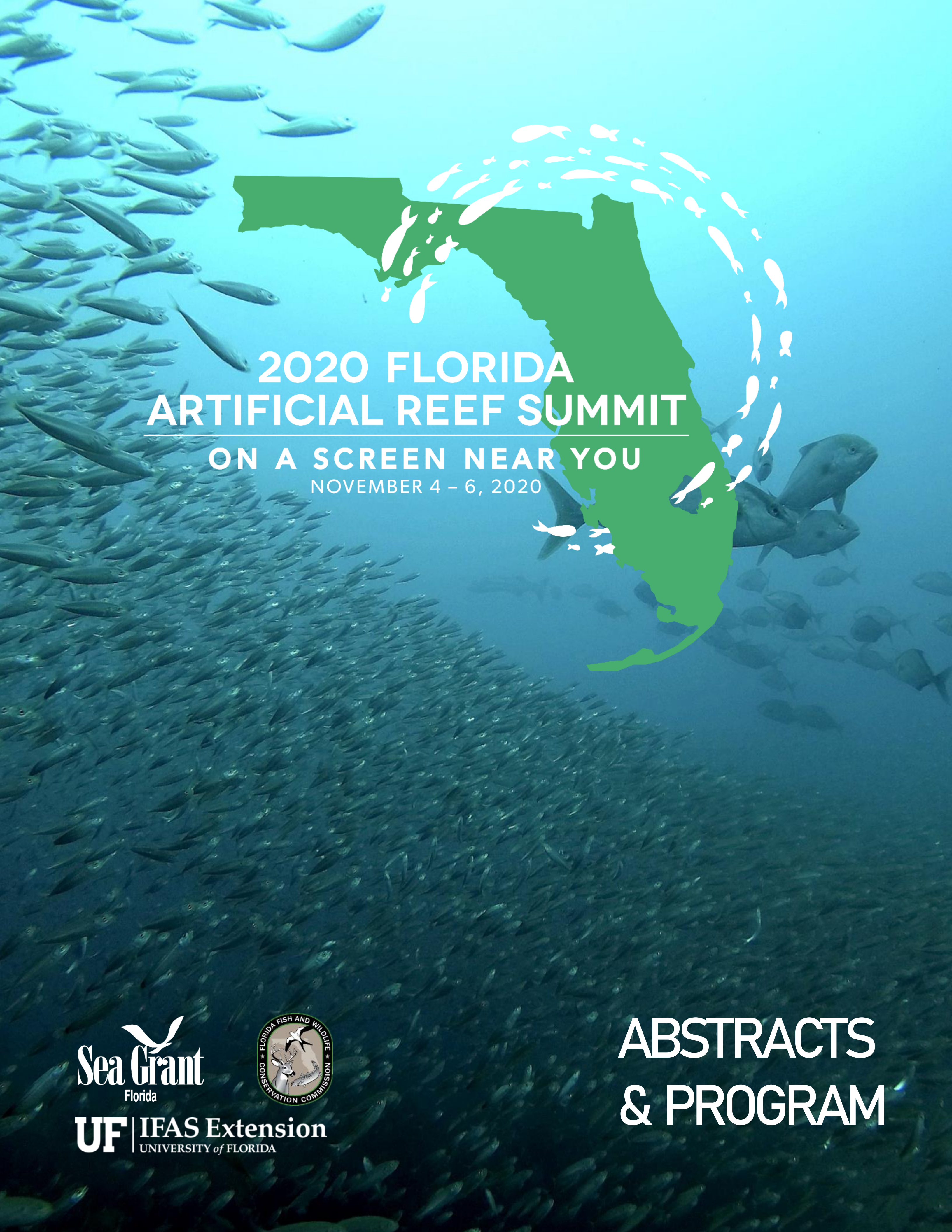

2020 FLORIDA ARTIFICIAL REEF SUMMIT

ON A SCREEN NEAR YOU

NOVEMBER 4 – 6, 2020

ABSTRACTS & PROGRAM

Sea Grant Florida

Florida Fish and Wildlife Conservation Commission

UF | IFAS Extension
UNIVERSITY of FLORIDA

THANK YOU TO OUR SPONSORS!

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Cover photo credit: Schools of Almaco Jack, Round Scad and Barracuda above 430 tons concrete culverts and poles deployed July 2014 at the Indian River County Site #2NE-South (IR0012) located 11.3 nautical miles northeast from Sebastian Inlet at a depth of 70 ft. Photo by Christine Kittle, FWC Artificial Reef Program, 9/17/2019.

This publication was supported by the National Sea Grant College Program of the United States Department of Commerce's National Oceanic and Atmospheric Administration under NOAA Grant #NA18OAR4170085. The views expressed herein do not necessarily reflect the views of any of these organizations. Online copies are available at the Florida Sea Grant Web site, www.flseagrant.org. November 2020 TP-243.

2020 Florida Artificial Reef Summit Welcome

On behalf of the 2020 Florida Artificial Reef Steering Committee: Welcome to the 2020 Virtual Florida Artificial Reef Summit!

Wow, this has been a long and winding road. We commend all of the program contributors and sponsors for joining us on this voyage, which pivoted from the originally planned April 2020 in-person event, to a delayed and rescheduled in-person event, to this virtual format – now *On a Screen Near you*! Thanks to everyone's patience, presence and dedication! We are thrilled that our original list of sponsors, speakers, and poster contributions was almost entirely retained, and are honored to share this 2020 program with you.

The theme for the 2020 Summit, "Bringing the Future of Florida's Artificial Reefs into Focus," encourages you to reflect on lessons learned, zoom in on relevant and recent research, and focus on the future course of artificial reef initiatives. We encourage everyone to engage with the presenters and sponsors, through virtual chat and networking features of our online platform. Please share your thoughts, perspectives and questions as we consider the future of artificial reef research, monitoring, and development in Florida and beyond.

We like to think that the conversion of the 2020 Summit to a virtual format parallels artificial reef planning and development. Starting with a basic framework idea and an empty slate, the virtual Summit structure was created using basic elements, pathways and tools. Once the 'reef materials' for the Summit were in place, sponsors and speakers provided the 'life' with content, conversation and social networking, which generated additional participation and interest. Like a recently deployed artificial reef, the virtual Summit went from an empty structure to one teeming with energy. We are excited to watch it evolve when we go live November 4th – 6th with the most organic element of all – your participation and feedback! We hope the Q &A sessions and networking features facilitate knowledge exchange and professional connections that will grow and continue to expand beyond the scope of these next three days.

Thank you to our sponsors, to our keynote and special session featured speakers, to all of our oral and poster presenters, to our steering committee, and most of all to you: the participants that have stayed on the boat with us as we navigated these uncharted waters! We are honored to share the virtual 2020 Florida Artificial Reef Summit with you and we look forward seeing everyone '<u>On a Screen Near You</u>'!

Keith Mille, Florida Fish and Wildlife Conservation Commission &
Angela Collins, University of Florida & Florida Sea Grant

2020 Florida Artificial Reef Summit: November 4 – 6, 2020
Schedule at a Glance

On a Screen Near You

Wednesday, November 4th – Summit Day 1				
8:00 AM	Webinar Opens – Check Out Our Sponsors Exhibit Hall and Poster Showcase!			
8:30 AM	Virtual Coffee & Preview Session in the Lobby	Rolling Videos from Sponsors – Meet Our Sponsors in the Channel Section and Visit Them in the Exhibit Hall.		
Welcome and Morning Session				
9:00 AM	Summit Welcome	9:00 AM	Sherry Larkin, Florida Sea Grant	Welcome from Florida Sea Grant
		9:05 AM	Keith Mille, FWC & Angela Collins, Florida Sea Grant	Welcome to FLARS2020
9:15 AM	Special Session: Hindsight is 2020	9:15 AM	Heyward Mathews, St. Petersburg College	History of Florida's Artificial Reefs
		9:27 AM	Jim Bohnsack, NOAA/NMFS, University of Miami, Retired	Florida Artificial Reef Science in the 1970s and 1980s: A Retrospective
9:45 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
10:00 AM	**BREAK (15 Minutes)**			
10:15 AM	Statewide Update	10:15 AM	Keith Mille, FWC	Statewide Update
	A Local Lens: Regional Artificial Reef Updates	10:24 AM	Joe Nolin, Volusia Co.	Northeast Florida
		10:31 AM	Jessica Garland, Martin Co.	East Central Florida
		10:40 AM	Jena McNeal, Palm Beach Co.	Southeast Florida
		10:50 AM	Katie Laakkonen, City of Naples	Southwest Florida
		11:00 AM	Keith Kolasa, Hernando Co.	West Central Florida
		11:10 AM	Melinda Gates, Walton Co.	Northwest Florida
11:23 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
11:45 AM	**BREAK (15 Minutes)**			
12:00 – 1:00PM	**Poster Social and Lunch Hour**			

2020 Florida Artificial Reef Summit: November 4 – 6, 2020
Schedule at a Glance

On a Screen Near You

Thursday, November 5th – Summit Day 2				
8:00 AM	Webinar Opens – Check Out Our Sponsors Exhibit Hall and Poster Showcase!			
8:05 AM	Welcome and Keynote Address	8:05 AM	Jessica McCawley, FWC	Welcome
		8:10 AM	Bill Lindberg, University of Florida	Keynote Address
8:40 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
8:55 AM	Focus: Research and Monitoring	8:55 AM	Chris Stallings, University of South Florida	Synthesis of Research on Paired Artificial-Natural Reefs
		9:06 AM	Matt Ajemian, Harbor Branch Oceanographic Institute	Beyond Reef Fish: Clarifying the Role of Artificial Reefs for Highly Mobile Species
		9:15 AM	Alastair Harborne, Florida International University	The Effects on Natural Reefs of Predatory Fish Aggregations Around a Nearby Artificial Reef
		9:39 AM	Kerry Flaherty-Walia, FWC	Fish Communities Associated with Natural and Artificial Hard Bottom Habitats within the Tampa Bay Estuary
		9:43 AM	Lauren Floyd, Coastal Protection Engineering	Artificial Reef Monitoring in Florida: A Comparison of Recreational and Mitigation Reef Monitoring Programs
9:50 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
10:05 AM	**BREAK (15 Minutes)**			
10:20 AM	Focus: Research and Monitoring	10:20 AM	Avery Paxton, NOAA/NOS	Artificial Reefs can be Effective Tools for Fish Community Enhancement but are not One-Size-Fits-All
		10:31 AM	D'Amy Steward, Duke University	Quantifying Spatial Distributions & Benthic Footprints of Artificial Reefs on the SE USA Continental Shelf

Thursday, November 5th		SESSION CONTINUED		
	Focus: Research & Monitoring	10:39 AM	Mike McCallister, Harbor Branch Oceanographic Institute	Fish Community Assessment of Mesophotic Artificial Reefs
		10:48 AM	Sara Thanner, Miami-Dade Co.	Re-Evaluation of Module and Boulder Reefs: Miami-Dade Co. Artificial Reef Program
		10:58 AM	Amber Whittle, Florida Aquarium	A Call to Action: Artificial Reefs in Coral Reef Restoration
11:05 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
11:20 AM		**BREAK (10 Minutes)**		
11:30 AM	Focus: Socioeconomics and Human Dimensions	11:30 AM	Christa Court, University of Florida	Measuring Economic Contributions and Impacts Associated with Artificial Reefs
		11:40 AM	Ed Camp, University of Florida	Effects of Ars on Recreational Fisheries: What We Don't Know Might Hurt Us
		11:50 AM	Lisa Chong, University of Florida	Spatial Considerations can Determine Net Socioecological Effects of Artificial Reefs on Recreational Fisheries and Their Management
12:00 PM	**Moderated Audience Participation and Q&A (15 Minutes)**			

2020 Florida Artificial Reef Summit: November 4 – 6, 2020
Schedule at a Glance
On a Screen Near You

Friday, November 6th – Summit Day 3				
8:00 AM	Webinar Opens – Check Out Our Sponsors Exhibit Hall and the Poster Showcase!			
8:05 AM	Summit Day 3 Welcome Note	8:05 AM	Bill Seaman, University of Florida, Emeritus	Welcome to Day 3 of the Summit
8:10 AM	Focus: New Perspectives, Regulation and Mitigation Part I	8:10 AM	Victor Blanco, UF/IFAS & Florida Sea Grant	Artificial Reef Monitoring: A Citizen Science-Based Program in Taylor County, Florida
		8:19 AM	Chip Baumberger, CSA Ocean Sciences, Inc.	High Resolution Underwater Mapping of the Osborne Tire Reef, Ft. Lauderdale, Florida
		8:29 AM	Amelia Castelli, Penalties and Forfeitures Miami Field Office	U.S. Customs and Border Protection Partnering in Support of Florida's Artificial Reef Program
		8:31 AM	Lance Roddy and Paul Gionis, NOAA/NOS	Nautical Charting of Artificial Reefs
		8:43 AM	Lisa Lovvorn, US Army Corps of Engineers	Artificial Reef Federal Regulatory Review Process
8:55 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
9:10 AM	Focus: New Perspectives, Regulation and Mitigation Part II	9:10 AM	Karen Holloway-Adkins, East Coast Biologists Inc. and David Snyder, CSA Ocean Sciences, Inc	Brevard County Mid-Reach Artificial Reefs: Turtles, Epibiota and Fishes
		9:21 AM	Erik Neugaard, Broward Co.	Overview of Port Everglades Artificial Reef and Mitigation Reef Programs
		9:31 AM	Shelby Thomas, UF/IFAS Evan Snow and Stacy Brown, 1000 Mermaids	Transformative "Art"ificial Reef Project, 1000 Mermaids Artificial Reef Project
9:43 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
10:00 AM	**BREAK (10 Minutes)**			
10:10 AM	Focus: Fisheries Monitoring and Management	10:10 AM	Sean Keenan, FWC	The Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) Program

Friday, November 6th		SESSION CONTINUED		
	Focus: Fisheries Monitoring and Management	10:20 AM	Kevin Thompson, FWC	Incorporating Data from Artificial and Natural Reefs into Indices of Relative Abundance to Support Assessment and Management of Reef Fishes
		10:34 AM	Tiffanie Cross, FWC	Assessing Reef Fish Habitat Restoration and Recreational Fishing Enhancement Efforts Using Fisheries Dependent Monitoring Methods
10:45 AM	**Moderated Audience Participation and Q&A (15 Minutes)**			
11:00 AM		**BREAK (10 Minutes)**		
11:10 AM	Focus: Fisheries Monitoring and Management	11:10 AM	Roy Crabtree, NOAA/NMFS	Artificial Reefs: Too Much of a Good Thing?
		11:33 AM	John Walter, NOAA/NMFS	Artificial Structure Implications for Fisheries Management (and the Science around it)
12:08 PM	**Moderated Panel Discussion: Artificial Reefs Implications for Fisheries Management**			
		Closing Remarks		
		Adjourn by 1:00 PM		

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Keynote Address: *Through Which Lens Shall We Focus?*

William "Bill" J. Lindberg[1]

Florida Artificial Reef Summits typically attract a rather diverse group of stakeholders to share their findings, recent progress and perspectives. Summit objectives are usually educational, with the goal of improving practices within our broad community. But, "improvement" can be in the eye of the beholder. The theme for this 2020 Summit, "Bringing the Future of Florida's Artificial Reefs into Focus", is implicitly strategic, as well as educational, asking us to envision a desired future with pathways for getting there together. That's easier said than done. The aim for this talk is to have a conversation about diverse viewpoints on artificial reefs, especially the differences in and integration of scientific thinking applied to artificial reef issues. Science informs policy, it doesn't make policy. Public decision-makers, resource managers and their constituents are consumers of science, hopefully well-informed and discerning consumers. Importantly, the title for this talk poses an ethical question, which is only secondarily a political one.

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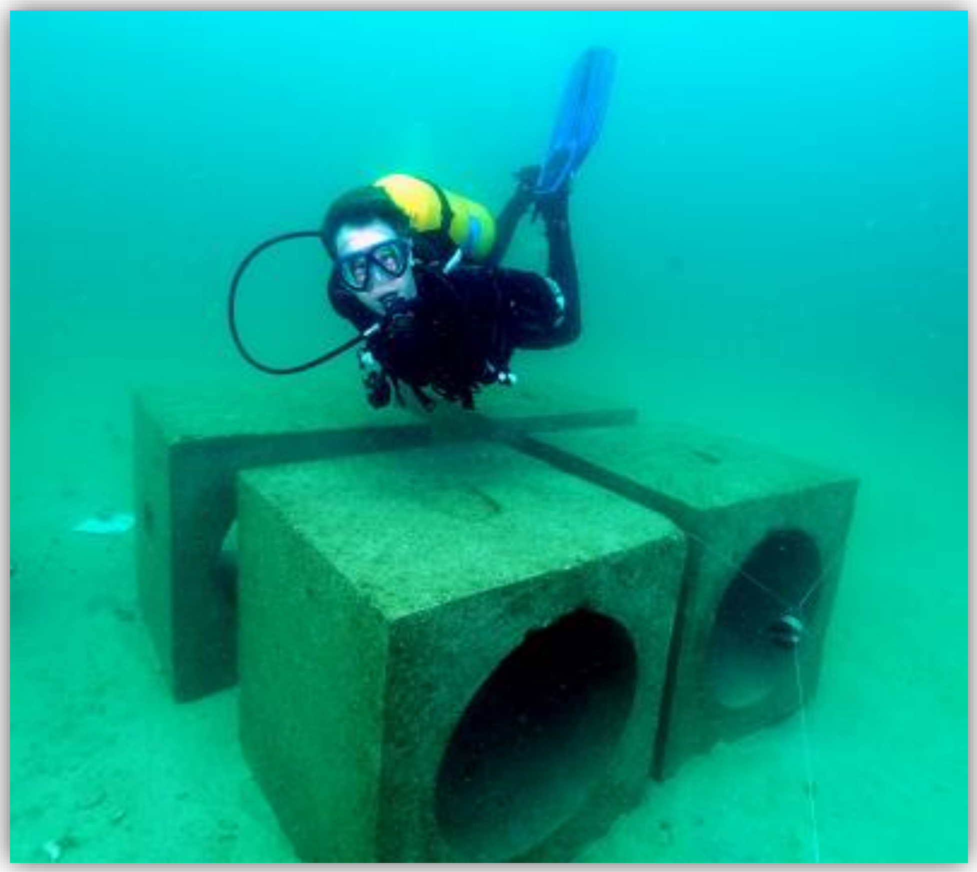
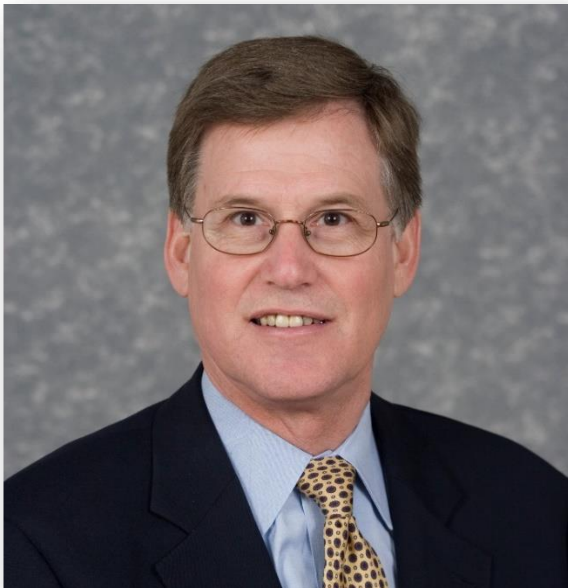
[1]Retired from the Fisheries and Aquatic Sciences Program, School of Forest Resources and Conservation, University of Florida, Gainesville, FL





Dr. Bill Lindberg,
University of Florida Fisheries and Aquatic Sciences, Emeritus Faculty

Dr. Bill Lindberg (PhD, 1980 from FSU) is an emeritus faculty and retired administrator of Fisheries and Aquatic Sciences at the University of Florida, where he began his career with Florida Sea Grant (FSG) in 1981. His research addressed behavioral processes contributing to population and community dynamics, assessment of reef fisheries habitat and the application of artificial reefs in fisheries management. For more than two decades, he taught philosophy of science for UF graduate students in ecology. Bill also served as an FSG Extension Specialist, helping to plan regional artificial reef workshops, statewide summits and two international artificial reef conferences. In the early 1990's he created the Suwannee Regional Reef System, a large-scale, long-term experimental system manipulating reef habitat patchiness. With this system, he led a collaborative research team in studies of habitat selection, trophic coupling and density-dependent growth and condition. Results from that effort led to the creation of the Steinhatchee Fisheries Management Area, a large-area artificial reef project to demonstrate reef technology applied directly to fisheries conservation objectives. Sponsors of his program included NOAA Fisheries, Sea Grant and the Florida Fish and Wildlife Conservation Commission. Bill was a member of the Florida Artificial Reef Advisory Board that drafted the Florida Artificial Reef Strategic Plan, adopted by FWC in 2003. He also gained perspective on federal fisheries management by serving on the Special Reef Fish Scientific and Statistical Committee for the Gulf of Mexico Fisheries Management Council.

Special Session: *Hindsight is 2020*

History of Artificial Reefs in Florida

Heyward Mathews[1]

Florida has been one of the leaders in artificial reef construction since 1953 when a group of Chamber of Commerce anglers led by Wakeman Porter, built a small artificial reef of St. Petersburg Beach pushed a bunch of concrete ballasted car tires into Gulf waters to improve fishing for local anglers.

In the early 1960's Pinellas County funded Misener Marine in Tampa to construct several barge loads of an artificial reef unit called a Japanese Pill Box. These concrete structures were rectangular boxes with round opening in all 4 sides and the top. These structures were deployed on two sites off Indian Rocks and one off Clearwater.

After the start of the Clearwater Artificial Reef program with Florida Park Service funding, and later the Pinellas Reef Program, Florida Sea Grant funded the Artificial Reef resource team that traveled all around the state at the request of local Sea Grant marine agents to assist local municipal groups select sites and obtain state and federal permits for new reef construction.

The next 50 years saw Florida to build more artificial reefs and publish more research papers on reef ecology than any state in the country.

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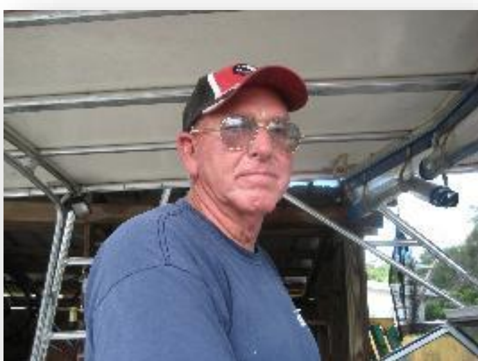
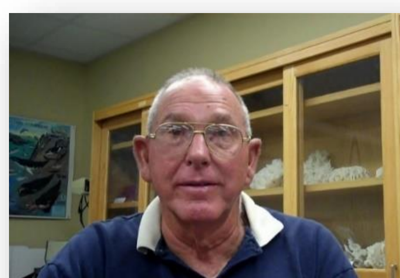


Heyward Mathews,
St Petersburg College, Emeritus Professor

Dr. Heyward Mathews has been working on artificial reefs since the 1960s. He became an instructor of marine biology for Saint Petersburg College in 1967, and although he retired from the full-time faculty in 2003, he continues to teach oceanography and scuba diving. In 1972, he started the Clearwater Artificial Reef Program. That same year, he co-founded the Clearwater Marine Science Center, which converted an obsolete sewage treatment plant into what is now the Clearwater Marine Aquarium. His scuba program that has certified more than 1,700 divers. Dr. Mathews' team has traveled around Florida to assist local groups in starting artificial reef programs. In 2010, he founded a non-profit corporation (Reef Monitoring, Inc.), that trains recreational divers to collect data on natural and artificial reefs.



Florida Artificial Reef Science in the 1970s and 1980s: A Retrospective

James Bohnsack[1]

Artificial reef (AR) planning requires understanding history. Florida AR science started in the 1970s & 1980s when public enthusiasm for AR construction exploded with the mantra "If you build it, they will come". NOAA once announced zero funding for AR research because everyone knows they work. The lack of science led to many failures, damage to natural habitats, and wasted resources. Unable to quantify AR benefits, the Florida legislature once diverted $50,000 from a state AR program to support a beauty pageant. Florida Sea Grant leadership helped supported research, fill knowledge gaps, develop monitoring methods, and elucidate AR understanding and the guideline that ARs should do no harm. ARs are a multipurpose tool that can create fishing opportunities and enhance resources, but sometimes can have conflicting uses: solid waste disposal; court ordered; research; coastal protection; diving tourism; tax deductions for donated material; and public relations (advertising, art, tributes to individuals or organizations). A belief that ARs were a panacea for overfishing potentially distracted limited resources away from other beneficial tools, such as protecting essential settlement and nursery habitats or creating marine reserves protected from fishing. Science drew attention to the crucial *attraction versus production* question: Do ARs increase total fish production or merely concentrate existing fish, making them easier to exploit? Research showed that attraction vs. production was a continuum that varied by species, location, reef characteristics, and fishing pressure. High catchability at ARs can exacerbate overfishing. An assumption that natural habitat availability limited population growth and that adding ARs would increase fish production was discreated under overfishing where population growth is limited by the supply of new recruits. In this case, protecting spawning adults is more important than adding habitat. Likewise, populations of many target fishery species are limited by the availability of settlement or nursery habitat, not adult reef habitat. AR planning needs to be based on science, not belief; integrate ARs in holistic fishery management; and provide AR studies not confounded by fishing. Projected Florida human population growth mandates an urgent need for aggressive and effective conservation measures to ensure the persistence of quality resources.

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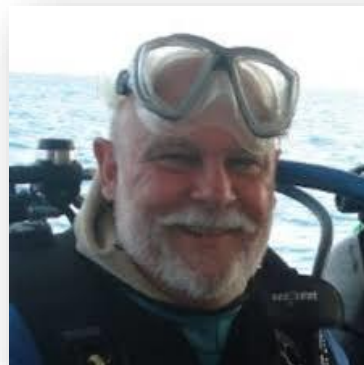
James Bohnsack,
Research Fishery Biologist, Retired

Dr. Jim Bohnsack has been a Research Fishery Biologist for the National Marine Fisheries Service Southeast Fisheries Science Center and an Adjunct Professor at the Rosenstiel School of Marine and Atmospheric Science at the University of Miami since 1984. His research has spanned decades, with recent emphasis on the use of marine reserves to protect marine biodiversity, support ecosystem function and promote sustainable fisheries. His expertise includes reef fish ecology and fisheries, artificial reefs, marine reserves, and diver-based, fishery-independent, stock assessment methods. He has published over seventy peer-reviewed papers, plus numerous technical reports and book chapters on the subject of fisheries ecology as related to artificial and natural habitats.



Special Feature: *Mitigation Reef in Brevard County*

Articulated Reef Mat Construction at Brevard County

Kevin R. Bodge[1] and Michael McGarry[2]

In 2017-19, a novel artificial reef project was constructed along the "Mid Reach" Atlantic Ocean coastline of Brevard County, Florida to mitigate potential impacts of beach nourishment construction. Part of this reef project is located within 1000 feet of the shoreline at the 2020 Artificial Reef summit conference site. The presentation will describe the rationale and development of the reef's unusual engineering design, its construction, and its physical performance upon the shallow sand seabed after several years and three hurricanes.

The project consists of 1,638 articulated-concrete mattresses, each 8-ft x 16-ft with embedded coquina stone surfaces, strategically placed to create 36 distinct reef "sets" along 4 miles of shoreline, and comprising 4.8 acres of reef structure in all. In each "set", 42 mattresses are placed less than 12-inches apart in staggered rows and columns, with an underlying geotextile foundation atop a sandy seabed, in 15-ft water depth (MLW). A top 'ledge' of 3 additional mattresses provides additional relief and spatial complexity.

The articulated concrete reef structures emulate the physical nature of the existing nearshore rock reefs that outcrop in shallow water along the beach fill shoreline area. An articulated mattress design -- in lieu of conventional fields of boulders or monolithic structures -- was required to reduce scour and settlement into the sandy seabed, below which there is no underlying rock. The mattresses were fabricated at an upland yard, transferred by truck, then transported and placed via barge, crane and divers. Seabed installation was conducted in Summer 2017, 2018, and 2019. The project was designed & permitted, and is monitored, by the authors *et al.* Construction was managed and supervised by the US Army Corps of Engineers.

High-resolution multi-beam survey imagery, and diver images, reveals the physical performance of the reef structures and adjacent seabed – which, to-date, has met expectations, even after experiencing the project's design storm wave conditions more than once.

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A Local Lens: Regional Artificial Reef Updates

NE Florida Regional Update

Joe Nolin[1], Joe Kistel[2], Amy Stroger[3], Kathy Russell[4], Melissa Long[5], and Diana Gorski[6]

The NE Florida region is located on the upper east coast of the state from the Georgia border to Cape Canaveral encompassing Nassau, Duval (City of Jacksonville), St. John's, Flagler and Volusia counties. The continental shelf in this region is characterized by broad areas of sandy seafloor with widely scattered, low-relief, natural sandstone outcrops and ledges deemed live bottom reef. Gray's Reef National Marine Sanctuary located off the coast of SE Georgia is an excellent example of natural live bottom reef found in the NE Florida region.

Artificial reefs in the NE Florida region are constructed for fishing, diving and marine habitat and to support the fishing, diving and boating industry. Reefs are constructed using large steel ships and barges and discarded concrete structures, culverts, utility poles, railroad ties, jersey barriers and bridge sections. Reefs are built on permitted reef construction areas in both Federal and state waters. Recreational, commercial and charter fishermen and divers are primary reef site users. Anchored bottom fishing, trolling, drift fishing and SCUBA diving are typical artificial reef uses. State and local government agencies, regional marine industry associations and organized fishing and diving associations fund and support artificial reef site development and construction.

Funding, project staffing, public and organizational support, reef site access, size and location, reef materials availability, staging, storage and transport and reef monitoring and permit compliance are all important issues impacting reef development in the region. Reef development and reef permit maintenance is highly variable in the region according to funding availability and organizational support.

Future reef trends for the NE Florida region include reef sites within state waters to allow for the legal harvest of Red Snapper under state regulations, increasing reef promotional media to expand support, refining reef monitoring and mapping using side-scan sonar and establishing buoys at reef and wreck sites for easy reef locating and as a form of surface habitat.

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[5]City of Jacksonville Environmental Div., 214 N. Hogan St., Jacksonville, FL 32202
[6]St. John's County Parks, 2175 Mizell Rd. St. Augustine FL 32080

Regional Update: East Central Florida

Jessica Garland[1], James B. Oppenborn[2], Matt C. Culver[3], and Molly Klinepeter[4]

Martin County's artificial reef program continues the mission that was started by a group of retirees and sport fishing enthusiasts in the 1970's. Our program focuses on the use of materials of opportunity to build our reefs. Using these materials reduces costs of each reef and provides recycling credits to the Utilities and Solid Waste department. The County is currently in the process of creating a staging/loading area that will be used within our County to reduce hauling expenses. The County has created 6500 tons of new reefs using materials of opportunity as well as deploying a 200ft. long vessel.

The St. Lucie County continues to provide recreational fishing and diving opportunities to local and visiting watermen through the creation of a diverse number of artificial reefs. The use of the County's Harbour Pointe Park stockpiling and staging area is severely restricted such that St. Lucie County is more focused on steel vessels and artificial reef modules to enhance its existing artificial reefs. The program will also focus on inshore habitats, including oyster reefs, seagrasses, water quality, and a snorkel trail. Restoration of Moore's Creek, an urban tributary, may benefit many of these inshore habitats.

Indian River County's artificial reef program utilizes secondary use mixed concrete and prefabricated artificial reef modules to deploy reefs in the County. These deep water reefs are used for fishing and diving opportunities, as well as the creation of diverse ecosystems. Through recent deployments, the County has added new reefs approximately 5.5 miles south of the Sebastian Inlet and has added 1,752 tons since 2017. Indian River County continues to prepare for new deployments and monitor existing reefs.

Brevard County continues to provide recreational fishing and diving opportunities to locals and visitor alike. Due east out of Port Canaveral, the County's single 3085 Acre permitted site has been the target of 4 patch reef deployments over the past 5 years, with a large reuse concrete deployment scheduled for 2020. The Space Coast Artificial Reef Advisory Board (SCARAB), developed through partnerships with the Florida Sports Fishing Association (FSFA), the Central Florida Offshore Anglers (CFOA) and the Coastal Conservation Association (CCA) has continued to guide projects through sustained community, management, and financial support.

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[3]Boating & Waterways Program Coordinator; Brevard County, 2725 Judge Fran Jamieson Way, Viera, FL 32940

[4]IRL Plan Coordinator; Indian River County, 1801 27th Street, Vero Beach, FL 32960

Palm Beach to Monroe Regional Update

Jena McNeal[1], Angel Rovira[2], Sara Thanner[3], Richard Jones[4], Pat Quinn[2]

Over the past five years Palm Beach, Broward, and Miami-Dade Counties have had very active artificial reef programs with a combined 67 deployments. Currently Monroe County does not have an active program; therefore, the abstract pertains only to the three active counties. Three main topics were identified that directed the advancement of artificial reef deployments over the past 5 years and will continue to influence placements in the coming 5 years. Those were funding sources, technology, and resilient artificial reefs.

In the past 5 years, each County has deployed all or most of their artificial reefs in conjunction with non-profit foundations or other non-county funding or donation sources. These outside groups are helping to advance each County's ability to create reef habitat while influencing what an artificial reef looks like. In the past, artificial reefs have typically taken the form of ships, piles of limestone boulders, or some version of a pre-fabricated module. Today, with influence from outside funding sources, artificial reefs are now incorporating underwater sculptures, artwork, and interactive pieces for SCUBA divers to enjoy. With new and innovative artificial reefs becoming more mainstream, they require placements that are more precise. Two-point anchoring systems with GPS and DPS technology have become typical technology on contractor's equipment, while Broward and PBC County's now have side scan technology on their County vessels. PBC also has singlebeam sonar for hydrographic surveys for more accurate as-built maps. Lastly, the topic of resiliency and resilient shorelines has become mainstream. Miami-Dade County anticipates the push for nearshore resilient artificial reefs or breakwaters that serve as a biological enhancement, promotes shoreline protection, and has recreational value for snorkelers. PBC has been constructing living shorelines and resilient breakwaters for the past 15 years along publicly owned property and is now receiving requests for similar projects on private property to enhance the environment while increasing the resiliency of their shoreline.

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[1]Palm Beach County
[2]Broward County
[3]Miami-Dade County
[4]Monroe County

Southwest Florida Artificial Reefs: An Overview of Reef Deployment Activities, Trends, and Future Initiatives from Pinellas County South to Collier County

Katie Laakkonen[1], Kristin Erickson[2], Lesli Haynes[3], Chris Pratt[4], Chris D'Arco[5], Charles Mangio[6], Michael Solum[7], and Robert De Bruler Jr.[8]

Numerous artificial reefs have been deployed historically within the Southwest Florida region which includes the following counties: Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee and Collier. This region has many tidal inlets, barrier islands, and mangrove wetlands including the Ten Thousand Islands. There are over 10 estuaries from Collier County to Pinellas County, many of which are Aquatic Preserves. Artificial reefs along this stretch of coastline contribute to enhanced recreational opportunities for divers and anglers, provide economic benefits to the community, as well as offer educational and scientific research opportunities. Many artificial reefs offshore of these 7 counties are monitored as a part of the Great Goliath Grouper Count, initiated by Florida Sea Grant and the Florida Fish and Wildlife Conservation Commission, which now has 10 years of data that has been collected and analyzed. The Ten Thousand Islands in Collier County is one of the largest nursey grounds for this species. During this discussion, the presenter will address recent trends and successes for reef construction within the past 5 years (2015-2020) in Southwest Florida. An overview of lessons learned along with funding and other logistical constraints counties face for future reef deployments will be presented. Future initiatives for reef construction, monitoring, and research needs will also be discussed.

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Artificial Reefs Projects to Receive a Boost in Funding in the Big Bend Region

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The Big Bend Region is poised for a boost in funding for artificial reefs over the next ten years. Approximately $3,850,000 has been allocated in RESTORE funds (Pot 3, Spill Impact Component) to Citrus, Hernando, and Pasco Counties for artificial reef projects. Additionally, Taylor County was awarded grant funding through FWC for the expansion of the Buckeye Reef, with plans to deploy 48 engineered concrete modules. Pasco County will use RESTORE funds to expand the Pasco Reef #4 in 2020, and then design, permit, and construct shallow nearshore reefs in 2022. Hernando County's first funding award will be used to complete design and permitting of ten new artificial reef sites with additional funds allocated for future deployments. Citrus County will utilize their RESTORE funds in 2026, focusing on the expansion of their largest permitted reef (Fish Haven #1). It's important to note each of these reef projects will include monitoring of success metrics such as recreational usage and fish populations. Since multiple years of monitoring is required there will opportunities for developing a regional monitoring network. Although Dixie and Levy Counties aren't currently planning any artificial reefs using RESTORE funds, they are leading the Big Bend region in the development of coastal enhancement projects, with $5,000,000 allocated in RESTORE funds for both oyster reef restoration and living shoreline projects

Over the past five years as progress has been made on the RESTORE funding front, several successful reef deployments have been accomplished within the Big Bend Region. Highlights include the deployment of 300 Lindberg cubes in Taylor County, 600 tons of high quality secondary use concrete in Hernando County, and the creation of three nearshore reef ball arrays in Hernando County. Other significant accomplishments include the implementation of a citizen science-based monitoring programs in both Taylor County (Sea Grant UF/IFAS Extension and Taylor County Reef Research Team) and Hernando County (Scubanauts International and Hernando County Port Authority). Lastly, all of the counties in the Big Bend Region wish to express their appreciation to FWC for the collection of side scan sonar data at each County's respective artificial reef sites.

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Northwest Florida Region

Melinda Gates[1]

Northwest Florida is known for their white sandy beaches and emerald green waters, however over the past few years this region has also become well known for their artificial reefs. The Northwest Florida region is made up of eight Counties: Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, Franklin, and Wakulla. Although there are a few natural reefs within the region, the northern Gulf of Mexico has miles of sandy bare ocean floor. Artificial reefs are critical to this area's marine fisheries and tourism-based economy. During this discussion the presenter will address environmental uniqueness of the region, deployments over the past five years, and new methods and advanced technology of deployments. Portions of northwest Florida were directly hit by a Category 5 Hurricane Michael. The presenter will provide an overview on the post-storm resiliency data obtained on the previously deployed artificial reefs. The presenter will also focus on the future of artificial reefs including marketing techniques, stakeholder involvement especially with public-private partnerships, and innovative artificial reef material. Northwest Florida is "850 Strong". This community is committed to building strong, resilient artificial reefs for future generations.

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Focus: *Research and Monitoring*

Synthesis of Recent and Ongoing Research on Paired Artificial-Natural Reefs

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Through FWC's Artificial Reef Program (ARP), Florida has demonstrated a strong effort to deploy and maintain public artificial reefs in state and adjacent federal waters. The ARP operates under a strategic plan involving six general goals that incorporate ecological, economic, societal, and management objectives. Using a programmatic approach, my research has addressed most of these goals while also establishing a long-term monitoring program on artificial reefs off west-central Florida. I will provide a synthesis of the work accomplished to date and the next steps in my research program on these reefs. This work has involved 1) the development and testing of a rotating camera system that mimics the standard Bohnsack-Bannerot method used for quantifying fish assemblages on reef habitats, 2) acoustically measuring boater visitation rates as a proxy of fishing intensity and comparing them between artificial and natural reefs, 3) estimating biological production of economically important species of fishes between reef types, 4) characterizing the benthos associated with artificial and natural reefs, 5) spatially expanding the long-term monitoring program to examine how large-scale variation in nutrient regime can affect the associated biological communities, and 6) determining the sampling frequency required to capture long-term population and community dynamics at inter- and intra-annual temporal scales. Collectively, my lab's research program on artificial reefs has used classical approaches while developing novel ones to improve our understanding of the ecological, economic, and societal functions of these important habitats to the coastal ecosystems around Florida.

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Beyond Reef Fish: Clarifying the Role of Artificial Reefs for Highly Mobile Species

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Artificial reefs such as oil and gas platforms, shipwrecks, and concrete pyramids are known fish aggregation habitats that span the continental shelf across the southeast USA. While numerous studies have documented elevated reef and forage fish biomass associated with artificial reefs, little is known concerning the biology and behavior of top predators such as highly migratory species (HMS; tunas, swordfish, billfishes, and sharks) that are presumably attracted to these sites due to abundant prey resources. This is unfortunate as many HMS support significant commercial and recreational fisheries themselves and some, particularly sharks, may also be vulnerable to snapper-grouper fisheries (recreational hook-and-line, commercial bandit gear) that target these same artificial habitats. In this talk, we provide a short review of recent literature documenting interactions between sharks and artificial reefs and highlight some data from recent fishery-independent surveys that suggest potential preferences for habitats. Lastly, we discuss how implementing persistent-presence approaches may offer tremendous value to identifying dynamic processes such as fish spawning aggregations at artificial reefs off Florida. The results of these studies are used to develop a roadmap for improving our scientific understanding of how HMS use artificial reefs.

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The Effects on Natural Reefs of Predatory Fish Aggregations around a Nearby Artificial Reef

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Artificial reefs typically support distinct fish assemblages compared to natural reefs, including a much higher biomass of predatory species. There are currently few data available to address critical management questions such as whether artificial reefs have significant effects on nearby natural coral reefs by increasing predation rates, the spatial scale of any interactions, and the degree to which predatory fishes may move from protected artificial reefs to nearby fished areas. Consequently, making recommendations regarding the spacing between natural reefs and proposed new artificial reefs is currently challenging. This project focused on Florida International University's Aquarius Reef Base (ARB; Conch Reef, Florida Keys) to examine interactions between an artificial reef and an adjoining coral reef. The project used acoustic telemetry to track movements of barracuda and schoolmaster snapper between ARB and surrounding fished and protected reefs, grazing assays to assess gradients of acute and chronic risk on parrotfish foraging with increasing distance from ARB, and Ecopath models to assess whether the food web at ARB is self-sufficient or requires a subsidy from surrounding natural reefs. The project tagged 17 barracuda and 17 schoolmasters, and because of their residence at ARB losses from the array of receivers provide rare data on natural and fishing mortality rates. Furthermore, snappers exhibited clear nocturnal foraging migrations to sites outside the array. Barracuda behaviors were more variable, but clearly included foraging on nearby reefs. The gradient of decreasing risk from barracuda predation with increasing distance from ARB led to non-linear impacts on parrotfish foraging, with fish generally bolder closer to ARB. Food web modelling highlighted the need for a spatial subsidy from surrounding natural reefs. The project demonstrates that artificial reefs placed close to natural reefs can have significant impacts that should be considered during planning stages, although more work is required to identify critical distances.

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Fish Communities Associated with Natural and Artificial Hard Bottom Habitats within the Tampa Bay Estuary

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Hard bottom habitats such as corals, sponges, limestone ledges and artificial reefs are known to support diverse fish communities in offshore areas of the Gulf of Mexico. Less is known about inshore hard bottom habitats in Tampa Bay due to the limitations of traditional fisheries gear (nets). This study was designed to determine the distribution of hard bottom habitats in Tampa Bay, the fish species that are using these habitats, the temporal and spatial use of these habitats by fish and how fish use these hard bottom habitats in comparison to other habitats within Tampa Bay. Using baited remote underwater video surveys and timed-drop hook-and-line sampling based on current sampling of offshore reefs, we collected data on species composition and abundance for natural and artificial hard bottom habitats within Tampa Bay. Species that have not been or are rarely collected in fisheries-independent monitoring efforts within Tampa Bay were documented. Information on hard bottom habitat use was collected for a variety of economically important species, including reef fish that aren't typically considered estuarine dependent (i.e., Red Grouper). These results suggest that Tampa Bay hard bottom habitats likely function as an extension of nearshore hard bottom habitats and support unique fish assemblages within the estuary. In addition, these habitats probably serve as a nursery for emigrating estuarine-dependent reef fish as they move to shallow nearshore reefs farther offshore (e.g., Gag, Gray Snapper). Hooked gear sampling allowed us to obtain accurate lengths on many of these key estuarine dependent reef fish species and provided data on species that are commonly captured by the recreational fishery. This research could help resource managers prioritize habitat conservation and artificial reef enhancement throughout Tampa Bay and surrounding waters and serve as a model for other estuarine systems along the Florida coast.

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Artificial Reef Monitoring in Florida: A Comparison of Recreational and Mitigation Reef Monitoring Programs

Lauren Floyd[1], Stacy Buck[2], and Katy Brown[3]

Hundreds of artificial reefs have been deployed in Florida waters and monitoring programs have been implemented to assess their function in compliance with permit and/or funding requirements. While artificial reefs can be constructed for various purposes, this presentation will focus on reefs constructed for recreational activities (e.g. diving, fishing) and reefs deployed as compensatory mitigation to offset impacts to natural reefs or hardbottom damaged by human activities, such as beach nourishment.

Recreational reefs are typically constructed of opportunistic materials with the primary goal of providing fishing and diving opportunities. Funding is limited and generally comes from diving or fishing groups, or taxes and fees related to those groups. The goal in providing this funding is to enhance recreational activity, therefore monitoring efforts are typically not included. For recreational reefs that have obtained necessary state and federal permits, the FWC Division of Marine Fisheries Management manages a state artificial reef program that provides financial and technical assistance to construct, monitor, and assess artificial reefs. Mitigation reefs, on the other hand, are permitted and authorized by FDEP and USACE as part of the permitting process for the coastal projects for which they are providing mitigation, and the associated monitoring requirements and funding are linked to the coastal projects. Since mitigation reefs are designed (and required) to offset any unavoidable impacts to coral reef or hardbottom, permits include clear monitoring methods and success criteria to ensure the mitigation reef mimics the community and function of the impacted hardbottom.

This presentation will compare monitoring goals and methods utilized on recreational and mitigation reefs, with some specific examples of reefs monitored by the authors throughout Florida. It will include suggestions on how consistent data collection methods and analysis on both reef types may benefit a greater overall understanding of artificial reef ecology and function.

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Artificial Reefs can be Effective Tools for Fish Community Enhancement but are not One-Size-Fits-All

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Approaches towards habitat conservation and restoration often include supplementing or enhancing existing, degraded, or lost natural habitats. In aquatic environments, a popular approach towards habitat enhancement is the introduction of underwater human-made structures or artificial reefs. Despite the nearly global prevalence of artificial reefs deployed to enhance habitat, it remains debated whether these structures function similarly to comparable natural reefs. To help resolve this question, we conducted a literature review and accompanying meta-analysis of fish community metrics on artificial reefs within the coastal ocean and made comparisons with naturally-occurring reference reefs (rocky reefs and coral reefs). Our findings from a synthesis of 39 relevant studies revealed that, across reef ecosystems, artificial reefs support comparable levels of fish density, biomass, species richness, and diversity to natural reefs. Additional analyses demonstrated that nuances in these patterns were associated with the geographic setting (ocean basin, latitude zone) and artificial reef material. These findings suggest that, while artificial reefs can mimic natural reefs in terms of the fish assemblages they support, artificial reefs are not one-size-fits-all tools for habitat enhancement. Instead, artificial reefs should be considered strategically based on location-specific scientific assessments and resource needs to maximize benefits of habitat enhancement.

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Quantifying Spatial Distributions and Benthic Footprints of Artificial Reefs on the Southeastern USA Continental Shelf

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Artificial reefs are commonly deployed to enhance fish habitat and provide fishing and diving opportunities. Despite the widespread occurrence of artificial reefs, relatively little is understood about their spatial distributions and how much area of the seafloor these reefs cover. To help fill these knowledge gaps, we quantified the spatial distribution and benthic coverage ('footprint') of artificial reefs along the continental shelf of the southeastern United States (Florida, Georgia, South Carolina, North Carolina). Specifically, we examined the distribution of artificial reefs by geography, depth, material, and structure type. We then estimated the minimum, mean, and maximum coverage of artificial reefs across the southeastern USA using multiple quantitative approaches. By increasing knowledge and understanding of the distribution and associated attributes of artificial reefs, this research may help inform future designs, deployments, regulation, and restoration along US coastlines.

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Fish Community Assessment of Mesophotic Artificial Reefs off St. Lucie County

Michael McCallister[1] and Matthew J. Ajemian[1]

Our scientific understanding of how artificial reefs ecologically facilitate marine fisheries in mesophotic (>30 m) habitats is limited. The objective of this study was to conduct a fishery-independent assessment of fish communities inhabiting St. Lucie County Sportfish Artificial Reef site, which spans bottom depths of 30 to 50 meters. Sampling efforts consisted of 20 baited remote underwater videos (BRUV), 3 roving diver surveys, and 88 vertical longline sampling (VLL) events. Vertical longline sampling showed that the two most abundant species caught on the artificial reef sites were red snapper (*Lutjanus campechanus*) and vermillion snapper (*Rhomboplites aurorubens*). Red snapper catch rates were significantly greater on artificial reefs deeper than 40 m and made of rubble, while vermillion snapper catch rates were significantly greater on artificial reefs shallower than 30 m. Community analysis of BRUV samples revealed significant differences in species composition among seasons, depth ranges, and sites. Seasonal differences were largely attributed to the increased abundance in *Decapterus sp.* during the summertime upwelling period, while differences between depths were explained by a greater abundance of tomtates (*Haemulon aurolineatum*) and vermillion snapper at artificial reef sites less than 30 m deep and greater abundance of red snapper at sites deeper than 40 m. These BRUV-based findings are consistent with data from VLL sampling. Although there were no direct observations of confirmed spawning aggregations for snapper-grouper species, potential pre-spawning behavior and spawning coloration were observed on occasion at multiple sites during the winter sampling period. Further monitoring is needed to examine the interactive effects of reef type and season on fish assemblages.

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Re-Evaluation of Module and Boulder Reefs: Miami-Dade County Artificial Reef Program

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For decades, limerock boulder and module artificial reefs have been deployed offshore of Miami-Dade County for a variety of purposes. Seven of these artificial reefs were evaluated from 2007-2009 and again in 2019. Five reefs (PMBP, PMBR, SIMB, SIMM, and PMAM) were constructed with a broad goal to serve as mitigation for dredging related impacts. One reef was constructed for fishery enhancement (ANCB) and one for both fishery enhancement and recreational diving opportunities (GDBB). All seven artificial reefs provide habitat that supported abundant and diverse biological assemblages and met the broad objectives for which they were deployed. The density of the fish increased in 2019 on ANCB, GDBB, and PMAM largely due to the abundance of grunts, namely *Haemulon aurolineatum* (tomtates), and decreased on the other sites due to fewer grunts and gobies. Other common reef fish families in both monitoring periods were snappers, wrasses, damselfish, and parrotfish. In general, more gamefish species were observed on the higher relief boulder reefs—GDBB, ANCB, PMBR, and PMAM. However, of those gamefish species regulated by size, only a few individuals were of legal harvesting size. In both monitoring periods, benthic assemblages on all seven artificial reefs were dominated by turf algae coverage followed by soft coral on PMBP and PMBR and sponge species on the other five sites. Soft coral cover increased in 2019 on six of seven sites. Hard coral cover increased on all sites except PMAM which had a nearly 3% decline due to loss of *Oculina diffusa*. Both boulders and modules can provide suitable substrate for benthic assemblages but could be tailored toward modules if porifera cover is a priority. If fisheries enhancement is the project goal, higher relief boulders would be preferable and placing a large material footprint may minimize the dominance of large schools of grunts.

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A Call to Action: Artificial Reefs in Coral Reef Restoration

Amber Whittle[1]

An unidentified disease event began in 2014 in Miami-Dade County and has spread north through Broward, Palm Beach, and Martin counties and south through the Florida Keys, and past the Marquesas. The disease, Stony Coral Tissue Loss Disease (SCTLD), has been confirmed to affect 22 species of stony corals, including key reef building species, five species listed pursuant to the Endangered Species Act, and inflicts varying levels of loss, with the most susceptible coral species suffering complete mortality. Overall, stony coral absolute cover has catastrophically declined from 60% in the 60s and 40% in the 80s to 2% today (*Mission: Iconic Reefs*). A bold decision was made to rescue corals ahead of the disease margin and The Florida Aquarium (FLAQ) currently holds, breeds, and rears 400 Atlantic corals of 15 species, including 117 rescue corals. Predictable and sustained land-based spawning, sexual propagation, and rearing of all Florida corals are critical to maintaining genetic diversity and adaptability along the Florida Reef Tract. Artificial reefs could play an important role as structure for coral outplants, but their use would need to be scientifically sound—augmenting the natural reef, not replacing it. Data from the Florida Coastal Mapping Program and reef erosion rates (Kuffner, 2015, 2019), restoration planning efforts (*Mission: Iconic Reefs*), and past lessons learned (SEFCRI. 2011) should steer the research and technology needed to pair the strengths of artificial reefs with the dire necessity of reef restoration. The artificial reef community and restoration scientists need to work together to maximize the potential of artificial reefs in environmental restoration.

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Focus: *Socioeconomics and Human Dimensions*

Measuring Economic Contributions and Impacts Associated with Artificial Reefs

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Artificial reefs are manmade structures intended to mimic the characteristics of a natural reef in order to restore structure and habitat diversity in areas where coral reefs have been diminished or destroyed. In addition to their environmental benefits, these structures often attract recreational fishers, divers, and snorkelers, potentially bringing new money to the local area. Although the biological and environmental impacts of artificial reefs are well studied, decision makers are often also interested in what type of economic impacts might result from a new artificial reef or what an existing artificial reef is contributing to the local economy. Existing studies on these economic measures use a variety of economic metrics and methods, making them hard to compare and limiting opportunities for generalizing the potential impacts of artificial reefs over time and across sites. This presentation will discuss the variety of methods and measures used to estimate economic contributions and impacts, the benefits and drawbacks to each method, and their potential usefulness to the topic area of artificial reefs.

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Effects of Artificial Reefs on Recreational Fisheries: What We Don't Know Might Hurt Us

Ed V. Camp[1]

Artificial reefs are increasingly deployed in marine waters to enhance reef fish populations, augment recreational fishing opportunities, and bolster local economic metrics. Artificial reefs almost certainly affect fish and fishers, and thus should have the potential to affect local economies, but their capacity to address simultaneously all of their intended purposes has not been well evaluated. This knowledge gap may result in inefficient use an otherwise powerful management tool. To understand better the potential artificial reefs to address ecological and socioeconomic objectives, I developed a conceptual and quantitative model representing gag fisheries in Northwest Florida, an area that has been increasingly enhanced via artificial reefs. The results of the model show that *both* overall socioeconomic *and* conservation benefits derived from implementing artificial reefs are only possible under relatively specific and narrow assumptions regarding fish and fishers. Under more generally assumptions, artificial reefs may well increase overall fishing related mortality on key reef species, though this harvest would cause a short-term increase in some economic metrics. This means artificial reefs may cause trade-offs among different intended objectives. The primary implications of this work is that (1) management agencies, extension organizations, and end-user groups should develop explicit objectives for artificial reefs, and (2) regional strategic plans for artificial reef implementation may be needed to mitigate unintended consequences of reefs.

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Spatial Consideration Can Determine Net Socioecological Effects of Artificial Reefs on Recreational Fisheries and their Management

Lisa Chong[1] and Edward V. Camp[1]

Artificial reefs are increasingly deployed in marine waters to enhance recreational fisheries, restore reef fish populations, and provide economic benefits to surrounding communities. Reefs can alter vital rates affecting fish populations, but they may also influence angler fishing behaviors such as site choice, total effort, and catchability. This means that artificial reefs can not only increase fish populations and bolster economies, but also can increase fishing mortality that could eventually trigger stricter regulations. These effects may depend on the spatial placement of these reefs, though this has not been well evaluated. To better understand the possible outcomes of artificial reef implementation and spatial disposition, we developed a spatial integrated socioecological model representing a red snapper population and simulated how effects of artificial reefs and their placement affect the fishery. Our results demonstrate that simultaneously increasing socioeconomic fishery objectives (greater catch rates, more fishing effort) and conservation objectives (greater spawning biomass) would be very difficult to achieve—and are only possible if the placement of artificial reefs allow biological benefits to greatly outstrip augmented fishing opportunities. Under most placement scenarios, artificial reefs would often lead to more depleted fish populations and more restrictive regulations that could have undesired effects on nearby coastal communities. How many artificial reefs and where they are deployed relative to the coast, natural reefs, and cities are essential to balance the socioeconomic and conservation objectives of the overall fishery. These results highlight the importance of understanding spatial dynamics of fish population and anglers, the potential of using assessment models as engagement tools to help develop understanding between managers and fishers, and the need to consider fisheries management in the siting and decision-making of the implementation of artificial reefs.

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Focus: *Fisheries Monitoring and Management*

Improved Data from Artificial Reef Habitats to Better Inform Management: The Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) Program

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Reef fish assemblages in the Gulf are structured by a complex interaction among drivers at multiple scales, including habitat availability, episodic events, and fisheries management among others. Nevertheless, the nature of these interactions, and how drivers may ultimately influence the productivity and sustainability of fisheries resources, are not well known. Entities responsible for the assessment and management of reef-fish populations throughout the Gulf have identified a general lack of high-quality fishery-independent survey data collected at appropriate spatio-temporal scales as a major obstacle to an improved understanding of habitat-specific, population dynamics. Through the G-FISHER program, we are addressing these critical needs by integrating three regional reef fish surveys (involving habitat mapping and underwater video surveys) and expanding the breadth of spatial and habitat coverage. As part of these efforts, an optimized survey design is being developed that incorporates an integrated spatial–habitat stratification scheme to increase sampling efficiency and improve the precision of estimates of relative abundance and size composition. By expanding survey efforts Gulf-wide and incorporating the full spectrum of artificial and natural reef habitats available to reef-fish populations, the data products provided by this project will represent the most comprehensive and representative characterization of reef-fish abundance, size composition, assemblage structure, and habitat dynamics yet available in the Gulf.

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Incorporating Data from Artificial and Natural Reefs into Indices of Relative Abundance to Support Improved Assessment and Management of Reef Fishes

Kevin A. Thompson[1], Theodore S. Switzer[1], Sean F. Keenan[1], and Mary C. Christman[2]

Stereo-baited remote underwater video (S-BRUV) surveys have been used to assess trends in the relative abundance of reef fishes in the Gulf of Mexico since the early 1990s. Through time, efforts have increased through a collaboration between NMFS and the Florida Fish and Wildlife Research Institute (FWRI). Recent efforts to combine survey data across labs has demonstrated the efficacy of a habitat-based statistical modeling approach to generate a single index of relative abundance for the eastern Gulf, which has become one of the primary fishery-independent data inputs in recent reef-fish assessments. However, these ongoing surveys have focused solely on natural reef habitats, excluding anthropogenic habitats (i.e. artificial reefs) that are regionally important for several reef fishes, and are increasingly being deployed as a mitigation measure for restoration efforts. Accordingly, the FWRI S-BRUV survey was expanded in 2014 to not only extend into the Florida Panhandle, but also incorporate artificial reef habitats. In this talk, we apply the analytical methods used to develop a combined eastern Gulf index to integrate information on population trends from both artificial and natural reef habitats. By incorporating estimates of habitat quality and overall habitat availability, indices generated better represent the overall status and trends of reef fish populations and will aid in improved assessment and management capabilities. Results from these initial analyses provide a reliable framework for incorporating these potentially valuable habitats into assessments of reef fish in the region. As time series continue for both artificial and natural reef habitats throughout the eastern Gulf, these methods will be applied to create indices incorporating data from all available natural and artificial habitats in the region.

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Assessing Reef Fish Habitat Restoration and Recreational Fishing Enhancement Efforts Using Fisheries Dependent Monitoring Methods

Tiffanie Cross[1], Beverly Sauls[1], Keith Mille[2]

Florida's Artificial Reef Program is one of the most active in the Gulf of Mexico region. To date, 2,421 patch reefs have been deployed in Florida's Gulf waters. The NRDA Phase III Florida Artificial Reef Creation and Restoration project is a collaborative effort between FL FWC and FL DEP to provide enhanced reef fish habitat and long-term recreational fishing opportunities in the northwestern panhandle of Florida. In addition, the program requires post-construction monitoring to assess how well habit enhancement efforts are meeting intended objectives. Monitoring the recreational fishing component of an artificial reef program is necessary to understand how large-scale artificial reef projects influence recreational fishing behavior, catch-per-unit-effort (CPUE), and overall landings of managed reef fish species.

To achieve monitoring requirements, we utilized a specialized recreational fishing survey that was implemented in Florida during 2015 with funding through the NFWF Gulf Environmental Benefit Fund. The Gulf Reef Fish Survey (GRFS) was designed to improve recreational fishing statistics for reef fish stocks in the eastern Gulf following the *Deep Horizon* oil spill. In 2016, new questions were added to quantify recreational fishing trips that utilize artificial reefs. In addition, we conducted separate surveys at major inlets in the panhandle to assess artificial reef use during two recreational fishing seasons for Red Snapper in 2017 and 2019. Here we summarize trends in recreational fishing effort and catch from artificial reefs across the west coast of Florida, compare artificial reef angler trip estimates in the panhandle region generated from two separate surveys, and provide discussion on assessment of project objectives and the use of artificial reefs in marine fisheries management.

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Artificial Reefs – Too Much of a Good Thing?

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NMFS works with regional councils to manage federal fisheries to provide the greatest national benefit, including recreational opportunities. State and federal agencies deploy artificial structures for many reasons, often to enhance recreational fisheries. While such structures can improve the angler experience by making fish easier to locate and catch, they can also decrease opportunities by causing quotas to be reached more quickly, reducing access to the resource.

Recreational catch rates for Gulf red snapper have expanded 4-fold as the population rebuilds. This trend required fishery managers to reduce the fishing season from 122 days to as few as 9 days at the same time they increased the quota from 5 million pounds to nearly 14 million pounds. Shorter seasons frustrate anglers who value the opportunity to target red snapper, create allocation conflicts, and erode relationships between fishermen, scientists, and managers.

Karnauskas et al. (2017) found that red snapper catch rates are up to 20 times higher on artificial reefs and up to 26 times higher on platforms relative to natural reefs. Analyses suggest that even modest (≤ 5%) shifts in effort from natural reefs to artificial structures could shorten season lengths by as much as 50%. While artificial structures may increase productivity, the debate over whether any such offsets increased fishing pressure remains unresolved.

Artificial structures may also impact fishery allocations by concentrating fishing effort in certain areas. Nearly 40% of the recreational red snapper catch is landed in Alabama, which has just 3% of red snapper domain, but roughly 50% of the artificial structures in the Gulf.

Artificial structures as a fishery enhancement tool is a complex issue with many tradeoffs. Greater collaboration with federal fishery managers during permitting processes, along with additional research, could improve the success of artificial structures in achieving fishery objectives and reduce unintended consequences.

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Artificial Structure Implications for Fisheries Management (and the Science around it)

Mandy Karnauskas[1] and John F. Walter[1]

Large-scale artificial structure deployment has been widely used as a tool for improving recreational fishing opportunities. Yet, artificial structures in the Gulf of Mexico may have had the unintended consequence of limiting fishing opportunity, due to the extremely high catch rates associated with these sites. It is exactly these types of counterintuitive and underappreciated tradeoffs that form critical elements of Ecosystem-Based Fisheries Management (EBFM). In contrast to the rather specific focus on maximum sustainable yield of single-species management, EBFM focuses on and provides the opportunity for defining system-wide management objectives. Critically, it requires explicit consideration of tradeoffs that are inherent in any management decision. Considering artificial structures in an ecosystem context 'takes the blinders off' the process of considering the full range of impacts, providing critical context and more informed management decisions. As artificial structures are a key element of fisheries management, a target destination for fishing but also potentially major interventions to the ecosystem, they require an ecosystem approach to consideration. In this talk, we will demystify the concept of EBFM and related ecosystem approaches, using examples from the southeastern U.S. for illustration. We will show how evaluation of individual management actions with respect to overall ecosystem objectives can lead to more transparency, reduced conflict, and improved support for governance, which should greatly facilitate management over the long term.

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Focus: *New Perspectives, Regulation, and Mitigation*

Artificial Reef Monitoring: A Citizen Science-Based Program in Taylor County, Florida
Victor Blanco[1]

Taylor County have been deploying different artificial reef materials to create an artificial reef at the "Buckeye", located 22 miles offshore of Steinhatchee. As it has become a popular fishing spot, it is necessary to describe the fish structure associated to the artificial reefs and assess the structures. Grant funds from FWC were allocated to perform the Buckeye Reef Monitoring Program. A Social media campaign helped enroll volunteer divers to support the monitoring efforts on a Citizen Science-based program. The training session, including an online module for fish identification in the Gulf of Mexico, and an in-person training session for fish census, artificial reef structure assessment and fish identification methods was held in 2018. A total of 30 volunteer divers were trained. The goal was to collect valid scientific data over fish population and artificial reef structures at 18 different deployment sites in Buckeye Reef to promote this location for recreational fishing and diving and to evaluate the impact of the county reef program. During 2018 and 2019 volunteer divers have invested 868 total hours, of which 76 are diving hours, equivalent to $19,647 in contributions. Fish data of monitoring surveys documented the presence of 29 species of 17 families for the stationary count method. For roving dive counts, a total of 35 species of 23 families were recorded. Gag groupers and Amberjacks represent the largest abundant fish in the Sportfish group, followed by Hogfish, Red grouper, Barracudas, Sheepshead, Red Snapper, and Gray triggerfish. No Lionfish has been recorded during the monitoring program. Fish has a relative higher abundance in scrap metal, tetrahedrons, culverts, and Lindberg cubes, respectively. In average, 98% of the reef material is intact with incrusting algae, sponges and anthozoans as predominant coverage species. The bottom coverage of reef materials assessed is 5,576 sqft. Scrap metal is the material covering the largest surface (75%).

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High Resolution Underwater Mapping of the Osborne Tire Reef, Ft. Lauderdale, Florida

Chip Baumberger[1], Mark Schroeder[1], and Keith Spring[1], John Morgan[2], and Chris Creed[3]

In 1975, bundles of two million tires were deployed one mile offshore of Fort Lauderdale, forming the Osborne Tire Reef (OTR), an artificial reef to attract fish for sportsmen while reducing the number of tires clogging Florida's landfills. The project became an environmental problem as few organisms attached to the tires, and the bundles eventually broke apart with tires diffusing across the nearshore reef environment. Prior to this survey, it was estimated the tires covered an area of 250 ha across the Broward nearshore seafloor.

Florida's Department of Environmental Protection (FDEP) is considering novel tire removal methods with a long-term goal of removing all accessible tires. To accomplish this, a better understanding of the extent of tires from the OTR and the location and condition of nearby reef and benthic habitats was needed.

CSA and M&E were tasked with collecting data with side-scan sonar, multi-beam fathometer, diver-held underwater GPS tracking, and towed digital video to create a GIS of remotely sensed data and diver verified condition of the OTR and adjacent hardbottom areas. Scientific diver investigations were conducted to ground truth sonar signatures of unidentified and man-made objects including artificial reefs and shipwrecks. The GIS detailed the distribution and density of tires and allowed production of highly detailed maps of the tire reef extent and tire densities around the OTR.

The presentation will provide background on the Osbourne Tire Reef origin and current conditions, highlighting the methods used to conduct high resolution underwater mapping and diver verification of the current conditions. An important finding of the geophysical survey was the increase in tire distribution over 1 km north of the original site. The adaptive surveying techniques, in situ assessment of factors that could impact recovery operations, and cutting-edge technologies combined with GIS led to a successful survey.

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U.S. Customs and Border Protection Partnering in Support of Florida's Artificial Reef Program

Robert M. Del Toro[1] and Amelia Castelli[2]

The U.S. Customs and Border Protection (CBP) Miami Field Office has partnered with counties around the State of Florida to donate seized vessels to be converted into artificial reefs and sunk in an effort to bolster marine life through the creation of new habitats. Most recently, the Agency transferred the M/V Ana Cecilia, the M/V Philomena and the M/V Voici Bernadette to counties along with East Coast of Florida. These vessels were used in attempted efforts to smuggle hard narcotics into the United States and were ultimately seized and forfeited to the US Government. CBP Miami recognizes the significant long-term benefits of partnering on the artificial reefing projects – benefits beyond the immediate consequences of seizures for the criminal organizations, to include the positive impact on the ecosystem as well as the economy for the State of Florida and the Federal Government. CBP Miami wishes to continue partnering to further both the Agency's Mission and the State's future artificial reef projects.

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Nautical Charting of Artificial Reefs

Lance Roddy[1] and Paul Gionis[1]

The Office of Coast Survey (OCS) of the National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service (NOS) is congressionally mandated to produce nautical products for U.S. waters. Our current mission is to ensure safe navigation by maintaining over 1,200 Electronic Navigational Charts (ENCs) and over 1,000 Raster Navigational Charts (RNCs). A portion of this mission includes the charting of obstructions, e.g. artificial reefs/fish havens.

Permits issued by the U.S. Corps of Engineers (USACE) are the sole source for classifying obstructions as artificial reefs/fish havens for charting purposes. Upon receipt of a USACE public notice or permit, cartographers will pre-process the information; checking for inaccuracies, completeness, and potential charting conflicts. Essential information is required for NOS to chart artificial reefs, including accurate geographic positions (NAD83) and accurate dimensions of the reef (polygon or circular). For each specific reef, NOS policy requires one definitive single numerical clearance in order to chart an authorized minimum clearance to convey available depth to the mariner. In addition to the engineering and biological aspects of an artificial reef, potential effects on maritime navigation and nautical charting must be considered. Accurate information allows NOS to verify that there are no conflicts with other charted features (i.e. safety fairways, anchorages, etc.). Consideration of NOAA charting requirements during the planning phase will make the permitting and charting phases more efficient for all stakeholders.

NOAA ENCs® are the primary navigational product of OCS. ENCs are updated weekly and provide the most current information; whereas paper/RNC updates may be one month, or more, behind the corresponding ENC coverage. By 2025, OCS will end production of traditional raster chart products (e.g. Print-on-demand [POD] paper nautical charts and RNCs). An alternative to current raster products, derived from the ENC, is under development (i.e. NOAA Custom Chart [NCC] https://nauticalcharts.noaa.gov/about/nav-cast.html#enc-based-paper).

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Artificial Reef Federal Regulatory Review Process

Lisa Lovvorn[1]

The Corps authorizes permits to deploy artificial reef material under Section 10 of the Rivers and Harbor Act and Section 404 of the Clean Water Act. Applicants are typically local government entities (cities or counties) due to insurance and liability issues. The Corps encourages pre-application meetings to discuss new reef sites or existing sites with applicants. See our website at https://www.saj.usace.army.mil/Missions/Regulatory/Office-Locations/for the appropriate Corps office. The proposed reef site should be depicted on the most recent NOAA chart and the navigational clearance indicated in the application and must not be situated in an area where there are conflicting uses of the aquatic resource, i.e. transit lane for shipping. Acceptable reef material needs to be durable and stable such as prefabricated modules of ferrous and/or aluminum-alloy metals, concrete, and rock. The Corps also authorizes vessel reef deployments. Deployed material(s) must not move on the submerged bottom or break up such that there would be a loss of benthic habitat. New or existing reef site(s) are noticed to the public by the Corps. During the permit process, the Corps consults with the National Marine Fisheries Service - Protected Resources Division and when appropriate, the U.S. Fish and Wildlife Service, under Section 7 of the Endangered Species Act. Artificial reef permits include special conditions to ensure deployed material does not harm endangered species or existing aquatic resources. Also, pre- and post-monitoring reports requirements are included as special conditions of the permit. Reports are sent to the Corps and Florida Fish and Wildlife Conservation Commission for compliance review. Permits are generally authorized for ten years and a valid permit is needed to deploy material.

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Mitigating Nearshore Hardbottom Reef Functions for Juvenile Green Turtles (*Chelonia mydas* Linnaeus 1758) in Waters Adjacent Florida's Brevard County Mid Reach

Karen G. Holloway-Adkins[1]

Sea turtle observation data were collected via vessel-based transects during and after the construction of juvenile green turtle-friendly artificial reefs deployed in the summers of 2017, 2018 and early 2019. Reefs were deployed in advance of the Brevard County Beach Restoration Project that began December 2019. At least one shallow (approximately 2.0 m water depth) and one deep (approximately 5.5 m water depth) transect were conducted each survey day. The 14.5 km long transects spanned the length of the waters adjacent to the Brevard County Mid Reach with control/reference areas. Sea turtle sighting data included: species (loggerhead or green turtle), life history stage, location (latitude/longitude), water column position and activity/behavior. The distribution of sea turtles on shallow vs. deep transects was similar during and after mitigation reef construction. Juvenile green turtles, while observed at both transect depths, were more frequently observed in shallow, nearshore transects (83.7%) over rock-dense reef areas. Adult and subadult loggerhead, and adult green sea turtles were only observed in the deeper, offshore transects and were predominantly sighted in and around mitigation reef sites. This study provides an opportunity to fill the paucity of available data concerning the efficacy of mitigation reefs to provide adequate resources (food and/or shelter, predator refuge) for sea turtles as well as compare sea turtle abundance and distribution data collected since 2003, prior to beach nourishment activities. Key future contributions include the determination of: (1) what features best mitigate for the loss of a habitat's function, (2) where competition might unexpectedly be created and/or (3) the effect of partitioning resources. Extracting as much information from this region, where study conditions are comparably more challenging than better-studied tropical habitats, could benefit many areas that will meet similar challenges to protect infrastructure in the face of sea level rise and coastal migration.

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Colonization of Brevard County Mid Reach Artificial Reefs by Epibiota and Fishes

David B. Snyder[1]

The colonization of artificial reefs placed off the Brevard County Mid Reach shoreline by epibiota and fishes was assessed during June and July 2019. Five of 10 reef sites were sampled for the first time since they were deployed 10 to 24 months prior to the assessment. Quantitative photographic samples revealed that the epibiota cover was dominated by turf, but also included macroalgae, sponges, tunicates, biotic turf, and other sessile taxa. Various motile invertebrates such as sea urchins (*Arbacia punctulata*), crabs (*Menippe* sp.), and gastropods were also recorded. The quantitative photographs identified the dominant substrate cover as sand veneer; a thin sand layer over the hard structure. Baited remote video cameras recorded a total of 17 fish species over the five reef sets. The most abundant species were pigfish (*Orthopristis chrysoptera*), hairy blenny (*Labrisomus nuchipinnis*), and sergeant major (*Abudefduf saxatilis*). Sheepshead (*Archosargus probatocephalus*), pigfish, sergeant major, hairy blenny, and yellow jack (*Caranx bartholomaei*) were observed in all video samples from all five reef sites. A qualitative list of fishes developed from all observations made during the survey included 33 species from 20 families. Adult and juvenile life stages were present for several species. Comparisons of epibiota and fish composition were made between Mid Reach natural reefs sampled from 2013 to 2019 and the 1-year post-construction artificial reefs sampled in June and July 2019.

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Overview of Port Everglades Artificial Reef and Mitigation Reef Programs

Erik Neugaard[1]

Located in Broward County/Fort Lauderdale, Port Everglades is the nation's leading gateway for trade with Latin America. It is also the primary source of fuel for eight million Southeast Floridians, the third largest cruise port in the world, and the twelfth largest freight port in the United States. Our mission statement is to achieve advancements focusing on efficient facilities, trade and cruise expansion, jobs growth, safety, security and environmental stewardship for our customers, stakeholders and community. Our economic activity value is $34 billion, involving more than 230,000 jobs of which 13,000 provide direct services to Port Everglades.

On June 22, 1982, Port Everglades commenced its artificial reef program with the deployment of the 60-meter AFDL-E floating drydock, at a depth of 67 meters in what is now permitted as the Port Everglades Artificial Reef Area. This artificial reef area, located 2.5 kilometers northeast of Port Everglades, consists of 133 hectares with a minimum authorized depth of 43 meters, and has received many subsequent deployments. This presentation will provide a brief history of the Port Everglades Artificial Reef Program and describe the GIS mapping of material deployed below recreational diving depths using LiDAR and side-scan sonar data.

On May 24, 2018, Port Everglades commenced construction of its first mitigation reef located approximately 1.5 kilometers east of Dania Beach at a depth of 11 meters. This reef consists of 5 conical boulder piles each approximately 15 meters wide and 4 meters high. Mitigation included the relocation of 814 corals colonies from the nearby Southport Turning Notch Expansion Project. Due to significant parrotfish predation it was necessary to install protective cages over each colony. This presentation will also describe the strategies and challenges of the reef construction and coral relocation and provide updated information relative to the past and planned coral mitigation initiatives.

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Transformative "Art"ificial Reef Project, 1000 Mermaids Artificial Reef Project

Shelby C. Thomas[1], Ernest Vasquez[2], Sierra Rasberry[2], Evan Snow[2], Chris O'Hare[2], and Stacy Brown[2]

Environmental changes have caused stress to and loss of more than half the world's reef building corals. Coral cover is now only 10%-20% worldwide with the Caribbean losing 80% of its coral cover in the last 50 years. Reef degradation and habitat loss will continue to compromise many marine species and local economies. Innovative solutions which create continuous complex habitat such as artificial reefs are needed to assist in maintaining and restoring these vital ecosystems.

The 1000 Mermaids Artificial Reef Project is a transformative art project that takes a multidisciplinary approach to changing public perception on restoration and conservation through art. Eighteen Hand casted mermaid sculptures have been placed as a network of artificial reef modules in South Florida with permitting approved to deploy more in Broward & Palm Beach Counties in 2020. The 1000 Mermaids Project appeals to & networks with local businesses, artists, citizen scientists, environmental stewards, and social influencers with the result of connecting sustainable solutions that will assist in effective reef restoration.

The project's innovative artificial designs promote micro and macro habitats which create more biodiverse fish community structures and recruitment for coral and other marine life. This project also intimately connects humans with the ocean providing a deeper sense of responsibility for our marine environments.

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An Offshore Behavioral Contingent of an Estuarine Fish Population, Common Snook (*Centropomus undecimalis*)

Erick Ault[1], Derek Cox[1], and Sarah Webb[1]

Adult common snook are historically thought to be estuarine residents that make regular trips to inlets and passes in summer and early fall to spawn, then move into rivers and deep channels during late fall and winter for foraging opportunities and thermal refuge. However, recent research has demonstrated that the spatio-temporal patterns of common snook are more complex than this paradigm suggests and that behavioral contingent groups occur in a variety of habitat systems. Employing a three-part approach over five years of data collection, this study utilized a combination of underwater visual observations, specimen collections, and acoustic telemetry to document and describe a population of snook in Southeast Florida that utilize offshore habitat. A contingent group of these typically estuarine fish was found to reside offshore year-round as mature adults and frequently in large shoals (up to 225 individuals) from Fort Pierce to Jupiter. Throughout this study, snook were documented up to 20.4 km from an inlet and 14.4 km offshore in waters up to 36.6 m deep. These snook were present in 75% of surveys conducted on artificial reefs, while only being found on 24% of surveys of natural reefs. The lack of juveniles offshore indicates they likely rely on immigration from inshore populations, although the transition to becoming an offshore resident is not yet clear. From June through September, 89.1% of fish sampled from offshore reefs were spawning capable, with some classified as actively spawning (15.8%) and thus potentially contributing to the population via larval transport into the estuary. Additional research on this contingent population may provide crucial information to better understand the biology and life history of snook in Florida and help to make informed management decisions.

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One Fish, Two Fish, Ten Years of Huge Fish: The Great Goliath Grouper Count

Angela Collins[1], Bryan Fluech[2], H. Abeels[3], Elizabeth Carnahan[3], Joy Hazell[3], Shelly Krueger[3], Rick O'Connor[3], Betty Staugler[3], John Stevely[3], and Ana Zangroniz[3]

Following decades of overfishing, harvest of Goliath grouper *Epinephelus itajara* in U.S. waters was prohibited in 1990. The Goliath grouper population in Florida has responded well to protective measures and numbers have been rebounding since the moratorium; however, the lack of landings data confound traditional stock assessment efforts. Comprehensive population assessment remains complicated and the full extent of recovery throughout their geographic range is not fully understood. Fishery managers therefore rely on a suite of fishery-independent data to inform regulatory policy for this species. Goliath grouper have strong site fidelity, and are most often associated with structurally complex habitats including artificial reefs, making them an excellent candidate for visual surveys and diver monitoring programs. Florida Sea Grant and the Florida Fish and Wildlife Conservation Commission (FWC FWRI) initiated the "Great Goliath Grouper Count" in 2010. This annual citizen science event coordinates scientists with volunteer divers to provide data as related to the recovery of Goliath grouper. During the first two weeks of June, volunteer divers donate their time and vessels to count Goliath grouper at specified artificial reef sites around the state. Over the past ten years, 633 surveys have been submitted and participating divers have spent over 290 hours under water! This coordinated data collection over a broad geographic area within a relatively short time frame provides an efficient and cost-effective way to obtain information on "data-poor" species. Long-term data series such as the Great Goliath Grouper Count have the potential to be especially informative, and it is the goal of this project to provide data that will assist policy makers in future management efforts related to this species.

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Effect of Location, Design and Development Time on Fishes Associated to Artificial Reefs in Santa Marta region, Colombian Caribbean

Oscar Delgadillo-G[1], Laura C. Franco-L[1], and Luz H. Gualdrón[1]

Santa Marta region is a highly touristic place with an intense port activity for coal and hydrocarbon trade, as well as a large community of artisanal fishers. Natural habitats and fishery resources have been affected by those and other coastal activities, therefore actually reveal signs of environmental degradation. Artificial reefs (AR) have been deployed with different purposes and locations representing an opportunity to assess the effects of location, design, and development time in the biodiversity and its potential for management. Fishes assemblages were assessed through random visual census in regular time intervals in: six cubic (4.5 x 4.5 x 4.5 m) and six pyramid (3 x 3 x 2.8 m) steel pipe reefs deployed in Pozos Colorados Bay in 2013 and 2015 respectively, as well as in 10 bucket concrete reefs of 1 m^3 installed in 2014 and an old cargo shipwreck of 30 m long with 30 years sunken in the Bay of Gaira. Descriptive and inferential univariate and multivariate statistics were used to compare fishes assemblages in terms of richness and abundance. A total of 108 species and 11516.5 individuals were recorded, including ten endangered. Concrete and shipwreck reefs showed higher richness average, while the mean abundance was superior in the wreckage and steel pipe AR1. Differences (ANOVA: $p < 0.01$) and segregation of the assemblages (NMDS by abundance, stress = 0.1) were found for the proposed factors, suggesting that fishes communities were chiefly modulated by high complexity (volume and design) and development time, as well as location related with nearby natural habitats. The high diversity of fishes in these artificial reefs and its potential contribution to conservation and protection purposes, should be included in the environmental plans of the region, in order to promote sustainable interventions and reliable economic opportunities for coastal communities.

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Passive Acoustic Monitoring of Artificial Reef Sites Reveals General Boat Traffic Patterns (but not Fishing Effort) in the Northwest Florida Gulf of Mexico

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We used passive acoustic monitoring (PAM) to investigate boater behavior on thirteen sites in Northwest Florida where artificial reefs have been or will be constructed, with the goals of improving our ability to monitor and manage recreational use of artificial reefs. Hydrophones attached to underwater dataloggers recorded acoustic information at various sites from February 2017 to May 2019, and we developed automated algorithms to differentiate vessel noise from ambient oceanic noise and biological sounds in the acoustic data. Analyses showed that, unfortunately, our algorithms were unable to distinguish between boats that actually stopped to use an artificial reef from boats simply transiting past a site at high speeds. However, there are multiple indications that we are able to accurately identify general patterns of boating behavior in the Northwest Florida Gulf of Mexico. We detected more boats on weekends and holidays than on weekdays, more boats in summer months than in winter months, and more boats on calm days than on windy days. These results corroborate local knowledge of boater patterns in the region, suggesting that our algorithms can reliably detect high-speed vessels traveling within hundreds or thousands of feet of a hydrophone. While we could not identify boats making use of individual artificial reef sites, PAM remains a cost-effective form of data collection with great potential for improving monitoring and management of the marine environment, including artificial reefs. We are continuing to explore ways to develop this technology in order to eventually quantify recreational angler activity on artificial reefs.

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Evaluation of the Successional Stages of the Sessile Biota on Artificial Reefs of Pozos Colorados Bay, Colombian Caribbean

Laura Franco-L[1], Oscar Delgadillo-G[1], and Luz H. Gualdrón[1]

In 2013 and 2015 six cubic (4.5 x 4.5 x 4.5 m) and six pyramidal (3 x 3 x 2.7 m) artificial reefs of steel pipe were deployed in Pozos Colorados Bay aiming conservation and tourism purposes to support the economy of local communities. To evaluate their potential to create suitable habitat for marine species, during 2016 the sessile biota was assessed in four reefs of each design. Through the disposition of quadrants of 0.5 x 0.5 m randomly localized over the structures at different angles, photographs were taken and analyzed with Coral Point Count (CPCe) to obtain coverage percentage, richness and ecological descriptors. Univariate and multivariate analysis were performed to test for differences in design, time from deployment and location. The sessile assemblages were composed by 14 main categories of nine phyla and 40 secondary components, dominated by hydroids (43 %), bryozoans (34 %), and octocorals (15 %). The 2013 structures presented higher richness (17 to 26) compared to 2015 (12 to 16). Statistical differences were evident among reefs according to Kruskal-Wallis test and NMDS (stress = 0.01). Among the species, an octocoral and seven ascidians represented new records to the Colombian Caribbean biodiversity. The actual stage of the sessile biota suggests an initial succession pattern with pioneer and opportunistic filtering species favored by turbid waters and accelerated settling and reproduction rates. The coverage of these groups changed in relation to time and biological growth, increasing the diversity of minor groups such as ascidians, sponges, bivalves and solitary hard corals in the older reefs. The impact of the artificial reefs in the diversification of barren soft-sandy bottoms, creates habitat and biological productivity that could support diverse assemblages for conservation and touristic alternatives, and also function as effective tools for biodiversity evaluations.

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A Hydroacoustic Spatial Evaluation of the Effective Area Sampled Baited Underwater Camera Surveys in the Eastern Gulf of Mexico

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Stereo Baited Remote Underwater Video arrays (S-BRUVs) provide fisheries-independent, multi-species relative-abundance and length-frequency data for stock assessments and ecological studies. The Florida Fish and Wildlife Research Institute (FWRI) and other organizations worldwide have used S-BRUVs to quantify aquatic and marine organisms associated with a range of habitats for decades. Despite the increasing popularity of S-BRUVs, more information regarding the area and total biomass sampled are needed to assess whether absolute abundance estimates can be generated from S-BRUV data. As an initial step towards addressing these information gaps and increasing the utility of data provided by S-BRUV surveys in the eastern Gulf of Mexico, we evaluated the fish re-distribution in relation to S-BRUV presence. A vessel-mounted hydroacoustic array equipped with calibrated, split-beam 38 and 120 kHz Simrad Ek80 transducers was used to survey 41 transects (375 x 375 m) centered around sampling sites before and during camera deployments at multiple natural and artificial habitat types in waters 10–91 m depth. Mean volume backscatter and target strength estimates were used to calculate fish densities within 5-m horizontal intervals along the survey track for the lower water column. Fish density data were mapped in relation to S-BRUV deployment site and proximate reef habitats. Distances from the S-BRUV site were examined as a factor influencing density patterns. Average density per distance bin were exported to compare trends before and during S-BRUV deployment. Overall trends were variable between fish densities before and during the S-BRUV soak as well as distance from the site, however there were consistently higher fish densities over natural habitats versus artificial habitats. Hydroacoustics offer promise to quantifying biomass distributions (i.e., fishes) in proximity to baited camera systems.

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Spatial Dynamics of the Quantity and Quality of Natural and Artificial Reef Habitats in the Eastern Gulf of Mexico

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Since 2010, the Florida Fish and Wildlife Research Institute has conducted habitat mapping to support reef fish survey efforts in the eastern Gulf of Mexico. Through 2018, more than 4,400 randomly-selected surveys (each approximately two km^2) have mapped more than 7,700 km^2 of seafloor using side scan sonar. Following standardized protocols, side scan sonar imagery was processed prior to manually identifying and delineating polygons encompassing individual reef features. To date, 33 unique habitat classes have been identified, including a wide diversity of natural and anthropogenic reef types. Overall, 97.1% of the total area mapped was comprised of non-reef, unconsolidated sediments. Of the 222.4 km^2 of reef habitat classified, 60.7% (134.9 km^2) was comprised of flat hard bottom, characterized by generally low-relief (less than 0.1m), hard substrate often colonized by attached biota. Unidentified artificial reef habitat was the most common anthropogenic reef type delineated (greater than 2,700 polygons totaling 0.2 km^2). Over 67% of all artificial reef features identified were located within the Florida Panhandle. While the primary objective of mapping efforts is to inform habitat-based reef fish surveys, the randomized design employed represents the largest scale habitat mapping effort conducted in the eastern Gulf of Mexico to date and allows for broad-scale inferences into reef habitat composition and coverage throughout the region.

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Fish Monitoring at Three Shallow Estuarine Artificial Reefs in Sarasota Bay, Florida

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The Sarasota Bay Estuary Program was awarded an FWC artificial reef monitoring grant in 2016 to document the ecological use and diversity of three shallow artificial reef sites within Sarasota Bay, Florida. The project consists of 1) collecting side-scan sonar mapping, and 2) reef fish census data on three different reef module designs deployed in the summer of 2013. The reef fish census data compares species preference, abundance, diversity, and richness between different module designs within the permit sites. Side-scan sonar mapped the seafloor and artificial reef materials within each permitted reef site. Reef fish surveys, consisting of 1) baited remote underwater video stations (BRUVS) and 2) underwater visual census (UVC) characterized and compared fish abundance, species richness, and composition at artificial reef locations.
Six sampling events are planned. Three events were completed before a severe red tide in 2018 decimated fish population throughout the bay. Monitoring is resuming in February 2020 after fish populations have recovered. Pre red tide monitoring data are presented and showed a diverse fish assemblage at each reef site. In particular, juvenile gag grouper were found to use the "deep cover" reef modules which were designed to target this valued species.

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Assessment of PCB accumulation in reef fish collected on the Oriskany Reef

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The Oriskany Reef, a decommissioned US Navy aircraft carrier, was deployed 23.5nm southeast of Pensacola at a depth of 212 ft in May 2006. The Navy was permitted by the US Environmental Protection Agency (EPA) to allow an estimated 722 pounds of non-liquid PCBs (distributed in wiring, insulation, paint and gaskets) to remain on board the vessel when sunk as an artificial reef. Annual reef fish monitoring by FWC and Escambia County is required as a condition of the EPA permit to measure the local accumulation of PCBs in reef fish. Tissue analysis from this monitoring indicated that reef fish species have different accumulation rates of PCBs, most likely influenced by their life history, diet, and location on the vessel. As tissue samples continue to exhibit PCB values greater than the 20 ppb threshold set by the EPA, monitoring of those specific fish species with high PCBs levels will carry on.

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SMART Reef™ Innovative Approaches to Artificial Reef Systems

Victoria Odena[1] and Mike Herman[1]

The enrichment of U.S. coastlines has become increasingly vital as a huge portion of our citizens rely on them. An ideal coastline prevents storm hazards and promotes favorable financial, recreational and environmental conditions. The SMART Reef™ (SR™) teams' mission is to improve our coasts using multiple methods utilizing artificial reef systems.

Our reefs are comprised of (SR™) Rock; a porous, primarily calcium carbonate, rock material formed from mined coral skeleton. This unique substrate presents a bio-available source for growth and an ideal settlement area for coral larvae and spat. The structure of the reef further aids shoreline expansion by allocating near shore sediment deposition, using wave attenuators, and a decrease of onshore wave energy.

The depletion of oyster populations has also been incredibly detrimental to healthy coastlines, especially since oysters significantly enhance water quality. The reduction of oysters at unsustainable rates is largely due to loss of habitat and invasive Drill Snail species, which feed on oysters. For this reason, the (SR™) team designed drill snail traps to place near vulnerable oyster communities. We've also created Bioloading LED Devices (BLD) for the reefs which attract phytoplankton and facilitate an immediate bioloading effect.

Our team understands the importance of public interest. Therefore, project areas will be designed in a way to promote tourist destinations, such as providing beautiful scenic boardwalks built on top of the reef structures. These attractions grant local economies an overall increase in real estate and revenue. This approach immerses the public into the project and also motivates educational opportunities.

The (SR™) teams mission is to save our coasts and waterways through our unique artificial reef systems. Our methods focus on creating and implementing sustainable reef habitats which inherently produce strong, stable and functioning coasts.

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Creation of Hard Bottom Habitat: The Texas Artificial Reef Program is Giving Nature a Helping Hand

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The ecological and economic effects of the 2010 *Deepwater Horizon* oil spill were far-reaching across the five Gulf of Mexico (GoM) states. The impacts to coastal Texas were largely from lost fishing and diving recreational activities. These activities were impacted because the few charter vessels available were diverted to Louisiana waters to assist with clean-up efforts or provide berthing for workers. In April 2011, a Natural Resources Damage Assessment (NRDA) resulted in BP agreeing to provide funds toward Early Restoration Projects in which injuries to natural resources and services caused by the spill could be addressed. Some of these NRDA funds were distributed to the Texas Artificial Reef Program for the purpose of creating three artificial reef enhancement projects to mitigate against the lost value to recreational fishing and diving opportunities. The projects included: (1) the Ship Reef Project, in which the *Kraken* – a 371-ft long cargo carrier – was sunk in 136 ft of water to create an offshore artificial reef; (2) the Freeport Artificial Reef Project, in which 800 prefabricated concrete pyramids (height, 8 ft; base, 10 ft) were added to the nearshore George Vancouver Liberty Ship reef site in 55 ft of water; and (3) the Matagorda Artificial Reef Project, in which a new nearshore reef was created from 1,600 pyramids deployed in 60 ft of water. Here we highlight some of the biological recruitment data obtained from the *Kraken* ship reef since the installation in 2017.

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A Preliminary Comparison of Red Snapper Utilization of Artificial and Natural Reef Habitats between the Gulf of Mexico and the U.S. South Atlantic

Richard Paperno[1], Russell B. Brodie[2], Justin J. Solomon[2], Heather M. Christiansen[3], Brent L. Winner[3], and Theodore S. Switzer[3]

The benefit of artificial reefs has been a long debated topic between fisherman, scientists, and resource managers, and centers on the question of whether artificial structures aid reef fish stocks by creating more overall biomass as a result of increased habitat availability, or whether these structures simply relocate the existing biomass to a location that is more easily accessible to the fishery. Regardless, with the increased deployment of artificial reefs in the Gulf of Mexico (GOM) and the U.S. South Atlantic (SA), it is apparent there is a need to better understand how these two reef habitats function in support of reef fish communities. To begin to evaluate to what degree key population metrics (e.g., relative abundance, size/age composition) may differ between artificial and natural reef habitats as well as between regions, we conducted a preliminary comparison of habitat utilization for Red Snapper collected during FWC fisheries-independent hooked-gear surveys in 2017 and 2018 in the GOM and the SA in water depths <30 m. Over the two-year study period, 151 sites [93 natural hard-bottom (HB) and 58 artificial reefs (AR)] were sampled in the GOM and 195 sites (159 HB and 36 AR) sampled in the SA. To our knowledge, this is the first study to quantify whether regional differences exist in regards to catch-per-unit-effort and the size/age structure of Red Snapper on artificial and natural reef habitats. As most fishery-independent surveys providing data for the assessment of Red Snapper exclude AR habitats, it is becoming increasingly essential to assess whether key population metrics differ between AR and HB habitats. Should these metrics differ markedly, the accuracy of population metric estimates used to evaluate stock status may be improved upon by incorporating artificial reef habitats into ongoing surveys.

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A Survey of Epifaunal Communities on Artificial Reefs in Tampa Bay

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The epifaunal communities on three artificial reefs in Tampa Bay were surveyed in spring and fall 2016 in order to evaluate the current condition of these reefs and to compare results with a previous survey conducted in 2004. The three reefs represented different locations along the estuarine salinity gradient in Tampa Bay. Each reef was sampled during April-May 2016 and August 2016 to document seasonal changes in the epifaunal community as well as differences between reefs within each season. Ten samples were collected per reef during each sampling event by SCUBA divers using a 16 cm x 16 cm area epifaunal sampler. Epifaunal species were sorted and identified to the lowest practical taxonomic level and counted. Wet weight biomass was also measured for larger specimens and colonial organisms. Results showed seasonal changes in the species composition, with the oyster Ostrea equestris dominating the community in the spring while barnacles were dominant in the fall. Spatially, species richness increased with the salinity gradient. Comparison with the 2004 study showed changes in the epifaunal community with a decrease in the abundance and biomass of the invasive Asian Green Mussel, Perna viridis, which was dominant in 2004 but was nearly absent in 2016. The epifaunal community was primarily influenced by salinity and temperature with salinity influencing spatial distributions and both temperature and salinity affecting seasonal trends.

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Assessment of Artificial Reefs in the Direct Path of a Major Tropical Cyclone

Jeffrey Renchen[1], Keith Mille[1], and Christine Kittle[1]

On October 10, 2018, Hurricane Michael made landfall in Mexico Beach, Florida with maximum sustain winds of 160 mph and storm surge exceeding 10 ft in height. Hurricane force winds extended an estimated 30 miles from the eye, encompassing 650 artificial patch reefs. Using high resolution pre-storm side scan sonar mapping completed in September 2017, post-storm side-scan and dive observations were conducted during January 2019 to assess impacts within two artificial reef permitted areas within the hurricane path. The Bell Shoals permitted area represented the most susceptible area to storm impacts due to its shallow depth (20 ft) and close proximity to shore (2 nautical miles offshore), while the Sherman permitted area is deeper (60 ft), 8 nautical miles offshore, and closer to the path of Hurricane Michael. No damage or movement was observed within either permitted area for four of the five types of artificial reef structures (concrete culverts, dome-shaped modules, modules on pilings, and box-shaped modules), although significant sand movement resulted in some of those becoming uncovered or buried. Analysis of the 8 ft tall concrete tetrahedrons in the shallow Bell Shoals area found that 65% of all tetrahedrons moved further than 150 ft from their original location with the mean distance moved of 803 ft. Dive inspections of twelve tetrahedrons that moved found that all were toppled but only one was damaged. While the Bell Shoals tetrahedrons that have moved may be more challenging for anglers to locate initially, the more widespread distribution provides an overall increase in distinct patch reefs for fishing destinations throughout the site. The long-term effect of the new reef configuration on local fish communities is unknown, but we expect the change in forage area and available ledge space to alter fish behavior and species diversity. Events like these highlight the necessity of baseline physical, biological and human use monitoring.

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Comparing the Ecological Effects of Casitas to Natural Reef Structures on the Benthic Flora and Fauna in the Florida Keys

Erica P. Ross[1], Jack Butler[1], Thomas R. Matthews[1]

Artificial shelters, called casitas, are used widely in the Caribbean to facilitate the harvest of lobsters by divers. However, their ecological function remains largely unknown. Research on the effect of casitas conflict on whether they serve as crucial habitat for lobsters within shelter-limited regions or as ecological traps for juveniles. As part of our charge to understand the impacts of different fishing gear on the ecosystem, we examined benthic habitat distribution, and fish and motile invertebrate abundance and diversity at casitas, large boulder corals, and control plots. Casita exhibited similar habitat and halo features (i.e., decreased algae cover and an increase of bare substrate) to those near coral heads. Ordination of fish communities indicated no difference between casitas and corals, yet control plots were significantly different from both. Invertebrate communities exhibited similar trends seen in fish communities, with the exception of lobsters. Lobsters were found in significantly higher abundance at casitas than either corals or control areas. Ecologically, casitas appear to function similarly to corals within shelter limited regions, and may be efficient dual-purpose devices; that is, they function not only as habitat and fauna restoration tools, but also as lobster fishing gear.

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Miami-Dade County Artificial Reef Program Re-Evaluation of Module and Boulder Reefs

Sara Thanner, Rebecca Ross, Michael Greenemeier, and Jenna Soulliere

For decades, limerock boulder and module artificial reefs have been deployed offshore of Miami-Dade County for a variety of purposes. Seven of these artificial reefs were evaluated from 2007-2009 and again in 2019. Five reefs (PMBP, PMBR, SIMB, SIMM, and PMAM) were constructed with a broad goal to serve as mitigation for dredging related impacts. One reef was constructed for fishery enhancement (ANCB) and one for both fishery enhancement and recreational diving opportunities (GDBB). All seven artificial reefs provide habitat that supported abundant and diverse biological assemblages and met the broad objectives for which they were deployed. The density of the fish increased in 2019 on ANCB, GDBB, and PMAM largely due to the abundance of grunts, namely *Haemulon aurolineatum* (tomtates), and decreased on the other sites due to fewer grunts and gobies. Other common reef fish families in both monitoring periods were snappers, wrasses, damselfish, and parrotfish. In general, more gamefish species were observed on the higher relief boulder reefs—GDBB, ANCB, PMBR, and PMAM. However, of those gamefish species regulated by size, only a few individuals were of legal harvesting size. In both monitoring periods, benthic assemblages on all seven artificial reefs were dominated by turf algae coverage followed by soft coral on PMBP and PMBR and sponge species on the other five sites. Soft coral cover increased in 2019 on six of seven sites. Hard coral cover increased on all sites except PMAM which had a nearly 3% decline due to loss of Oculina diffusa. Both boulders and modules can provide suitable substrate for benthic assemblages but could be tailored toward modules if porifera cover is a priority. If fisheries enhancement is the project goal, higher relief boulders would be preferable and placing a large material footprint may minimize the dominance of large schools of grunts.

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Escambia County Concrete Tetrahedron Patch Reefs: Opportunities for Artificial Reef Research

Robert Turpin[1], Madison Williams[1] and Keith Mille[2]

One of the greatest challenges for artificial reef research is a sufficient number of replicated reefs to conduct rigorous statistical analysis. With a few notable exceptions (Bortone, Lindberg, et al, and others), artificial reef research budgets do not include sufficient funding to construct reefs in an experimental design. Researchers are often faced with a limited number of reefs of identical dimensions within a given area.

In response to this challenge, Escambia County Marine Resources Division (MRD) obtained permits for a large (nearly 9 square nautical miles) artificial reef site in the northeastern Gulf of Mexico (Figure 1). Escambia South-East Reef Site (ESERS) is located approximately 8.5 nautical miles south of Pensacola Beach with water depths of 80-100 feet. MRD utilized GIS to create 572 grid areas (approx. 250, 000 square feet each), within which artificial 132 “patch reefs” have been deployed (Figure 2.) Each patch reef consists of one large concrete tetrahedron and two small concrete tetrahedrons. Large tetrahedrons are 16 feet along each base dimension and 15-18 feet tall. Funding for the construction of these patch reefs was obtained through FWC from Natural Resources Damages Assessment (NRDA) resulting from the Deepwater Horizon oil spill.

These concrete tetrahedron patch reefs provide an experimental design of sufficient replication for testing hypotheses related to artificial reef ecology. MRD, FWC and others may utilize these reefs to conduct various artificial reef research objectives. Although these NRDA-funded artificial reefs were intended to restore fishing and diving opportunities lost during the 2010 Deepwater Horizon oil spill, the large number of replicated “patch reefs” are available for scientific study to answer important questions about artificial reefs and their role in fisheries management.

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