVIRONMENT, AND HEALTH**

Dr. Dawn Ford  
The University of Tennessee at Chattanooga  
Chattanooga, TN, USA

While the Gerace Research Centre is primarily a place ‘for the study of archaeology, biology, geology, and marine science,’ with the shifts in post-pandemic higher education, it is an opportune time to reflect on how faculty and students can engage with the people, culture, and environments of San Salvador and other islands of The Bahamas. This keynote will discuss approaches and opportunities for institutions of higher education and other organizations to provide meaningful learning experiences while benefitting the local communities of the Bahamas.

## ABSTRACTS

### **BAHAMIAN FIELD EXPERIENCES: PAST, PRESENT, AND FUTURE**

**Baker, Laura**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Ford, Dawn**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA

*Presenter: Laura Baker, Saturday Poster 7*

The positive impacts of field experiences are well documented in the pedagogical literature, with students reporting such experiences as having a high impact on their professional development, personal development, and international perspective. Some students carry on this work as they become professors leading their own trips. While the pandemic put a temporary pause on this work, we are now at a point to reflect upon the past and envision how we engage students in field experiences moving forward. This poster will display some historical artifacts and narrative about the BFS, GRC, and GRI and the involvement of undergraduate and graduate students that have led to long-term engagement on San Salvador, Bahamas and on other islands of the Bahamas. This poster also presents questions for reflection in designing and implementing field experiences in a post-pandemic world that consider how scientific research, Bahamian culture, and the local community intersect.

### ***ELEUTHERODACTYLUS ROGERSI* (BAHAMIAN FLAT-HEADED FROG) ON SAN SALVADOR, THE BAHAMAS WITH COMPARISONS TO OTHER ISLANDS**

**Bakkegard, Kristin**, Samford University, Birmingham, AL, USA

*Presenter: Kristin Bakkegard, Friday 9:20 AM*

*Eleutherodactylus rogersi* (Bahamian Flat-headed Frog) is The Bahamas only endemic frog and one of three native species. It was not afforded full species status until 2007. Data on *E. rogersi* are

limited to the 1955 description by Goin (subspecies) and a 1974 summary by Schwartz (subspecies); thus little is known about this frog. I measured the snout-vent length (SVL) and weight of *E. rogersi* across several Bahamian Islands in winter (October - December 2022) and early spring (February - March 2023) to include Andros (N=18; winter), Eleuthera (N = 110; winter & spring), Exuma (N=3; spring), and Long Island (N=42; spring), noting dorsal patterns, habitats and the temperature/relative humidity above and below cover objects with frogs. The mean SVL of San Salvador winter frogs (N=108) was 18.5mm (range 7.3 - 32.6mm, SD =  $\pm$  7.2); mean weight was 0.61g (range 0.02 - 2.52g, SD =  $\pm$  0.58). The mean SVL of early spring frogs (N=107) was 21.7mm (12.7 - 32.8mm, SD =  $\pm$  4.4); mean weight was 0.74g (0.16 - 2.26g, SD =  $\pm$  0.44). On San Salvador, early spring frogs were significantly larger than winter frogs (F = 2.69, P < 0.001) and in early spring, no frogs were found in the smallest size classes, suggesting seasonal reproduction, most likely late spring to early winter. Long Island frogs (N=42) were the largest - mean SVL of 21.7mm (12.2 - 37.7 mm, SD =  $\pm$  5.5) and mean weight of 0.81g (0.13 - 3.51g, SD =  $\pm$  0.68) - one frog here being exceptionally large. Striped and unstriped morphs were found on all islands sampled with unstriped morphs predominating except for Andros where 83% of the frogs were striped. This frog occupies a variety of habitats including black coppice, white coppice, and they can be easily found around human-built structures and landscaping. During the day, they are found under cover objects during the day (rocks, boards, banana leaves, discarded building materials, old metal), and are terrestrially active at night. The highest temperature for a cover object with frogs underneath it was 33.8°C (under a rock) and the lowest relative humidity was 55.1% (old piece of concrete).

**INVESTIGATING THE RELATIONSHIP  
BETWEEN LAKE CONNECTIVITY AND  
GENESIS: EVIDENCE FROM BASIN  
MORPHOLOGY AND LAKE LEVEL  
VARIABILITY ON SAN SALVADOR  
ISLAND, BAHAMAS**

**Breithaupt, Charles**, Exxonmobil, Houston, Texas, USA; **Knoll, Ronnie**, University of South Florida, Tampa, FL, USA; **Gulley, Jason**, University of South Florida, Tampa, FL, USA; **Moore, PJ**, Exxonmobil, Houston, Texas, USA

*Presenter: Charles Breithaupt, Sunday 8:20 AM*

Lake-aquifer connectivity in coastal carbonate platforms is governed by depositional and diagenetic processes which create and modify the pore systems contained in modern lakebeds. Because coastal aquifers are known to have tidally controlled fluctuations in water level, variability in lake stage can be used to estimate regional scale permeabilities and link lake genesis to pore system evolution. As a result, concepts for coastal lake formation may be applied to scale-up wellbore observations and predict connectivity in aquifers and hydrocarbon reservoirs. In this study, we collected water level fluctuations at high temporal resolution in the ocean and twenty-four water bodies on San Salvador Island, Bahamas. We estimated hydraulic diffusivity (transmissivity/storativity) and calculate apparent permeability from dampened tidal amplitudes and link connectivity to lake formation processes. The highest permeabilities (10-14.4 to 10-9.8 m<sup>2</sup>) were calculated in lakes and blue holes which contain direct conduit connections extending into bedrock older than that composing the lakebed. The lowest permeabilities (10-14.4 to 10-9.8 m<sup>2</sup>) were calculated in MIS 5e and Holocene lakes which tend to lack conduits and bare evidence of formation through depositional processes. Permeability values could not be calculated in some lakes due to a lack tidal variability. As a result, we suggest some lakebeds become isolated from the groundwater system by horizons of low permeability exposure surfaces such as paleosols, calcretes, and exposure breccias which form

during sea level lowstands. Isolation between lakes and the groundwater system may also be promoted during sea level highstands when elevated salinities result in salt rich muds and microbialites lining the lakebed. Our findings suggest that lake genesis in semi-arid isolated carbonate platforms largely drives hydraulic isolation between vertical successions of carbonate rocks while dissolution and karst processes may subsequently result vertical connections.

**THE WIND-BLOWN SEDIMENTARY  
ORIGIN OF QUATERNARY  
CALCARENITES ON SAN SALVADOR  
ISLAND, THE BAHAMAS: HOW WE  
KNOW AND WHAT WE KNOW SO FAR**

**Caputo, Mario**, University of Nevada, Las Vegas, NV, USA

*Presenter: Mario V. Caputo, Sunday 9:00 AM*

In the 1800s, wind-blown (eolian) ripple and dune deposits composed of calcium carbonate (CaCO<sub>3</sub>) grains had been recognized on other Bahamian islands and along other shorelines where ocean conditions favored the making of skeletal and nonskeletal sand by marine invertebrate organisms. The development of the Bahamian Field Station (now the Gerace Research Centre) fostered work by geoscientists on the sedimentary bedrock of San Salvador. Notions emerged on the eolian origins of Pleistocene and Holocene carbonate sandstones (calcarenites) on the island in the 1980s and were based mainly on cross-stratification associated with terrestrial (nonmarine) plant and insect traces, crusts and hardened soils, and invertebrate fossils despite the unequivocal marine nature of component sand grains. Later studies on these San Salvador eolian calcarenites recorded grain properties, and occurrence and geometry of strata that are identical to those described in modern quartz-rich (siliciclastic) eolian dune sand and in Paleozoic and Mesozoic eolian dune sandstones. Sand ripples migrating in wind create thin, cyclic wind-ripple laminations; sand, partly suspended by



wind, settles as grainfall laminations; and sand grains remobilized by avalanching (grainflow) on dune slopes come to rest as sandflow beds. These processes and resulting strata combine to form the familiar cross-stratification or crossbedding of eolian dunes. Field and microscope study of Pleistocene and Holocene eolian calcarenites on San Salvador further revealed that grain size, packing, and cementing differ among wind-ripple, grainfall, and sandflow strata and determine the degree of resistance to weathering in outcrop. Wind-ripple strata weather as alternating thin resistant ledges and recesses; grainfall strata as thin resistant ledges; and sandflow beds as lens-shaped less resistant recesses. Adhesion structures, formed by loose sand transported by wind across moistened sand, are eolian features newly discovered in Pleistocene and Holocene calcarenites. Dominance of wind-ripple laminations, scarcity of sandflow beds, mound-swale topography of the present-day North Point peninsula, coupled with a near 360° span of dip azimuths of foreset laminations, cross-bed bounding surfaces, reactivation surfaces, and bedrock mound-slopes suggest the build-up of eolian dome-dunes that deposited the Holocene calcarenites on the North Point peninsula of San Salvador.

### **SOIL METALS DISTRIBUTIONS ADJACENT TO THE DIXON HILL LIGHTHOUSE, SAN SALVADOR, THE BAHAMAS**

**Cardino, Nicole**, University of San Diego, San Diego, CA, USA; **Schwabe, Stephanie**, Rob Palmer Blue Holes Foundation, Charleston, SC, USA; **Cathcart, Eric**, University of San Diego, San Diego, CA USA  
*Presenter: Nicole Cardino, Saturday Poster 3*

Dixon Hill Lighthouse, built in 1887, was kerosene-lit and is one of the few remaining manually operated lighthouses in the world. Manual refueling used to occur between sunset and sunrise, every 135 minutes requiring the employment of two lighthouse keepers year-round. The Fresnel lens with its metal base floats

on a foundation filled with mercury, lessening friction and allowing free rotation of the lens. Human health impacts from mercury are well documented; however, the environmental impact to the areas surrounding this lighthouse has not been extensively studied. In addition to mercury exposure hazards, Kerosene, which has been used for more than 128 years before being discontinued, contains varying amounts of zinc, copper, chromium, lead, and cadmium. Also, lead based paint (outlawed in the US in 1978) is still being used on the Dixon Hill property. This study measures the distribution of metal-impacted soils adjacent to Dixon Hill lighthouse and compares these preliminary findings to human health risk screening levels. All analyses were completed in situ using a hand-held NITON Pro Gold X-Ray Fluorescence (XRF) machine with a minimum 90 second exposure. Six radial transects at roughly 60 degree intervals (approximately 50 meters in length) were completed extending away from the lighthouse to the outer property wall. For each transect, the first measurement included the side of the lighthouse (paint) followed by approximately 5 soil measurements (every 8-10 meters) for a total of 36 in situ paint and soil measurements. Of the 30 metals detected, 17 are known carcinogens. Copper, lead, and mercury were elevated above soil clean up target levels (SCTL) and human health risk (HHR) in accordance with Florida environmental standards. Copper levels ranged from 2.7 to 417.2 ppm. Lead levels ranged from 17.2 to 2,351.1 ppm. Mercury levels ranged from 2.2 to 113.7 ppm. Of particular note is that the transect running Northwest consistently had metals concentrations above SCTL and HHR. Initial explanation for this is the dominant prevailing winds from the Southeast. This ongoing study will further define the impacted areas to the north by increasing the sampling resolution and identifying the extent of the contamination of local soils and vegetation.

## **VIRTUAL FIELD EXCURSIONS' POTENTIAL FOR PUBLIC ACCESS TO UNIQUE KARST LANDSCAPES: CHALLENGES AND OPPORTUNITIES IN GEOHERITAGE**

**Clary, Renee**, Mississippi State University, Starkville, MS, USA; **Nagel, Athena**, Mississippi State University, Starkville, MS, USA; **Leesburg, Jessica**, Mississippi State University, Starkville, MS, USA; **Mylroie, John**, Mississippi State University, Starkville, MS, USA; **Mylroie, Joan**, Mississippi State University, Starkville, MS, USA  
*Presenter: Renee M. Clary, Sunday 10:40 AM*

The anchialine lake of Sweeting's Pond, Eleuthera, The Bahamas, not only contains the world's greatest density of seahorses, but its local karst landscape also hosts other unique flora and fauna. Approximately 2.17 km<sup>2</sup> has been slated to become Seahorse National Park. The expansion of virtual technologies can broaden public access to restricted locations and geographically distant areas through 3D virtual specimens and virtual tours, as well as augmented and virtual reality immersive experiences. We analyzed Sweeting's Pond for its Geoh heritage value, and assessed whether virtual technologies could effectively capture and represent this exceptional area. We documented the proposed Seahorse National Park area with a variety of photographic equipment and methods (DSLR cameras, GoPro, unmanned aerial vehicles [UAVs], Structure-from-Motion [SFM], and photogrammetry), focusing specifically on Sweeting's Pond and Hatchet Bay Cave. UAV imagery documented larger features of the ridgeline, forested areas, grasslands, shoreline, and anthropogenic agricultural impacts, while shoreline outcrops, underwater zones, fossil coral reefs, and karst were captured in greater detail. Images were processed with multiple software packages and used to create Gigapan images, outcrop and cave models, and virtual excursions. Three dimensional virtual specimens were created with fossilized corals from Sweeting Pond's shoreline. We encountered challenges in documenting the area, including time constraints

(i.e., 5-day summer 2019 field work), minimal underwater photography, and difficulties with aerial photography and illumination within Hatchet Bay Cave. However, the biodiversity and geodiversity of the area were effectively captured along with anthropogenic influences and impact. Virtual packages have potential for public education by communicating the site's scientific importance, illuminating critical issues of the planet, and promoting geoconservation and sustained protection of the area. Virtual excursions further permit people with disabilities, and those unable to travel, to experience Sweeting's Pond. The future Seahorse National Park represents an area of exceptional Geoh heritage with its scientific value, educational prospective, and geotourism potential, and virtual excursions may assist in its promotion and protection.

## **LESSONS FROM LINKED COURSES IN BIOLOGY AND ART**

**Cole, Eric**, St. Olaf College, Northfield MN; **Griep, Mary**, St. Olaf College, Northfield MN, USA; **Saurer, John**, St. Olaf College, Northfield MN, USA  
*Presenter: Eric Cole, Friday 10:40 AM*

In Natural History, we train our students to enter nature and open their eyes, to observe what others overlook, to measure and describe, to imagine unseen causalities, and design rigorous tests that challenge our favorite hypotheses. In exploring Natural History Illustration, we train our apprentices to observe nature with intimacy and a hunger for detail, to discern what minimal line or shading best captures and recreates the subject, be it landscape or portrait. The student learns to discern what to include and what to leave out, and what methods best capture the specimen or enrich the effect with attention to background and negative space. We experimented with linked courses on San Salvador Island, teaching 16 students the art of natural history exploration, and another 16 students in the science of illustration. Over numerous iterations, the professors began to

ease themselves out of their respective silos, and encouraged greater interaction and partnership between our Biology and Art students. This had the expected result of enriching both art and science experiences, and the unexpected consequence of enriching our overarching, emergent experience of the island in ways that transcended either discipline.

**CONFIDENCE AND COMMUNITY:  
ACHIEVING CRITICAL STUDENT  
OUTCOMES THROUGH FIELD-BASED  
RESEARCH PROJECTS IN A FACULTY-  
LED STUDY-ABROAD EXPERIENCE**

**Flint, Shelby**, Southwest Minnesota State University, Marshall, MN, USA; **Anderson, Alyssa**, Southwest Minnesota State University, Marshall, MN, USA; **Enevold, Alyssa**, Southwest Minnesota State University, Marshall, MN, USA; **Klett, MacKenzie**, Southwest Minnesota State University, Marshall, MN, USA; **Truedson, Regan**, Southwest Minnesota State University, Marshall, MN, USA; **Urness, Katelynn**, Southwest Minnesota State University, Marshall, MN, USA; **Vierstraete, Jackson**, Southwest Minnesota State University, Marshall, MN, USA

*Presenter: Shelby Flint, Sunday 11:00 AM*

Addressing wicked problems such as climate change and the biodiversity crisis will require the continued recruitment of knowledgeable and engaged scientists and citizens who have strong problem-solving, communication, and interpersonal skills as well as the mental flexibility and confidence required for successful field-based investigations. Study-abroad field courses - which also enhance the worldview of participants by connecting them to previously unfamiliar communities and ecosystems - strengthen these characteristics in undergraduates. Here, we describe the model of a research-themed field course offered by a small, public, primarily undergraduate institution in the upper Midwest. We will summarize select research projects developed and conducted by undergraduates having varied levels of previous experience in field ecology. Students successfully collected data

over the course of 10 days at the Gerace Research Centre (San Salvador Island, Bahamas); they then analyzed and communicated their results through written reports and poster presentations at an intramural research conference at their home institution. As case studies, these projects illustrate the scope and rigor of projects that undergraduates can complete within an academic semester built around a relatively short study-abroad experience. Additionally, we offer these projects as springboards upon which students from other institutions are encouraged to build. Finally, we highlight additional challenges and rewards offered by study-abroad field courses, such as confidence and community building, enhanced self, world, and cultural awareness, and the importance of flexibility.

**EXAMINATION OF RAINFALL  
VARIABILITY ON SAN SALVADOR  
ISLAND USING DATA FROM A  
VOLUNTEER RAIN GAUGE NETWORK**

**Fuhrmann, Chris**, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; **Rodgers, John**, Mississippi State University, Mississippi State, MS USA; **Wells, John**, Mississippi State University, Mississippi State, MS USA; **Landress, Christana**, Mississippi State University, Mississippi State, MS, USA; **Wood, Kim**, Mississippi State University, Mississippi State, MS, USA

*Presenter: Chris Fuhrmann, Sunday 9:40 AM*

Water resources in the Bahamas are currently under increasing stress from several factors. Rainfall in the region has been declining in recent decades and the latest suite of climate models from the Intergovernmental Panel on Climate Change suggest that this trend will continue in the future. Moreover, many Bahamian islands are experiencing population growth and an expansion of tourism, both of which lead to greater demands for potable water. Small islands like those in the Bahamas are especially prone to the combined effects of climate change and increasing population because of their limited land area and because rising sea levels are negatively impacting

the freshwater lens. Despite these concerns, there is a dearth of basic water resource information in the Bahamas, including measurements of rainfall. As freshwater consumption continues to deplete much of the groundwater storage, it becomes increasingly necessary to explore surface-based storage options such as catchment systems, which are strongly influenced by rainfall patterns. In 2017, we received funding through the 100K Strong in the Americas Program to collect rainfall data on San Salvador Island as part of the Community Collaborative Rain, Hail, and Snow network (CoCoRaHS). This is a volunteer network whereby local residents record rainfall once a day from manual rain gauges. Through the grant, we were able to install several gauges and recruit and train volunteers to record rainfall on San Salvador. Many of these gauges now have over five years of daily data. In this presentation, we provide a summary of the spatial and temporal patterns of rainfall across San Salvador during the period 2018-2022. In addition, we explore the different synoptic-scale weather types associated with rainfall on the island using surface weather maps, which provide insight into the processes that help generate rainfall. CoCoRaHS gauges have also been installed on other Bahamian islands, allowing us to better understand the important variation in rainfall and associated weather patterns across a larger portion of the Bahamian archipelago. In doing so, we hope to promote sustainable water resource management in the Bahamas that accounts for both short-term weather variability and long-term climate change.

## **FIFTY YEARS OF HISTORIC ARCHAEOLOGY**

**Gerace, Kathy**, Gerace Research Centre, San Salvador, the Bahamas; **Winter, John**, Molloy University, Rockville Centre, NY, USA  
*Presenter: Kathy Gerace, Saturday 10:00 AM*

From the first year it was established, the historic archaeology of the island was one of CCFL's major research foci. While teaching at Elmira College, Kathy Gerace and her students initiated

this work by investigating three separate plantation sites on San Salvador: Sandy Point Estate in 1973 and 1974, Prospect Hill (Farquharson's) in 1975, and Fortune Hill in 1975. Although written records provided information on the ownership of these plantations and their slaves, little was known about their day-to-day lives, other than the one diary of Charles Farquharson, which recorded daily life at Prospect Hill plantation from 1 January 1831 to 31 December 1832. And while this diary has provided some insight into the activities of the planters and the enslaved (it is on the UNESCO Memory of the World Register), archaeological studies of these sites have provided greater information about the plantation systems in the Bahamas. Through the study of site location, spatial organization, architectural styles and techniques, ceramics and other artifacts, rarely mentioned in written sources, the relationships between the planters and the enslaved on San Salvador is more clearly understood. Kathy will summarize her findings from these sites, including the follow-up mapping of the Fortune Hill and the Trial Farm Plantations by Dr. Ron Shaklee and his students (Youngstown State University). Dr. John Winter (emeritus, Molloy University) will describe his extensive exploration and photography of plantation ruins at numerous sites, which he learned about through speaking with local San Salvadorians, examining land records, and consulting Google Map images. He will present his findings from Trial Farm, Kerr Mount, Harbour Estate, Old Place, Hard Bargain, Polly Hill West, Holiday Tract, John Weir property, and the 'No Name' ruins. Dr. Shaklee and his students assisted in Winter's studies of Hard Bargain and Dr. Winter led Caribbean Volunteer Expedition participants in his studies of Kerr Mount, Hard Bargain, Polly Hill West, and the dump area at the lighthouse compound (United Estates). Without John's work, the Colonial Period occupation of the island would have remained hidden to us. Drs. Jane Baxter and John Burton (De Paul University) did extensive archaeological work over three field seasons at the Polly Hill site. Their work

documented the continued habitation and utilization of this space from the plantation era into modern times and the integration of the plantation and post-plantation economies and social systems into larger global systems. They also expanded studies of the Kerr Mount Plantation. Finally, in 2022 a group of University of The Bahamas students, with support of the Inter-American Development Bank, photographed the major buildings at Fortune Hill and Prospect Hill plantations, resulting in a three-dimensional tour of these two important sites.

### **CASSIOPEA LIFE HISTORY: IT TAKES 3 TO TANGO.**

**Hinrichs, Andrew**, Omaha's Henry Doorly Zoo and Aquarium, Omaha, NB, USA; **Cole, Eric**, St. Olaf College, Northfield, MN. 55057

*Presenter: Eric Cole, Friday 8:40 AM*

In searching for the various life history stages of the 'upside-down jellyfish, *Cassiopea xamachana*, within Anchialine environments of the Turks & Caicos Islands, we discovered a remarkable symbiosis involving a small, Cerithid snail, the massive egg masses of the Atlantic lugworm, (*Arenicola cristata*) and our jellyfish. It seems that the life history strategy of our jellyfish intersects that of the Lugworm twice, once as tiny polyps riding on the backs of grazing snails, and a second time, as a settling ephyra. We will share details of our observations of this remarkable opportunistic symbiosis.

### **REMOTE SENSING OF NOCTURNAL ATMOSPHERIC AEROSOLS IN THE BAHAMAS USING CAMERA LIDAR AND STAR-PHOTOMETRY**

**Kabir, Amin**, University of The Bahamas, Nassau, New Providence, The Bahamas; **Sharma, Nimmi**, Central Connecticut State University, New Britain, CT, USA; **Knowles, Edward**, University of The Bahamas, Nassau, New Providence, The Bahamas; **Gagnon, Seth**, Central Connecticut State University, New Britain, CT, USA; **Fagnoni, Justin**,

Central Connecticut State University, New Britain, CT, USA; **Barnes, John**, NOAA/ESRL/Global Monitoring Laboratory, Boulder, CO, USA

*Presenter: Amin Kabir, Sunday 10:20 AM*

Atmospheric aerosols have gained much research interests among the scientists over the past several decades due to their key effects on cooling/warming of the atmosphere, climate change, earth's ecology and health effect. Optical properties of aerosols like extinction, aerosol optical depth (AOD), mass scattering coefficient, and angstrom exponents can reveal the concentrations and type of the aerosols. Local and regional data of aerosol properties are vital for forecasting and predicting climate change. Aerosol extinction is a measure of solar and terrestrial radiation loss per unit length travelling through atmospheric aerosols. AOD is obtained by summing the aerosol extinctions at each altitude through the entire vertical column of atmosphere indicating the total aerosol concentrations from the top of the atmosphere to all the way to the ground. In this study, nocturnal aerosol optical depth (AOD) and altitude-dependent aerosol extinctions in Nassau, The Bahamas were measured simultaneously by employing star-photometry and a camera based imaging lidar (Clidar). A CCD camera fitted to a wide-angle lens takes the picture of stars and vertically transmitted lasers into the sky from ground to zenith at once without requiring expensive timing electronics. The images were analyzed to determine aerosol extinctions and AOD. On November 5, 2018, the top of the boundary layer beyond which aerosol extinction was nearly zero was detected at ~3 km above sea level. Excellent Clidar resolutions at lower altitudes allows in-situ environmental characterization by determining the variations of aerosol concentrations within the boundary layer. AOD was measured utilizing star-photometry and was found to be  $0.043 \pm 0.040$  which falls within the range of assumed values of MODIS (Moderate Resolution Imaging RadioSpectrometer) AOD near the regions. In this project, several STEM undergraduate students at the University of The

Bahamas and Central Connecticut State University were trained to set up the experiments, collect data at various field settings, analyze and present the research findings.

**SPATIAL STATISTICAL ANALYSIS AND GEOMODELLING OF BANANA HOLES USING POINT PATTERNS AND GENERATIVE ADVERSARIAL NETWORKS**

**Kanfar, Rayan**, Stanford University, California, USA; **Mukerji, Tapan**, Stanford University, California, USA

*Presenter: Rayan Kanfar, Saturday Poster 4*

Banana holes are oval or circular shaped karst depressions that form in limestone. In subsurface resource exploration and exploitation, banana hole systems can either be reservoirs to be targeted, or near surface drilling hazards to be avoided. Geomodelling of such caves is important for determining their spatial distribution, which is necessary for optimal field development. The focus of this study is two-fold; firstly, a spatial statistical analysis is performed on point pattern representations of observed banana holes. The banana holes are observed using a survey of airborne LiDAR (light detection and ranging) on San Salvador Island, Bahamas. Ripley's K-function, pair correlation functions, and fry plots are explored to assess the correlation, point interaction, and anisotropy of banana holes. Random geometric graphs of the point patterns are also generated to evaluate graph geometric and topological metrics of the caves such as central point dominance, assortativity, average degree, and degree dispersion. The goal of the statistical analysis is to better understand the morphology of banana holes as well as create an empirical reference for validating simulated cave systems. Secondly, Generative Adversarial Networks is explored for simulating banana holes. The network follows a progressively growing architecture. The performance of this geomodelling approach is investigated by comparing its realizations to observed caves using

multi-dimensional scaling and the statistical metrics introduced in this study.

**NSC1902/BIO3930 MARINE AND ISLAND ECOLOGY: 50 YEARS OF ELMIRA COLLEGE STUDENTS ON SAN SALVADOR**

**Kjar, Daniel**, Elmira College, Elmira, New York, USA

*Presenter: Daniel Kjar, Friday 11:00 AM*

Elmira College has been visiting the GRC since its inception in 1971. The course taught during the last 50 years has evolved but remains a very attractive offering for our students. Marine and Island Ecology briefly covers geology, oceanography, archeology, and natural history all focused on the systems and history of the Island of San Salvador. Elmira College (along with many of the other CCFL colleges) created a special short term, either in the spring or winter, to allow our students to spend up to six weeks on the island. Over the years the course has evolved and adapted to changing faculty and students. This talk will look back on what the class used to be and what it is today.

**A QUICK LOOK AT THE HISTORY OF ELMIRA COLLEGE FACULTY AND STUDENT RESEARCH ON SAN SALVADOR**

**Kjar, Daniel**, Elmira College, Elmira, New York, USA

*Presenter: Daniel Kjar, Saturday Poster 8*

For 50 years, Elmira College students and faculty have been conducting research on San Salvador Island, The Bahamas. This poster will list the work that has been done by faculty and students while at the Gerace Research Centre.

## **IRREGULAR ECHINOIDS OF THE BAHAMAS: PRELIMINARY BIO-INVENTORYING OF IMPORTANT ECOSYSTEM ENGINEERS**

**Kowalewski, Michal**, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; **Grun, Tobias**, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; **Portell, Roger**, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA

*Presenter: Michal Kowalewski, Friday 9:20 AM*

Multiple field surveys, focused on irregular echinoids (sand dollars and heart urchins), were conducted on multiple islands of The Bahamas, including Abaco, Long, and San Salvador islands. These efforts were conducted via SCUBA and included on-site surveys repeated over multiple seasons and years for some sites. The surveys indicated that multiple species of irregular echinoids are present around all surveyed islands, but their distribution is patchy and population densities are highly variable. The echinoid patches appear to be stationary across seasons and years. For example, based on multi-year surveys of San Salvador Island, a high-density patch of *Meoma ventricosa* persisted in the same area of Sand Dollar Beach and a dense population of *Leodia sexiesperforata* resided in the same area of Fernandez Bay. Most patches were either monospecific or dominated by one species. The commonly encountered species included *Meoma ventricosa*, *Clypeaster rosaceus*, *Clypeaster subdepressus*, and *Leodia sexiesperforata*. Predatory snails and sea stars were often found sympatrically with echinoid populations. Echinoids were commonly infested by symbiotic pea crabs. The species suite observed in the surveys was remarkably comparable to the suite of common echinoids species documented around the Florida Keys. The preliminary series of surveys reported here suggests that sand dollars

and heart urchins are widespread and locally abundant across shallow carbonate sand flats of The Bahamas. Because irregular echinoids are important ecosystem engineers and a food source for diverse predators (mollusks, crabs, seastars and fish), their widespread and abundant presence in The Bahama Archipelago points to their ecological importance for benthic ecosystems of the region.

## **NETWORKS OF PLANT-POLLINATOR INTERACTIONS IN COASTAL COMMUNITIES ON SAN SALVADOR ISLAND, BAHAMAS**

**Landry, Carol**, Ohio State University @ Mansfield, Mansfield, OH, USA; **Elliott, Nancy**, Siena College, Greenlawn, NY, USA

*Presenter: Carol Landry, Friday 9:00 AM*

Interactions between plants and their insect pollinators are critical to the maintenance of sustainable plant communities. For many plant species, insect pollination is the only mechanism for outcrossing; the plants may be able to set seed via self-pollination, but seeds produced by selfing are often less fit than those produced by outcrossing. Many insect species rely on floral resources as food for themselves or their progeny, and in the case of bees, are completely reliant on the plants. In this decade-long study (2010-2019), we have identified plant-pollinator interaction partners in coastal plant communities on San Salvador Island, Bahamas. Most of our work was performed on the northeastern (East Beach) and southeastern (Sandy Hook) coasts, but we also collected data on the northern coast (Grahams Harbour), the northwestern coast (Rocky Point) and the southwestern coast (Sandy Point). Here we document the frequency of pollination interactions between different interaction partners and the degree of specialization observed. Further, we estimate the relative importance of plant and insect species to the network of interacting partners and describe changes in the plant and

pollinator communities following hurricanes that occurred during the study period.

### **TI/TH AND TI/ZR VARIABILITY WITHIN SAN SALVADOR ISLAND PALEOSOLS**

**Lissner, Hannah**, University of San Diego, San Diego, CA, USA; **Cathcart, Eric**, University of San Diego, San Diego, CA, USA

*Presenter: Hannah Lissner, Saturday Poster 1*

Insoluble residues (IR) from paleosols in The Bahamas have been theorized to originate from atmospheric dust load, specifically Saharan dust or Lesser Antilles ash. These studies commonly utilize IR ratios of Al, Th, Ti, Y and Zr; however, most have not assessed variability of these ratios within specific paleosol layers. This study assesses the variability of Ti/Th and Ti/Zr within the younger Late Pleistocene / Holocene and older Pleistocene paleosol layers on San Salvador Island, The Bahamas. Forty-two (42) in situ measurements were collected using a hand-held NITON Pro Gold X-Ray Fluorescence (XRF) machine. All measurements were taken on flat, visibly dry surfaces and had a minimum exposure duration of 90 seconds. Preliminary findings show the younger Late Pleistocene / Holocene paleosols generally have lower average Ti/Th (32.2 +/- 26.0) and Ti/Zr (3.3 +/- 1.9) ratios than the older Pleistocene layers (275.4 +/- 139 and 23.6 +/- 13.5, respectively) and the ratios within paleosol exposures on the southern side of the island are elevated when compared to the northern exposures. However, since many of the older paleosol layers outcrop on the southern side of the island, this potential lateral variability needs to be further assessed with additional measurements. In addition, paleosol materials measured within infilled dissolution pits exhibit higher metals concentrations and ratios than the other locations (397 +/- 43.5 and 37.3 +/- 2.6). In general, the data from the older Pleistocene paleosols and the infilled dissolution pits more closely resemble current Sahara dust values and ratios. Future work will include higher resolution sampling of individual paleosol layers across the island as well

as additional measurements to include more IR ratios (e.g. Al<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub>). These datasets will be compared to modern Sahara dust values as well as Lesser Antilles ash.

### **THE POWER OF ARCHAEOLOGY FIELD SCHOOLS: THE GERACE RESEARCH CENTRE AND LUCAYAN ARCHAEOLOGY**

**Mary Jane, Berman**, Miami University, USA; **Joanna, Ostapkowicz**, Oxford University, USA  
*Presenter: Mary Jane Berman, Saturday 8:40 AM*

Since the founding of the Gerace Research Centre (previously CCFL), Lucayan archaeology has been a major focus. While archaeological investigations were not new to the island (in fact, archaeological work goes back to the late 19th century), it is the work accomplished under GRC stewardship that has contributed to a greater anthropological understanding of Lucayan history. Most of this work has been conducted under the umbrella of archaeology field schools that engaged students and volunteers. In this presentation, I will review the significant fieldwork findings from the following excavations: the Pigeon Creek Dune 1, Pigeon Creek Dune 2, Flat Topped Dune, North Storr's Lake, Fresh Lake, Three Dog, Long Bay, North Storr's Lake, Ward Minnis, and Palmetto Grove sites conducted by the following individuals Mary Jane Berman, Jeffrey Blick, Thomas Delvaux, Jonathan Gell, Gary Fry, Charles Hoffman, Perry L. Gnivecki, Matt O'Mansky, Marjorie Pratt, Peter Pratt, Richard Rose, and John Winter. Since the inception of the field station, the following universities and museums have trained undergraduate and graduate students and volunteers in archaeological method and theory and the Lucayan archaeology of San Salvador: Appalachian State University, Discovery Place, Elderhostel, Hartwick College, Miami University (Ohio), Molloy University, Northern Arizona University, Rochester Museum and Science Center, Sweetbriar College, Wake Forest University, and Youngstown State University. Moreover, students from other colleges and



universities enrolled in these field schools. Other critically important work includes archaeological surveys, rock art studies, and the study of human remains. Finally, the GRC has sponsored archaeological investigations on Long Island, Crooked Island, Great Inagua, and Rum Cay and provided financial support to work on Grand Bahama. The surveys and excavations have yielded numerous important finds including evidence for the earliest systematically-excavated open-air residential settlement in the Bahama archipelago (Three Dog site); proof of early Spanish presence in the Caribbean, possibly the site where the Lucayans and Columbus met for the first time (the Long Bay site); material confirmation of economic, social, and political links to Cuba and the Dominican Republic through the analyses of stone celts, pottery, and other remains; and a deeper understanding of the Lucayan diet, culinary habits, land use strategies, settlement patterns, and unique ceramic, stone tool, and shell traditions. Through this work, we have been able to create a chronological framework for the whole archipelago that did not exist previously and a more detailed and nuanced, less generalized view of how the Lucayans created sustainable lives in a challenging and fragile environment that differed from their homelands. Our work has also added to paleo-environmental studies. Additionally, noteworthy advances in archaeological method and theory have been made here. Many of these have been adopted elsewhere in the Caribbean. These include the use of fine-screen (1.58 mm) sieving allowing for the recovery of small items like glass and shell beads and microliths; the application of phytolith and starch grain analyses to artifacts; the development of a technique aiding the analysis of basketry designs, the radiocarbon dating of the first site to be systematically excavated on San Salvador, the first zooarchaeological analysis of Lucayan fauna, and important isotope work on human remains. Finally, what greater tribute can there be than to create an archaeological legacy? Many of our students have gone on to become professional and highly regarded archaeologists,

including the two leading Bahamian archaeologists, Dr. Michael Pateman, Archaeology Curator and Lab Director, AEX Bahamas Maritime Museum and Dr. Grace Turner, Chief Archaeologist and Research Officer, Antiquities, Monuments & Museum Corporation. Both attended archaeology field schools supported by the Gerace Research Centre. Bahamian students from the University of the Bahamas have also participated in our field schools. At least one doctoral dissertation, several MA theses, and numerous undergraduate and graduate papers and projects pertained to and were inspired by the archaeological work performed on San Salvador. Every few years there is a session on Bahamas archaeology at the Society for American Archaeology annual meetings and the work of our Gerace Research Centre archaeologists figures significantly. Sadly, the retirement and death of most of these investigators have created new challenges for the archaeology of San Salvador, but we look forward to future collaborations with the next generation of Bahamian archaeologists.

### **TEN YEARS OF THE CAT ISLAND HERITAGE PROJECT: COMMUNITY ARCHAEOLOGY AND FIELD-BASED EDUCATION**

**Meyers, Allan**, Eckerd College, St Petersburg, FL USA; **Hunter, Daisymae**, Port Howe, Cat Island, Bahamas

*Presenter: Allan Meyers, Saturday 10:20 AM*

The Cat Island Heritage Project launched in 2013 at the invitation of staff from the Antiquities, Monuments, and Museums Corporation. The endeavor aims to make an inventory of historical sites relating to the African Diaspora, including plantation landscapes associated with slavery and emancipation. The long-term goal is a heritage management plan that sets priorities for preservation, tourism, and public education. A primary focus of the project is collaboration with local stakeholders through a framework known as 'community archaeology'. Strategic partners with

ancestral connections to study sites help to shape the research design. They set priorities for fieldwork by identifying specific locations to investigate. Oral history interviews emphasize collective memory and the role of descendants as knowledge producers. The enterprise provides opportunities for island youth to learn about archaeology's relevance to African-Bahamian heritage. An annual field studies program brings together students from Old Bight High School and undergraduates from the United States. Students at both levels develop surveying skills and contribute to the data collection. Over the last decade, student-assisted surveys with total station, GPS, and 3D visualization technologies have documented more than 20 heritage properties. Among them are nationally significant sites such as Golden Grove Plantation and Newfield Plantation. Students have also cooperated on a service project that involves recasting an old teacher's cottage as a museum and cultural center. The field studies program, which welcomed participants from University of The Bahamas in 2021, fosters scientific literacy. At the same time, it examines the ethics of heritage stewardship, sustainability, and authenticity within the context of Bahamian legislation and national identity. Students consider how cultural heritage can be contested. Ultimately, they must contemplate the motivations for, and the consequences of, memorializing landscapes of suffering and struggle.

### **THE BAHAMAS AS A MODEL FOR THE SOLAR SYSTEM**

**Myroie, John**, Mississippi State University, Starkville, MS, USA; **Wynne, Judson**, Northern Arizona University, Flagstaff, AZ, USA  
*Presenter: John Myroie, Sunday 8:40 AM*

Caves on other bodies in the solar system (planets, moons, asteroids, and comets) are significant to exploration of our solar neighborhood, particularly Mars and Earth's Moon. On Mars, caves may contain evidence of extinct or perhaps extant life. These two bodies may also contain

important resources such as water ice to sustain humans and may eventually serve as key protected habitats for human colonization. Planetary speleology is emerging as an important sub-discipline of space exploration; how does Bahamian geology fit into such a scenario? Caves on Earth formed by rock dissolution are the most common, but soluble rocks elsewhere in the solar system are rare, although on Titan dissolution is methane-based. On other bodies, particularly on the Moon and Mars, lava tubes and other voids generated by volcanism are clearly present, potentially in large numbers. The Bahamas is made up solely of soluble rocks and have no volcanic or tectonic features. So, how are these islands relevant? The Bahamas abound in rocky coasts that contain sea caves produced by the mechanical action of waves. Similar caves might exist on the shorelines of the vanished lakes and seas of Mars. Bahamian sea caves have developed in very young rocks of uniform lithology that lack a tectonic overprint, allowing the cave-development mechanism to be studied from the wave-energy aspect. The Bahamas also contains fracture caves, talus caves, and tafoni, and as with sea caves, are developed in a single youthful, untectonized host rock material, removing speleogenetic complications regarding mechanisms. Almost all solar system bodies have tectonic activity (at some point) and relief, therefore fracture and talus caves may represent the most common cave types across the solar system. Exploration of caves beyond the Moon and Mars will likely be done remotely. Caves entered by way of blue holes in The Bahamas offer a test bed for a variety of autonomous underwater vehicles (AUVs) both tethered and untethered. Development of local expertise and capacity with AUVs could be beneficial to the Bahamas while advancing robotic technologies for the study of under-ice oceans as on Enceladus and other icy worlds.

**WAS SEA LEVEL EVER HIGHER-THAN-PRESENT ON SAN SALVADOR ISLAND IN THE BAHAMAS DURING THE MID-TO-LATE HOLOCENE?**

**Niemi, Tina**, University of Missouri-Kansas City, Kansas City, MO, U.S.A

*Presenter: Tina M. Niemi, Saturday Poster 9*

The island of San Salvador, located on the easternmost edge of the Bahamian carbonate platform, contains numerous examples of well-exposed beachrock both on the leeward (west, north) and windward (east, south) sides of the island, and at and above present sea level. The beachrock, designated as the Hanna Bay Member of the Rice Bay Formation, has been radiocarbon dated by multiple studies yielding ages of ca. 4 ka and 1 ka. Outcrops of the Hanna Bay reveal gently seaward-dipping, calcarenites with fenestral porosity and shells typical of the foreshore intertidal facies of a beach. Additional lines of evidence support the interpretation of the Hanna Bay beachrock as being deposited during a period of higher sea level on San Salvador Island including 1) the age of lake formation, 2) strandline progradation, 3) wave-cut platforms, 4) cemented boulder ridges, 5) fossilized offshore corral rubble of former staghorn reefs, and 6) distribution of archaeological sites. In this paper, I compile the data that support that during the mid-to-late Holocene, sea level was higher-than-present on San Salvador in The Bahamas. Glacio-eustatic models that provide the mechanism for equatorial higher-than-present mid-Holocene sea level have been extensively documented in the Pacific Ocean but not in the Atlantic Ocean.

**FROM BEACH SAND TO TABBY CONSTRUCTION: TEACHING PROCESS SEDIMENTOLOGY AND CULTURAL HISTORY IN AN INTRODUCTORY FIELD METHODS COURSE**

**Niemi, Tina**, UMKC, Kansas City, MO, USA; **Rucker, John**, UMKC, Kansas City, MO, USA

*Presenter: Tina Niemi, Sunday 11:20 AM*

The windward and deep ocean setting in the path of North Atlantic hurricanes make the small carbonate island of San Salvador in The Bahamas a dynamic environment to study coastal processes. Since 2007, we have taught a hands-on, field methods course at the Gerace Research Centre on San Salvador in late March that focuses on environmental change. Our urban Kansas City environmental science students mostly arrive with little geologic knowledge and minimal experience with coastal settings. Our interdisciplinary approach includes investigating the geological, biological, and cultural components of the environment and an opportunity for students to contribute to long-term research on coastal change. Our course begins with a beach characterization project that includes the creation of beach profiles using the Emery Method, identification of vegetation, and grain-size analyses of sand from different coastal environments around the island. Students also record wave height, wind speed and direction, and subtidal conditions from snorkeling observations. Together these data show how the present-day environments they see provide the basis for understanding the environment of deposition of rock formations on the island. As nearshore depositional environments only occur during sea level highstands, we explore caves and describe karst and pedogenic processes that modify the landscape of the island over the long, sea level lowstand intervals. Pace-and-compass mapping of an historical archaeological site along with discussions on historical and modern land use practices demonstrate the fragility of the soil and environment. Furthermore, over the years we have taught the class, we have introduced new technologies including advanced methods of aerial photography from kites to uncrewed aerial vehicles, real-time kinematic GNSS surveys, and digital mapping with cellphones and iPads, all while keeping a grounding in traditional methods of data collection and recording. Research projects have grown from this class, from a multi-year coring project involving many students and several of the ponds to documenting the

wrackline, boulder movement, and coastal damage from hurricanes. In addition to reinforcing the necessity of quality field notes, the integration of real research questions into the class stimulates motivation and interest in the fields of geosciences and archaeology.

### **AN OVERVIEW OF STONE CELTS FROM SAN SALVADOR**

**Ostapkowicz, Joanna**, University of Oxford, Oxford, UK; **Schulting, Rick**, University of Oxford, Oxford, UK; **Davies, Gareth**, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

*Presenter: Rick Schulting, Saturday 8:00 AM*

All hard stone had to be imported to the limestone islands of The Bahamas. This included ground and polished stone celts used both for everyday activities and as prestige objects. Only a few examples have been found in recent archaeological excavations, with a much larger number known from antiquarian investigations of the late 19th and early 20th centuries. In this paper we present an overview of the documented celts/celt fragments from San Salvador and Rum Cay and place them in the wider context of celts in The Bahamas and Turks and Caicos Islands (collectively termed the Lucayan archipelago). We provide broad material identifications and consider size and condition in relation to the wider corpus of Bahamian/TCI celts. Various grades of jades dominate the collection to a surprising degree, with recent studies suggesting a provenance to Guatemala (Harlow et al. 2019). Also present but far less common are celts made of igneous, meta-igneous, and meta-sedimentary rock. While length and width are broadly comparable to celts across the rest of the Lucayan archipelago, the length/width ratio is slightly lower for San Salvador, possibly suggesting more intensive re-sharpening as a result of greater distance from the source islands. This may be further supported by the significantly higher proportion of broken celts on San Salvador compared to the Bahamas/TCI overall. The focus on San Salvador provides new insights on the

circulation and use of hard stone celts in Lucayan archipelago.

### **GEOMORPHIC CHANGES TO SANDY POINT BEACH FROM ANALYSES OF AERIAL IMAGERY AND IMPLICATIONS FOR SEDIMENT TRANSPORT AND STORM WAVE DIRECTION ON SAN SALVADOR ISLAND, THE BAHAMAS**

**Payne, Elena**, University of Missouri-Kansas City, Kansas City, MO, USA; **Niemi, Tina**, University of Missouri-Kansas City, Kansas City, MO, USA; **Nolan, Joseph**, University of Missouri-Kansas City, Kansas City, MO, USA; **Rucker, John**, University of Missouri-Kansas City, Kansas City, MO, USA; **McEnaney, Trenton**, University of Missouri-Kansas City, Kansas City, MO U.S.A

*Presenter: Elena Payne, Saturday Poster 10*

Sandy Point beach is located at the southwestern-most point of the island of San Salvador in The Bahamas. Previously published research has shown that Sandy Point beach is subject to seasonal sand transport and changes in the deposition pattern of a spit. In the spring and early summer months with dominant NE trade winds, sand is moved by longshore transport toward the north and the beach narrows. Then in the stormy early fall and winter months, sand is transported toward the south and the beach widens. In this study, we use aerial imagery from Google Earth over the past two decades and high-resolution uncrewed aerial system (UAS)- and kite-mounted camera imagery to map changes in the spit shape. We compare these images to weather data including wind speed and direction for The Bahamas to determine whether the spit shape can be correlated to trends in the climate data. In February 2014, sand accumulated along the west side of the point, and by December 2014, the sand had eroded from the west with only minor transport of the sand to the south. By March 2015, our kite-camera imagery shows a wide spit developed to the west with a prominent ridge and runnel topography. Imagery for September 2015 also shows the large spit which is seen to expand

offshore to both the west and south. The runnel is filled with water. Satellite images for 2016 are of poor resolution but show that the spit was much reduced to about the 2014 size and shape. Our UAS data show a much-reduced size of the Sandy Point spit in 2022 and 2023. These data suggest that the pattern of deposition and erosion may be more complicated than the trends recorded in the 1990s. Statistics of hurricane activity compiled by the Caribbean Hurricane Network ([stormcarib.com](http://stormcarib.com)) indicate that the interval between 1995-1999 was the most active hurricane period since ca. 1850 with five storms passing within 60 nautical miles (69 mi; 111 km) of San Salvador island. The dynamics of the beach sediment supply may have been altered by these and subsequent hurricanes.

#### **A QUARTER CENTURY OF OBSERVED ECOLOGICAL CHANGES OF SHALLOW WATER CORAL PATCH REEFS OF SAN SALVADOR ISLAND, BAHAMAS: 1992-2019**

**Rollino, John**, AECOM, New York, NY, USA  
*Presenter: John Rollino, Friday 9:40 AM*

In the 1980s massed bleaching events of coral reefs were observed around the world. In response to these bleaching events to quantify the reefs' response to bleaching, we established permanent transects on the shallow water coral patch reefs around San Salvador. Starting in 1992, we surveyed each reef seasonally to quantify percent cover types of hard coral, soft coral, algae, sponges, sand and rock, as well as mapped all hard corals to scale in 10M belt transects as well as conducted other studies re: coral biomass studies, fish populations, beach profiles, etc. In the 25+ years that we have been studying the reefs, we have observed a reduction of over 50 percent of the mapped coral species and a dominance of fleshy coral species. Also identified were three major bleaching events in 1995, 1998 and 2005. Review of the data showed some substantial fluctuations between 1992 and the early 2000s, since then the reef biomass has somewhat stabilized; although there has been

noted reductions in reef diversity and an increase in stress tolerant species. In this paper we discuss the observed changes of San Salvador's patch reefs from 1992-2019.

#### **IDENTIFYING HISTORICAL PERIOD ARCHAEOLOGICAL SITES ON SAN SALVADOR ISLAND USING LIDAR SURVEY DATA**

**Rucker, John**, UMKC, Jefferson City, MO USA; **Niemi, Tina**, UMKC, Kansas City MO, USA  
*Presenter: John Rucker, Saturday 8:20 AM*

The bare earth Digital Elevation Model (DEM) produced by the aerial Light Detection and Ranging (LiDAR) survey collected and processed by the National Center for Airborne Laser Mapping (NCALM) during the summer of 2016 may provide the opportunity to create the most accurate map of the historic period archaeological sites on San Salvador Island in The Bahamas. Following the American War of Independence, many of the American colonists who had remained loyal to the British Crown found it desirable to leave the new country. Many of them, particularly wealthy slaveholders from South Carolina, relocated to The Bahamas. Upon arrival, they attempted to recreate their plantation system on the Bahamian Islands. San Salvador, with its thin soil, was particularly unsuited to that form of agriculture. However, before that system collapsed, a rich tapestry of cultural features, including architecture -buildings used as the manor house, kitchen, slave quarters, warehouses, latrines, etc., roads, and an extensive system of stone field walls were constructed. The current state of overgrowth in the interior of the island makes these cultural features very difficult to access, let alone map. Our current understanding of this 'Loyalist period' is limited and perhaps biased due to this lack of visibility. This airborne LiDAR survey data, with an elevation resolution of 1m and processed to remove vegetation should clearly show these field walls as well as other cultural features. These data have the potential for not only the creation of the most comprehensive

map of these features but also allow a much better understanding of the Loyalist period on the island.

### **ESTIMATING THE CAUSES OF LAKE LEVEL VARIABILITY ON A LOW-LYING CARBONATE ISLAND**

**Salazar, Natalie**, University of South Florida, Tampa, FL, US; **Spellman, Patricia**, University of South Florida, Tampa, FL, US; **Gulley, Jason**, University of South Florida, Tampa, FL, US

*Presenter: Natalie Salazar, Sunday 9:20 AM*

Freshwater resources on carbonate islands are vulnerable due to their small size, karstic porosity, and the dynamic interaction with seawater. Small low-lying carbonate islands where lakes occupy topographic depressions are especially vulnerable because the lakes expose the freshwater lens to evaporation. On carbonate islands where annual potential evapotranspiration exceeds precipitation (P), can dissect the freshwater lens into a network of smaller lenses by redirecting groundwater flowpaths toward the lake. Loss of freshwater through evaporation is exacerbated by the dynamics of the freshwater lens. However, little is known about the magnitude of connection between lakes and freshwater lenses. Recent work on lakes in low-lying carbonate islands revealed most lakes were isolated, thus opposing the common belief that such lakes are well-connected to the adjacent freshwater lenses. This study utilizes a water budget technique with high-resolution data to investigate the hydrologic factors that impact lake levels on San Salvador Island, Bahamas, with a focus on quantifying groundwater contributions to lakes. We examined water level data recorded in seven perennial lakes between August 2018 and September 2019. The water level data were corrected for barometric and tidal effects. After we subtracted barometric pressure from water levels, we applied the Godin low-pass filter to remove significant tidal effects. Additionally, we collected data needed to estimate daily potential evaporation (PE) with a Penman open water equation and downloaded daily precipitation data from the CoCoRaHS crowd-

sourced precipitation network. We used a water budget framework to estimate the contributions of P and PE to water level changes and designated groundwater as the residual component of the water budget framework. Each lake experienced water level changes that could not be accounted for by rainfall and PE, suggesting lakes exchange water with surrounding freshwater lenses on a seasonal basis. We found a preliminary correlation between the degree of freshwater lens connectivity and lake surface area, basin morphology, and relative age of surrounding bedrock. Generally, lakes in the less permeable Holocene bedrock had small and less frequent exchange rates with adjacent freshwater lenses. In contrast, lakes in MIS 5 bedrock had a more pronounced and recurrent connection with the freshwater lenses.

### **THE SAN SALVADOR COMMUNITY ENRICHMENT INITIATIVE**

**Saraney, Jillian**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Evans, Emory**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Woodson, Abbie**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Yates, Taylor**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Ellis, Ashley**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA; **Ford, Dawn**, The University of Tennessee at Chattanooga, Chattanooga, TN, USA

*Presenter: Dawn Ford, Saturday Poster 6*

The San Salvador Community Enrichment Initiative was created to address the increasing chronic disease prevalence in the Bahamas such as high blood pressure and obesity, and the limited access to fresh produce on San Salvador. For this project, the community garden space at the GRI was revitalized and planted in January 2023 with a ribbon cutting ceremony to introduce the residents to the garden. Soil microbial and nutrient analyses were conducted to understand best practices needed for productive gardening on the island. Additionally, survey data were

collected and analyzed regarding chronic disease prevalence and the nutrition security of San Salvador residents to better inform the expansion and improvement of the current initiative and future public health projects. This poster will display an overview of the project, health survey and soil testing results, and future directions of the initiative.

**A SHIFT FROM MARINE TO  
TERRESTRIAL RESOURCES? NEW  
RADIOCARBON DATES AND STABLE  
CARBON AND NITROGEN ISOTOPE DATA  
ON PRE-COLUMBIAN HUMAN REMAINS  
FROM SAN SALVADOR**

**Schulting, Rick**, University of Oxford,  
UK; **Ostapkowicz, Joanna**, University of Oxford, UK  
*Presenter: Rick Schulting, Saturday 9:40 AM*

While pre-Columbian burials are scarce in The Bahamas, the long history of exploration of San Salvador has resulted in a relatively large number of human remains from the island's many caves. These have recently featured in an overview involving radiocarbon dating and stable carbon and nitrogen isotope analyses, with the results suggesting a shift from predominantly marine resources in the centuries after initial colonization of the archipelago, to a greater reliance on terrestrial root crops (Schulting et al. 2021). However, this trend was identified for the archipelago as a whole, with some islands having predominantly early burials, and others later burials, complicating the interpretation. A focus on San Salvador permits an investigation of this trend on a single island. As a contribution to this, we present radiocarbon and stable isotope results for four new individuals. Added to the results for the nine individuals previously analysed, we can confirm the existence of a temporal shift in subsistence practices over ca. five centuries. This could reflect over-exploitation of highly ranked but vulnerable species from the near-shore marine environment. Two of the newly analysed individuals from Major's Cave, Hog Cay, appear to predate the wooden tray also found in the cave

by approximately a century. Either other burials were present, or the cave remained a focus of repeated visits and offerings to the ancestors long after the interments were made.

**'THE ELECTRONIC BEACH' AND  
COOPERATIVE LEARNING ON SAN  
SALVADOR**

**Smith, Sherilyn**, Le Moyne College, Syracuse, NY  
*Presenter: Sherilyn G.F. Smith, Saturday Poster 5*

Tropical marine biology is a very popular topic, especially among undergraduates in upstate New York with its cold and snow! I describe here a unique teaching technique from the pre-Zoom era, termed 'The Electronic Beach,' used to acquaint students from both Le Moyne College and Siena College with each other and with the rich marine ecosystems and environment of San Salvador. 'The Electronic Beach' used video and audio computer technology and a digital drop box that enabled students to see and talk with each other during the classroom portion of their respective courses as well as to complete joint assignments. It was used successfully for the tropical marine biology classes from Siena and Le Moyne in 1998, 2003, 2004, and 2007. Students got to know each other, select field questions for research, collaborate on joint assignments, and create joint project proposals before they arrived at the Gerace Research Center. Field work involved all of the student groups collecting data for each project, supervised by the group that designed the field study. This strategy, novel in the late 1990s and early 2000s, allowed for a level of engagement and cooperative field work that would not have happened otherwise. Some of the more successful projects included tracking homing behavior in chitons, thermal effects of shell color in intertidal snails, and influence of wave action on intertidal snail morphology. The 'Electronic Beach' pedagogical technique can easily be replicated now with current virtual video conferencing technology. This poster is dedicated to Drs. Nancy Elliott and the late David L. Smith, the architects of 'The Electronic Beach.'

## "GEOJOURNALISM" APPROACHES FOR FIELD AND VIRTUAL ENVIRONMENTAL EDUCATION

**Stephens, Mark**, School of Chemistry, Environmental and Life Sciences, Faculty of Pure and Applied Sciences, University of The Bahamas, Nassua, the Bahamas; **Yildirim, T. Emre**, School of Communication, Media and Journalism, College of Liberal Arts, Wenzhou-Kean University, Wenzhou, Zhejiang, China; **Cooper, Gyllian**, School of Chemistry, Environmental and Life Sciences, Faculty of Pure and Applied Sciences, University of The Bahamas, Nassua, the Bahamas; **Chen, Xinyan**, School of Communication, Media and Journalism, College of Liberal Arts, Wenzhou-Kean University, Wenzhou, Zhejiang, China; **Gao, Yakun**, School of Communication, Media and Journalism, College of Liberal Arts, Wenzhou-Kean University, Wenzhou, Zhejiang, China; **Gou, Yunhan**, School of Communication, Media and Journalism, College of Liberal Arts, Wenzhou-Kean University, Wenzhou, Zhejiang, China; **Russell, Ashawnt**, School of Chemistry, Environmental and Life Sciences, Faculty of Pure and Applied Sciences, University of The Bahamas, Nassua, the Bahamas

*Presenter: Mark Stephens, Sunday 11:40 AM*

Geojournalism is a growing movement at the intersection of both eco- and data journalism, that combines digital media technology approaches to create online platforms that provide scientific evidence for stories and narrative context for data. However, given its novelty there appears to be little formal recognition of 'Geojournalism' in an educational/academic context (Sachsman and Valenti, 2020). In this paper, we outline and review tools and techniques, and platforms that can be effectively applied by educators and learners to investigate and report on geographic and environmental issues (e.g. Faleiros, 2013). Outputs are included (weblog, radio show, infographic, and virtual fieldtrip) primarily resulting from a unique fieldwork collaboration between Geography and Journalism students at the University of The Bahamas (UB). Subsequent activities include collaboration between Geography (UB) and Journalism (Wenzhou-Kean

University, China) students who shared volunteered geographic information (VGI) on sustainability features in Nassau, The Bahamas, and intergenerational shifts due to climate change in Wenzhou, China. This study further assists in the promotion and formalization of Geojournalism in environmental communication and higher education.

## DEVELOPMENT OF AN ARCHAEOLOGY PROGRAM FOR THE GOVERNMENT OF THE BAHAMAS

**Turner, Grace**, Antiquities, Monuments & Museum Corporation, Nassau, New Providence, The Bahamas  
*Presenter: Grace Turner, Saturday 9:00 AM*

As this conference celebrates both the 50th anniversary of operations for the College Center of the Finger Lakes Field Station, now the Gerace Center, as well as the 50th anniversary of Bahamian independence, I thought it most fitting to reflect on the development of an Archaeology Program for the government of The Bahamas. I became closely involved with archaeology at the CCFL Field Station and transitioned into the government Archaeology Program that was developed within The Bahamas' Department of Archives. Nearing the end of my professional career as the first academically trained Bahamian archaeologist, I have the honor to help train a new cadre of young Bahamian archaeologists in both terrestrial and underwater archaeology.

## NEW LAST INTERGLACIAL PALEOCLIMATE DATA FROM SAN SALVADOR AND GREAT INAGUA

**Winkelstern, Ian**, Grand Valley State University, Grand Rapids, Michigan, USA; **Petersen, Sierra**, University of Michigan, Ann Arbor, Michigan, USA; **Phillips, Cecilie**, University of Michigan, Ann Arbor, Michigan, USA; **Quizon, Alex**, University of Michigan, Ann Arbor, Michigan, USA; **Curran, H. Allen**, Smith College, Northampton, Massachusetts, USA; **Glumac, Bosiljka**, Smith College, Northampton, Massachusetts, USA; **Griffing, David**,



Hartwick College, Oneonta, New York, USA  
*Presenter: Ian Winkelstern, Saturday Poster 2*

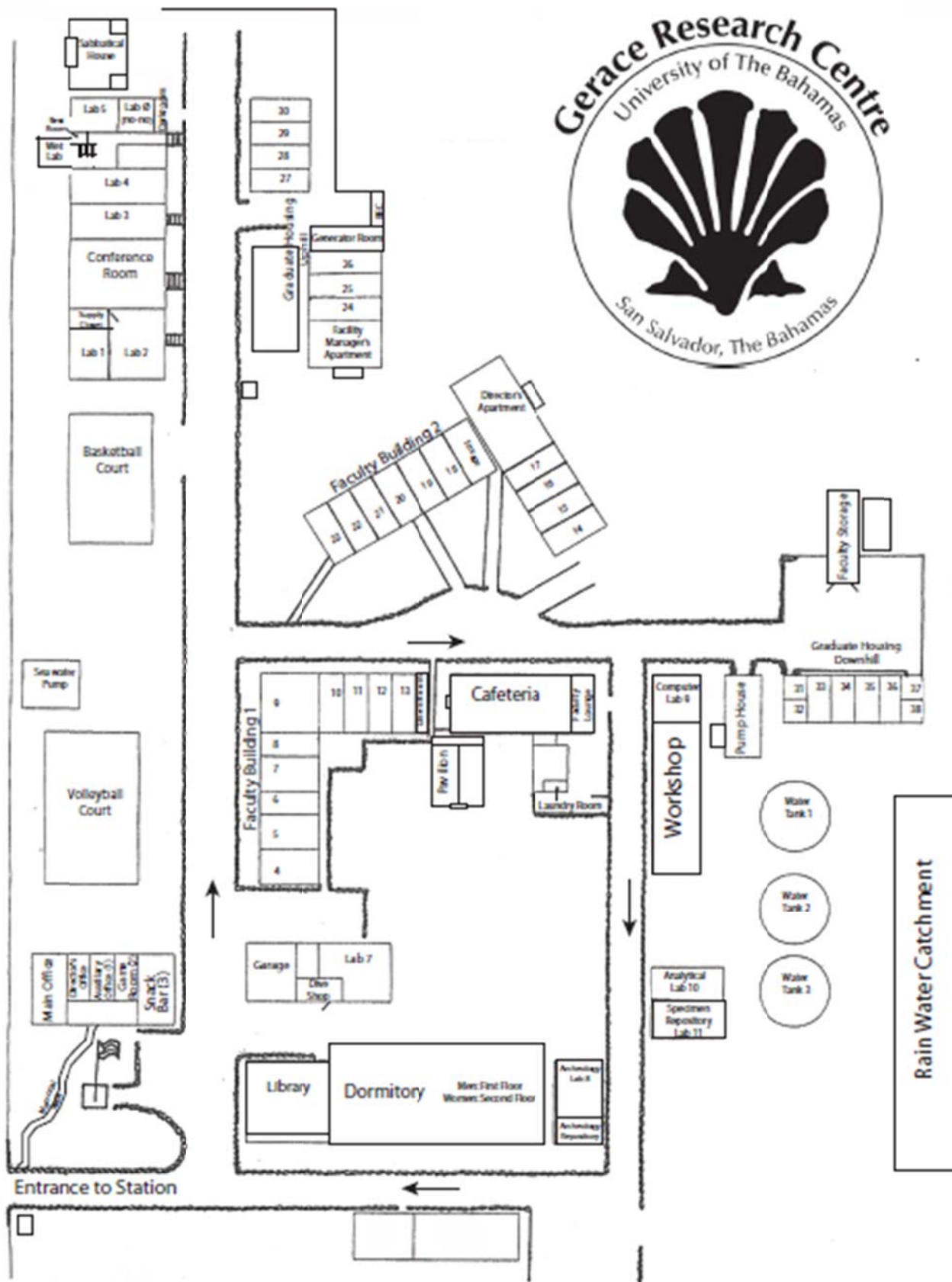
The Last Interglacial, occurring approximately 130-115 thousand years ago, is thought to be the last time that global climate was roughly as warm as today, with global sea level >3 m higher. Coastal deposits from this time are of interest because they can preserve information about past environments and provide insight into how this past global warm period affected specific regions (e.g., in this case, the western North Atlantic). We focus here on bivalve shells sampled from the Pleistocene (Eemian, MIS 5e) Cockburn Town Member of the Grotto Beach Formation exposed at the Cockburn Town Fossil Reef and Devil's Point sites on the western coast of San Salvador and Great Inagua Islands, respectively. It is possible to reconstruct the temperature and composition of the seawater that these animals lived in by using geochemical approaches. Our specific methodological tools are measurements of oxygen and carbon stable isotopes, and in particular clumped isotope paleothermometry, a novel method for measuring the formation temperature of carbonate materials (e.g. a clam shell). Here we present preliminary data from these shells, and compare the results with a growing compilation of similar data from Bermuda and the United States east coast. Those results suggest that latitudinal gradients in temperature and seasonality were markedly different from today. The San Salvador and Great Inagua shells in particular provide an important southern anchor for evaluating specifically how such gradients differed from the modern. These data also lay a foundation for a much more detailed geochemical study of the Cockburn Town Fossil Reef.

**SUCCESSFUL TEACHING AND TRAINING  
TECHNIQUES OF TROPICAL  
NEARSHORE COASTAL ECOLOGY FOR  
HIGH SCHOOL STUDENTS AND CITIZEN  
SCIENTISTS**

**Yoder, Theodore**, St. Stephen's & St. Agnes School, Alexandria, VA, USA; **Rollino, John**, AECOM, New York, NY, USA

*Presenter: Ted Yoder, Friday 10:20 AM*

Due to a myriad of environmental stressors (e.g., warming temperatures, sea level rise, development, etc.) near-shore tropical environments (coral reefs, mangroves, seagrass beds, beaches and sand dunes) are realizing notable impacts each year. As the geographical area of these resources is largely limited to the tropics, combined with the recorded reduction in study sites and diversity, this presents significant challenges in educating the next crop of student scientists who will ultimately ascend to positions of decision makers who will conduct research and develop future policies. San Salvador and the Gerace Research Centre (GRC) offer an environment that is ideal for immersive study and training in the marine environment. Both authors of this paper have a combined 40 years of experience teaching high school classes and/or training citizen scientists in the taxonomic identification of species and proper scientific monitoring protocols of the nearshore tropical environments on San Salvador. To date, they have trained over 100+ high school students and 700+ citizen scientist research volunteers at the GRC. In this paper we describe successful training and teaching techniques that have been employed. Scheduling and level of training of students and volunteers that yields the best results is described; moreover, we discuss the results of spot checks or comparative data sets collected between students/volunteers and trained scientists to confirm training accuracy. In addition to training in scientific protocols, we also discuss some of the sites on San Salvador whose features and accessibility allow for teaching opportunities in different environments. Finally, we discuss potential ideas for incorporating more citizen scientists into long-term scientific data collection.



## Notes