

**Bonefish
& Tarpon
TRUST**



6TH INTERNATIONAL SCIENCE

SYMPOSIUM

Bringing internationally recognized scientists and resource managers together with the angling community to collaborate in conservation



November 10-11, 2017

The Bonaventure Resort • Weston, FL



6TH INTERNATIONAL SCIENCE
SYMPOSIUM

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Spotlight on Science-based Approaches

Welcome to the 6th International Science Symposium! Your participation is a wonderful expression of your commitment to the conservation of our flats fisheries.

This gathering more than any other shines a bright spotlight on BTT’s mission and science-based approaches to conservation. Thanks to the tireless efforts of our Symposium Planning Committee, Co-chaired by Jeff Harkavy and Bill Stroh, we have an excellent program in store.

BTT is frequently cited as the organization that “punches above its weight,” which is made possible in no small measure by the world-class scientists who collaborate with us in conducting vital research. In this way, our organization is able to greatly amplify conservation outcomes through science-driven solutions. As in the past, science will be the centerpiece of the Symposium with a full schedule of interesting presentations.

You will also find panel discussions featuring the application of science to conservation as well as sessions on angling, fly-tying, adventure travel, photography, and so much more, including our first Flats Expo. Capping off our time together will be a very special banquet and awards ceremony, honoring BTT founders Tom Davidson and Russ Fisher, and bestowing the Curt Gowdy Memorial Media Award on Chris and Amy Dorsey for bringing us outstanding outdoor adventure programs on television.

We hope you will find these two days informative, fun and inspiring, and return to the flats with even greater resolve to protect and conserve our fisheries. On behalf of the BTT Board and staff, we appreciate your interest and support, and we are glad you are here!

Harold Brewer
Chairman

Jim McDuffie
President



Our Mission:

To conserve and restore bonefish, tarpon and permit fisheries and habitats through research, stewardship, education and advocacy.

With the support of our members, partner organizations, and corporate sponsors, BTT has....

- Worked with Florida's Fish and Wildlife Conservation Commission and anglers to implement catch-and-release-only regulations for tarpon and bonefish.
- Assisted the Bahamas National Trust in establishing 6 nationally protected bonefish conservation zones in the Bahamas.
- Created the first-ever permit-tagging program in Florida, Belize and Mexico, and improved permit fishing regulations in Florida.
- Conducted bonefish studies in Florida, the Bahamas, Mexico, Belize and Cuba that are being used to develop habitat and fisheries protections.
- Launched a collaborative Juvenile Tarpon Habitat Initiative to identify, protect and restore juvenile tarpon habitat.
- Mapped critical flats fishing areas in the Florida Keys that are helping to guide management strategies of the Florida Keys National Marine Sanctuary and Everglades National Park.
- Completed a tarpon genetics project in the Atlantic, Gulf of Mexico, and Caribbean, which will better guide our conservation of the fishery.
- Launched the largest study ever undertaken in bonefish reproductive science—a project designed to develop new tools for bonefish restoration.
- Launched the "Fix Our Water" campaign to inform and engage anglers in Florida's ongoing water management crisis.
- Worked with the state of Florida and governments of other countries throughout the Caribbean to protect multi-billion dollar recreational fisheries.

Bonefish & Tarpon TRUST



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Bonefish & Tarpon Trust

Celebrating 20 Years

Bonefish & Tarpon Trust traces its beginnings to 1997, the year that Tom Davidson and a small group of like-minded friends—Russ Fisher, Dick Farmer, Roe Stamps, Mike Smith, and Joel Shepherd—first became concerned about the declining bonefish population of the Florida Keys. Resolving to learn more about the causes behind the decreasing numbers of fish, each angler put \$10,000 “into the pot” for what became BTT’s first research endeavor—a contract with the University of Miami to search prior bonefish studies and existing knowledge for answers. Their aim was to compile what was known about bonefish and to initiate a tagging program to collect baseline data on population and behavior.

Early on, this small circle of friends concluded that if anything meaningful was to be accomplished, a group larger than six people would be needed to shoulder the responsibilities of research, fundraising, and outreach. Bonefish and Tarpon Unlimited (BTU) was thereby formed in 2000, and immediately set about to enlist the help of others. Jeff Harkavy, a Founding Director and initial member, played an instrumental role in contacting and soliciting a large number of early supporters. He also encouraged Bill Curtis, who was considering a similar effort for a tarpon study, to join forces with BTU.

Within a few months, more than 60 people representing the “Who’s Who” of saltwater flats fishing had joined the BTU board as founding members, and BTU held

its initial organizational meeting in February 2000. Rather than having a fixed list of directors, BTU established a flexible board, comprised of a large and interested group of supporters. This approach served the organization well and was helpful in energizing and rallying many friends and advocates to the cause.

Those who played significant roles in establishing the organization and guiding it through the early years included Davidson, Fisher and Harkavy, Stu Apte, Sandy Moret, Jeff Wilson, Billy Pate, George Hommell, and Jack Curlett. By this point, BTU was organized to pursue its important mission: “To conserve and enhance global bonefish, tarpon, and permit fisheries and their environments through stewardship, research, education and advocacy.”

The board was tasked with initiating the first research projects while also building public awareness and recruiting members. Early research projects focused on bonefish tagging to collect data on population size, size, growth, and range of movement; and the use of satellite tags, which at the time was experimental technology, attached to large tarpon to learn more about their migration patterns. The board was also responsible for building the membership base and raising the funds needed to make this work possible.



Standing L-R: Joel Shepherd, Billy Pate, Raleigh Werking, Stu Apte, Jeff Harkavy, Doug Hannon, Robert Humston, Chico Fernandez, Jack Curlett. Seated L-R: George Hommell, Jeff Wilson, Tom Davidson.

Russ Fisher became Chairman of the Research Committee and subsequently Vice Chairman of the Board. Around the same time, Doug Kelly, an outdoor writer and editor, was hired as a part-time executive director to grow the organization’s membership base. As BTT grew, it continued to attract more members, not just in Florida, but scattered across the country and around the world. Later efforts would result in expanded outreach through events in major cities, angler trips,

membership drives with improved benefits, and corporate partnerships with angling and boat companies.

In its fourth year, BTU held a Research Symposium, chaired by Jeff Harkavy, to encourage anyone who was involved in related research to come together. The event was sponsored by Bass Pro Shops and Florida Fish and Wildlife Conservation Commission (FWC), and provided a platform for scientists to showcase their work and findings. The first symposium was a success, with more than 20 participant scientists and a large group from the general public in attendance. Three years later, a second symposium was held with an even larger base of 35 scientists participating, which demonstrated the significant progress BTU had made since its founding six years earlier, when there was no one actively involved in bonefish or tarpon research.



Standing L-R: George Hommell, Jeff Harkavy, Joel Shepherd, Stu Apte, (?), Chico Fernandez, Rufus Wakeman, Doug Hannon, (?), Russ Fisher, Robert Humston, Jack Curlett, Curtis Bostic. Seated L-R: Billy Pate, Jeff Wilson, Henry Carmotto, Dr. Jerry Ault, Tom Davidson, Sandy Moret.

Dr. Aaron Adams began doing project work with BTU in 2003 and became part-time director in 2006. One of his early contributions was creation of the “Research Frameworks” (later known as the “Research Matrix”) in 2007. The Research Matrix enabled BTT to prioritize research funding to maximize conservation benefits.

In 2006, BTT partnered with the Fisheries Conservation Foundation to form the Flats Fishing Alliance. The Alliance identified research projects for funding (such as the important work on bonefish catch and release), and held a workshop, chaired by Dr. Adams and Dr. Dave Phillipp, to further refine and prioritize future research needs, at the 3rd Research Symposium in 2008.

In 2009, the organization was energized by the additions of Matt Connolly and Bill Klyn to the Executive Committee of the board, and by Connolly’s subsequent appointment as BTT President. At the same time, Dr. Adams became the full-time Director of Operations. This allowed the organization to lengthen its stride considerably, which was reflected in a change of name to Bonefish & Tarpon Trust (BTT). Bill Klyn’s involvement also brought the important corporate support of Patagonia to the organization, which was instrumental in enabling BTT to expand its donor base through special marketing campaigns featuring Patagonia products and incentives.

Bill Klyn, Chris Dorsey (Dorsey Television), and Michael Cassidy of ESPN jointly conceived the idea of a sporting show featuring celebrities bonefishing at some of the Caribbean’s famous lodges. The program attracted a substantial following in its inaugural year. BTT’s heightened visibility, in combination with a membership sweepstakes featuring a donated Hell’s Bay skiff, led to further growth in membership and greater awareness of the organization. The show continues today on the Outdoor Channel under the name of *Buccaneers & Bones* with many of the original participants—Lefty Kreh, Bill Klyn, Yvon Chouinard, Tom Brokaw, Tom McGuane, and Michael Keaton. Now in its eighth season, other celebrities have joined the cast, including Huey Lewis, Jimmy Kimmel, Liam Neeson, and Jim Belushi, among others. The series still generates meaningful exposure for BTT.

In 2010, BTT published its first journal. The popular and well-received publication quickly became an annual magazine highlighting research and conservation of bonefish, tarpon, and permit. The circulation in the first year was 2,500. By 2015, it had increased to 15,000 and become a recognized, widely acclaimed calling card for BTT. In 2017, BTT began publishing two issues of the journal per year with estimated circulation of 20,000.

In 2009, as part of the Flats Fishing Alliance, BTT began to broaden its scope as an active science and policy participant in Bahamian fisheries. At the same time, BTT expanded projects to Cuba, Belize, and Mexico. The research and conservation programs focusing on permit in Mexico became well established thanks to the assistance and generous support of Allen Gant and Costa Del Mar. BTT’s message and the importance of the organization’s work to conserve bonefish, tarpon, and permit was now truly international and gaining strength.

In recent years, BTT has been involved in applying its scientific credibility to policy and regulation advocacy in Florida and throughout the Caribbean. This included establishing a permanent office in the Florida Keys in 2012, in the Bahamas in 2014, and formalizing partnerships in Cuba, Belize, and Mexico. BTT has expanded its work

with the FWC to revise and improve regulations for bonefish, tarpon, and permit, and to conduct joint studies on all three species. BTT continues to work with FWC and agencies in other states and at the national and international levels to improve the conservation regulations for bonefish, tarpon, and permit.

In 2010, several fishing tournaments held in the Keys and Carolinas began identifying themselves with BTT's efforts by donating a portion of their revenues to the cause and contributing to research efforts. The March Merkin tournament has been especially supportive of BTT's mission. Through the efforts of Dave Horn and the late Jon Ain, the tournament has become a major annual contributor to the organization.

During the period of 2012 – 2014, BTT was successful in growing its funding base, which provided the support needed to expand the number, size and scope of scientific projects. A major driver in this financial expansion was the addition of special events led by board members and volunteer committees in Boca Grande, Naples, New York, Chicago, the Florida Keys, and Jackson Hole, WY. These events received significant support from lodges that donated trips for event auctions and from corporations, including Frontiers, Orvis, Maverick, and Hell's Bay.

The inaugural Keys event celebrated the memory of important Keys conservationist, guide, and businessman George Hommel Jr. This sold-out event was held at World Wide Sportsman and was supported by a significant lead donation by Johnny Morris and Bass Pro Shops. This event has become an annual gathering on the Islamorada social calendar.

The 5th International BTT Symposium was held in November 2014 and attracted a full house of scientists, anglers, and celebrities, and raised the bar for future symposia. It also served as a catalyst for continued growth in 2015 of BTT's research programs. Of particular note, BTT was awarded a \$1.5 million matching grant by the National Fish and Wildlife Foundation to fund the largest study of bonefish reproduction ever undertaken. BTT immediately started raising the required matching funds to launch the \$3 million, five-year Bonefish Restoration Research Project at Harbor Branch Oceanographic Institute, of Florida Atlantic University, which began in the spring of 2016. The project's objective is to pioneer the methods of spawning and rearing bonefish in captivity as a possible restoration tool in the Florida Keys. At the same time, a new \$1 million, five-year Tarpon Acoustic Tagging Program also launched and six new national parks were created in the Bahamas to protect bonefish habitat—an outcome supported by BTT research.

2015 marked the beginning of a two-year succession plan. Matt Connolly, longtime president of BTT, retired to become President Emeritus. Matt was succeeded by

Harold Brewer, who had been Managing Director of BTT's Bahamas Initiative for many years, and continues in that role as well.

With expanded scientific projects and greater funding needs, BTT now required additional oversight and staff support. Board President Harold Brewer led a national search that resulted in the hiring of Jim McDuffie as BTT's first fulltime Executive Director in the fall of 2015. Jim brought many years of experience in nonprofit management and fundraising to BTT, and was subsequently named President in late 2016. Under his leadership, a new five-year plan is being implemented to significantly increase and accelerate the organization's work in pursuit of its mission.

As BTT begins a new chapter as an organization, we remain committed to our collaborative science-based approach, with the aim of achieving meaningful conservation outcomes. BTT continues to work with a number of collaborating institutions and agencies on a variety of projects and initiatives. In addition to the Bonefish Restoration Research Project and Tarpon Acoustic Tagging Project, BTT is on the forefront of efforts to "Fix Our Water" as a founding partner of the Now or Neverglades coalition. The NoN coalition was instrumental in the passage of SB 10, which provides for a reservoir south of Lake Okeechobee that will help restore the natural flow of clean water to the Everglades and Florida Bay. Building on the success of 2015, when the Bahamas National Trust created six new national parks to protect bonefish habitats on Abaco and Grand Bahama, BTT is working with BNT, The Nature Conservancy, and others to identify additional bonefish habitats worthy of national park protection. The Permit Tracking study, which has already provided important information on permit movements in the Lower Florida Keys, will expand into the Upper Keys. BTT's Juvenile Tarpon Habitat program has already contributed to four habitat restoration projects, and through collaboration with FWC will increase the use of habitat data in fisheries management. Ongoing work in Belize and Mexico is identifying bonefish migrations and pre-spawning sites, information essential to improving conservation. And in Cuba, we continue to work with partners to better understand the "sport fisheries" and commercial fisheries, and how their harvest impacts the catch and release flats fishery. BTT and our partners have a long "to-do" list, but with many successes under our belts, we are approaching these challenges with energy and optimism. 



Schedule of Events (See map pages 82-83)

Friday, November 10, 2017

Prefunction: Fly Tying Demos 9:00 a.m - 4:00 pm.

	Amphitheatre	Grand Brm	Global Brm	Coral Spr	Society Rm
Start Time	Science Session	Fishing Panels	Flats Expo		
8:30:00 AM	Boucek - Keys Initiative Overview				
8:45:00 AM	Brownscombe - Permit acoustic tracking				
9:00:00 AM	Griffin - Tarpon acoustic tracking				
9:15:00 AM	EGgenberger - Tarpon & snook habitat				
9:30:00 AM	Goldberg - Bonefish disease				
9:45:00 AM	Larkin - Bonefish ecosystem model				
10:00:00 AM	Break	Permit Panel	Light Tackle Technique Chico/ Richardson	Pat Ford Travel Show Clinic	Orvis Rod Design Clinic by Shawn Combs
10:15:00 AM	Santos - Bonefish population changes				
10:30:00 AM	Rehage - Keys meta-analysis				
10:45:00 AM	Klarenberg - Bonefish population model				
11:00:00 AM	Davis - The Everglades and Florida Bay	Break			
11:15:00 AM	Adkins - Guides and social change				
11:30:00 AM	Wills - Bonefish Restoration Research Project	Andy Mill Tarpon Clinic			
11:45:00 AM	Mejri - Bonefish reproductive chemistry				
12:00:00 PM	Lunch				
12:15:00 PM					
12:30:00 PM					
12:45:00 PM					
1:00:00 PM	Fix Our Water Panel				
1:15:00 PM					
1:30:00 PM					
1:45:00 PM			Siem / Rudolph Casting Clinic		
2:00:00 PM					
2:15:00 PM					
2:30:00 PM					
2:45:00 PM					
3:00:00 PM					
3:15:00 PM	Break				
3:30:00 PM	Wilson - Juvenile tarpon habitat overview				
3:45:00 PM	Cissel - Mangrove mapping	Travel Panel			
4:00:00 PM	Mace - SC juveniles				
4:15:00 PM	Kurth - Juvenile habitats				
4:30:00 PM	Kurth - Juvenile biology				
4:45:00 PM	Cianciotto - Impoundment habitats				
5:00:00 PM					
	End 5:15PM				
Evening	Film and Art Festival				
6:00:00 PM					
7:00:00 PM	Film and Art Festival (Dinner & Drinks Will Be Provided)				
8:00:00 PM					
9:00:00 PM					
10:00:00 PM					

Schedule of Events (See map pages 82-83)

Saturday, November 11, 2017

Prefunction: Fly Tying Demos 9:00 a.m - 4:00 pm.

	Amphitheatre	Grand Brm	Global Brm	Coral Spr	Society Rm
Start Time	Science Session	Fishing Panel	Flats Expo	Clinics	
8:30:00 AM	Wallace - Tarpon genetics				
8:45:00 AM	Perez - Yucatan bonefish				
9:00:00 AM	Angulo - Cuban fisheries				
9:15:00 AM	Pina - Cuba Marine Protected Areas				
9:30:00 AM	Rennert - Cuban bonefish growth				
9:45:00 AM	Roffer - Bonefish larval transport				
10:00:00 AM	Wallace - Bonefish genetics		SUP Clinic		Legends Panel
10:15:00 AM	Break	Bonefish Panel			
10:30:00 AM	International Panel				
10:45:00 AM					
11:00:00 AM					
11:15:00 AM					
11:30:00 AM				Enrico Puglisi Fly Tying Clinic	
11:45:00 AM					
12:00:00 PM	Lunch	Lunch			
12:15:00 PM					
12:30:00 PM					
12:45:00 PM					
1:00:00 PM	Adams - Bahamas Initiative Overview				
1:15:00 PM	Lewis - Bonefish tag-recapture				
1:30:00 PM	Danylchuk - Bonefish spawning				
1:45:00 PM	Karrow - Traditional Ecological Knowledge	Tarpon Panel			
2:00:00 PM	Rossi - Mangrove disease				
2:15:00 PM	Lennox - Catch & Release predation				
2:30:00 PM	Danylchuk - Catch & Release education				
2:45:00 PM	Break				
3:00:00 PM					
3:15:00 PM					
3:30:00 PM					
3:45:00 PM					
4:00:00 PM					
4:15:00 PM					
4:30:00 PM					
4:45:00 PM					
5:00:00 PM					
	End 5:00PM				
Evening	Symposium Banquet				
6:00:00 PM					Silent Auction Cocktail Party
7:00:00 PM					
8:00:00 PM		Banquet			
9:00:00 PM					



Fishing Panels

Fishing Panels

Permit Panel

Sponsored by Fish & Wildlife Foundation of Florida

Friday 8:45AM – 10:45AM, Grand Ballroom

Moderated by Jon Olch

Carl Ball
Simon Becker
Will Benson
Bob Branham
Jake Brownscombe
Carlos Cortez
Mike Holliday
Nathaniel Linville
John O'Hearn
Charly Rendon
Lincoln Westby

Travel Panel

Sponsored by Global Rescue

Friday 3:00PM – 4:45PM, Grand Ballroom

Moderated by Carter Andrews

Steve Brown
Mike Fitzgerald
Jim Klug
David Leake
Luis Menocal
Mike Michalak
Dylan Rose
Rodrigo Salles

Legends Panel

Sponsored by Hell's Bay Boatworks

Saturday 9:00AM – 10:30AM, Society Lounge

Moderated by Jeff Harkavy

Stu Apte
Chico Fernandez
Steve Huff
Lefty Kreh
Andy Mill
Sandy Moret
Rick Ruoff
Bouncer Smith
Mark Sosin

Bonefish Panel

Sponsored by Admirable Devil

Saturday 9:45AM – 11:45AM, Grand Ballroom

Moderated by Russ Fisher

Brooke Black
Richard Black
Jim Bokor
Bob Branham
Dave Denkert
Joe Gonzalez
Mark Krowka
Diana Rudolph
Paul Tejera

Tarpon Panel

Sponsored by Loop Tackle

Saturday 1:00PM – 3:00PM, Grand Ballroom

Moderated by Bill Horn

Stu Apte
Paul Dixon
Lucas Griffin
Tim Hoover
Steve Huff
Tommy Locke
Andy Mill
Jay Robertson
Bouncer Smith
Paul Tejera



Clinics

Friday, November 10th

**Light Tackle Techniques for the Flats
with Capt. C.A. Richardson and Chico
Fernandez**

Sponsored by Hardy
Friday 9:00AM – 10:00AM, Casting Pond

**Orvis Rod Design Clinic with Shawn
Combs**

Sponsored by Fly WaterTravel
Friday 10:00AM – 11:00AM, Society Room

Pat Ford Travel Show Clinic

Sponsored by Baterbys Art Gallery
Friday 10:00AM – 11:00AM, Coral Springs
Room

Andy Mill Tarpon Clinic

Sponsored by Patagonia
Friday 11:15AM – 12:15PM, Grand
Ballroom

**Casting Clinic with Jerry Siem and
Diana Rudolph**

Sponsored by Ambush Skiffs
Friday 1:30PM – 2:30PM, Casting Pond

**Fly Fishing Technique Clinic with Lori-
Anne Murphy**

Sponsored by Cortland
Friday 3:30PM – 4:45PM, Casting Pond

Saturday, November 11th

Pat Ford Photography Clinic

Sponsored by IGFA
Saturday 8:30AM – 9:30AM, Coral
Springs Room

SUP Fishing Clinic

Sponsored by Bote
Saturday 9:00AM – 10:00AM, Casting
Pond

Break 10:15 - 10:30

Sponsored by Mang

Fly Tying Clinic with Enrico Puglisi

Sponsored by Dr. Slick
Saturday 10:30AM – 12:00PM, Coral
Springs Room

**Celebrity Casting Clinic with Capt.
Steve Huff and Capt. Rick Ruoff**

Sponsored by Power Financial Credit Union
Saturday 3:00PM – 4:00PM, Casting Pond

Friday, November 10th & Saturday, November 11th

Fly Tiers Row

Sponsored by Dragonfly Boatworks
Friday and Saturday 9:00AM – 4:00PM,
Expo Floor
Featuring:

SS Flies
Salt Water Fly Tyers
Curlies Flies
William Cochran
Rick Ruoff
Salty Fly Tying
Joe Mahler
Drei Flies
Bob McDonald
Dave Bullard
Chris Reilly & Chuck Kraft

Science Sessions

Bonefish
& Tarpon
TRUST



6TH INTERNATIONAL SCIENCE

SYMPOSIUM

Science Sessions All located in Amphitheater

Friday, November 10

8:30AM
Keys Initiative Overview
Presented by Ross Boucek

8:45AM
Permit Acoustic Tagging
Presented by Jacob W. Brownscombe

9:00AM
Tarpon and Snook Habitats
Presented by Lucas P. Griffin

9:15AM
Tarpon and Snook Habitat
Presented by Cody Eggenberger

9:30AM
Disease in Florida Keys Bonefish
Presented by Tony L. Goldberg

9:45AM
Bonefish Ecosystem Model
Presented by Michael F. Larkin

10:00AM
Break

10:15AM
Bonefish Population Changes in South Florida
Presented by Rolando O. Santos

10:30AM
Keys Bonefish Meta-Analysis
Presented by Jennifer Rehage

10:45AM
Modeling Bonefish Populations in Florida Bay
Presented by Geraldine Klarenberg

11:00AM
Sea Level Rise and Everglades Restoration
Presented by Stephen E. Davis

11:15AM
Keys Flats Guides and Social Change
Presented by Timothy J. Adkins

11:30AM
Bonefish Restoration Research Project
Presented by Paul S. Wills

11:45AM
Bonefish Reproductive Chemistry
Presented by Sahar Mejri

Fix Our Water Panel
Sponsored by the Everglades Foundation and Orvis
Friday, 1:00PM – 3:00PM

3:30PM
Juvenile Habitat Overview
Presented by JoEllen Wilson and Dr. Aaron Adams

3:45PM
Mangrove Mapping
Presented by Jordan R. Cissell

4:00PM
Juvenile Tarpon in South Carolina Estuaries
Marvin M. Mace III

4:15PM
Juvenile Tarpon Habitats in Florida
Presented by Ben Kurth

4:30PM
Biology of Juvenile Tarpon in Florida
Presented by Ben Kurth

4:45PM
Impoundment Habitats of Juvenile Snook and Tarpon
Presented by Anthony Cianciotto

Saturday, November 11th

8:30AM
Tarpon Genetics
Presented by Elizabeth M. Wallace

8:45AM
Yucatan Bonefish Connectivity
Presented by Addiel U. Perez-Cobb

9:00AM
Status of Cuban Fisheries
Presented by Jorge Angulo-Valdés

9:15AM
Protected Areas and Sustainable Tourism in Cuba
Presented by Fabián Pina Amargós

9:30AM
Cuban Bonefish Growth
Presented by Jake Rennert

9:45AM
Bonefish Larval Transport
Presented by Mitchell A. Roffer

10:00AM
Bonefish Genetics
Presented by Elizabeth M. Wallace

10:15AM
Break

International Panel
Sponsored by Frontiers Travel
Saturday 10:30AM – 12:00PM

12:00 - 1:00
Lunch

1:00PM
Bahamas Initiative Overview
Presented by Aaron Adams

1:15PM
Bonefish Tag-Recapture
Presented by Justin Lewis

1:30PM
Bonefish Prespawning Behaviors
Presented by Andy J. Danylchuk

1:45PM
Traditional Ecological Knowledge in the Bahamas
Presented by Thomas Karrow

2:00PM
Mangrove Disease
Presented by Ryann E. Rossi

2:15PM
Catch and Release Predation
Presented by Robert L. Lennox

2:30PM
Catch and Release Education
Presented by Andy J. Danylchuk and Steven J. Cooke

2:45PM
Break

Bahamas Panel
Sponsored by Bakers Bay Resort
Saturday 3:00PM – 5:00PM

Science Panel Discussions

Bonefish
& Tarpon
TRUST



6TH INTERNATIONAL SCIENCE

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Fix Our Water Panel *Sponsored by the Everglades Foundation and Orvis*

Friday 1:00PM – 3:00PM, Amphitheater - Moderator: Bill Horn, BTT

It's a challenging time in Florida's ongoing water crisis, but a newly introduced Florida Senate bill is a positive step in the efforts to restore the Everglades. In 2016, billions of gallons of nutrient-rich water were dumped out of Lake Okeechobee into the surrounding estuaries, leading to catastrophic algae blooms, killing marine life and endangering people and animals alike. Those challenges strengthened the movement to store, clean, and restore a more natural flow to the water coming out of Lake Okeechobee.

Panel

Aaron Adams – BTT

Daniel Andrews – Fishing Guide, Captains For Clean Water

Brooke Black – Recreational Angler, Scientist

Bob Branham – Fishing Guide, Florida Keys Fishing Guides Association

Mike Conner – Fishing Guide, Bullsugar

Stephen Davis – Scientist, Everglades Foundation

Mike Holliday – Fishing Guide, Costa

Luke Kelly – Fishing Guide, Lower Keys Guides Association

Jennifer Rehage – Scientist, Florida International University

Ed Tamson – Theodore Roosevelt Conservation Partnership

International Panel *Sponsored by Frontiers Travel*

Saturday, November 11, 10:30am – 12:00pm, Amphitheater - Moderator: Luis Menocal, BTT, Fly Shop of Miami, Owner
As flats fishing has expanded, so have the challenges and successes in conservation. As we've learned over the past 20 years, there is a substantial connection among many locations, whether it is via adult migration or the transport of larvae – actions in one location might have implications in other locations. And we've learned that the threats to the flats fishery are nearly universal: habitat loss and degradation, pollution, overfishing, and lack of enforcement. The goal of the International Panel is to provide a venue for guides and scientists from locations throughout the Caribbean to share some of their favorite fishing techniques and share their thoughts about the status of the fishery and conservation challenges and successes.

Panel:

Fabian Pina Amargos – Cuba: Scientist, Avalon Cuban Fishing Centers

Jorge Angulo – Cuba: Scientist, University of Florida, University Of Havana

Raúl Castañeda – Mexico: Owner, Tarpon Town Anglers, Campeche

Heizel García – Nicaragua: SportFishing Development Office, INPESCA-Nicaragua

Guilherme Gondolo – Brazil: Scientist, Instituto Taratarugas Do Delta

Alejandro Hernandez – Mexico: Owner, Campeche Tarpon, Campeche

Addiel Perez-Cobb – Belize: Scientist, El Colegio De La Frontera Sur (ECOSUR), Mexico

Charly Rendon – Mexico: Fishing Guide, Palometa Club, Punta Allen

Lincoln Westby – Belize: Fishing Guide, Blue Horizon Fishing Lodge

Bahamas Panel *Sponsored by Baker's Cay Resort*

Saturday 3:00PM – 5:00PM, Amphitheater - Moderator: Aaron Adams

The Bahamas Initiative is a collaborative, multi-year program to conduct and support research to better understand bonefish, their habitats, and the dynamics of the fishery, and to apply the information learned from this research to conservation, including habitat protection, and education. The goal is to ensure the economically and culturally important bonefish fishery remains healthy and sustainable.

Panel

Shelley Cant-Woodside – Director of Science and Policy, Bahamas National Trust

Eric Carey – Executive Director, Bahamas National Trust

Markk Cartwright – Fishing guide, lodge owner - Long Island Bonefishing Lodge

Jason Franklin – Fishing guide, lodge owner H2O Bonefishing, Grand Bahama Island

Justin Lewis – BTT

Buddy Pinder – Fishing guide, Abaco; Abaco Fly Fishing Guides Association

Benjamin Prat – Senior Manager, Ministry of Tourism

Benry Smith – Fishing guide, Andros

Oliver White – Lodge owner - Abaco Lodge, Abaco; Bair's Lodge, Andros

Cindy Pinder – Abaco Fly Fishing Guides Association

Art & Film Festival

2017 Bonefish & Tarpon Trust Art & Film Festival

November 11, 2017

Ampitheater / Bonaventure Resort / Weston, FL

Cocktails & Art Festival – 6:30pm to 10:00 pm

Film Festival – 8:00 pm to 9:00 pm

Presented by: Nautilus Reels

Sponsors: Herman Lucerne Memorial

SweetWater Brewing Company

Tito's Handmade Vodka

The evening kicks off at 6:30pm with complimentary drinks courtesy of Tito's Handmade Vodka and SweetWater Brewing Company and features an art gallery that includes some of the biggest names in saltwater art and photography. Many of the artists will be in attendance selling their works, with portions of the proceeds going directly to BTT.

Featured artists include:

Christopher Atkins

John Kobald

Mel Smothers

Tim Borski

Jorge Martinez

Mike Stidham

Eric Estrada

Yorgis Morejon

Andrew Thompson

Pat Ford

Paul Puckett

Adam Welsch

Matt Hart

Don Ray

David Wirth

James Harris

Kelly Reark

Mark Johnson

Mike Rivkin (Stanley Meltzoff)

The festival will also showcase a selection of micro-films from the world of fishing and conservation, submitted to the Nautilus Reels Film Contest. Winners will receive prizes from Nautilus and Bonefish & Tarpon Trust. The festival will conclude with Costa's film *SLAM*, the engaging story of three anglers from different walks of life in pursuit of the same epic challenge on the flats.

After the films, we will raffle off a Bote Stand-up Paddle Board, as well as some other great prizes from our sponsors.

Event admission is included with the All Access Pass. Tickets will also be available for purchase at the door.

Legends



Bonefish
& Tarpon
TRUST



6TH INTERNATIONAL SCIENCE

SYMPOSIUM

Legends

Stu Apte- A veteran of the Korean war, Stu was a Navy fighter pilot and later had a 30-plus year career with Pan Am Airlines. He began fly fishing in the 1940s and began guiding anglers in the Keys during the 1950s. Giant tarpon became Stu's obsession and it paid off; he holds the world's first tarpon record and was inducted into the IGFA Hall of Fame in 2005. He pioneered and heavily influenced most of the techniques used today for subduing large fish on light tackle.

Chico Fernandez- Since moving to South Florida from Cuba in 1959, Chico Fernandez has been instrumental in the advancement of saltwater fishing. An accomplished fly designer and a consultant for tackle and boat companies, Chico is the author of over 700 articles and several comprehensive angling books, such as Fly-Fishing for Bonefish. Many of his record-setting catches still stand, including a 42-pound redfish on 12lb tippet. Chico is a founding member of BTT, advisor to The Snook Foundation, and in the IGFA Hall of Fame.

Steve Huff- A member of the IGFA Fishing Hall of Fame, Steve guides from Everglades City to Key West and is one of South Florida's most highly respected flats fishing guides. He is a powerful and graceful caster, a superb teacher, and has guided anglers to more world records and major tournament wins combined than any other skiff guide in fly-fishing history.

Lefty Kreh- Accomplished outdoor editor, fishing show cohost, photographer, casting instructor...the list goes on. A native of Maryland, Lefty began his saltwater fly fishing pursuit in 1965 when he relocated to Miami. His instructional videos, books, and articles are go-to resources for every level of angler, and his fly patterns, such as Lefty's Deceiver, have caught fish around the world. Lefty currently designs and tests rods for Temple Fork Outfitters. Among his many accolades, Lefty is the recipient of ASA's Lifetime Achievement Award and NAFTTA's Lifetime Contribution Award, and was recently inducted to IGFA's Hall of Fame.

Andy Mill- Andy has always been a competitor; from 1972 to 1981 he traveled the world as a member of the U.S. Ski team and competed in two Olympics. Considered by many to be the best tarpon angler alive today, Andy has won The Gold Cup and The Golden Fly Tarpon Tournaments five times each and The Don Hawley Tarpon Tournament once. His book, A Passion for Tarpon, which has won multiple awards, is possibly the most concise and complete book written about tarpon angling, and clearly illustrates his passion for saltwater fly fishing. He was elected onto the IGFA Board of Trustees in 2016.

Sandy Moret- A familiar name in any saltwater fly fishing tournament, Sandy Moret has won the Gold Cup Tarpon Tournament and the Islamorada Invitational Bonefish Fly Championship multiple times. Also an avid conservationist, Sandy is a founding member of BTT and the Now or Neverglades Coalition, former president of the Everglades Protection Association, and served on the Everglades National Park Advisory Board at the appointment of Governor Bob Graham. After moving to Islamorada in 1985, Sandy founded the Florida Keys Fly Fishing School in 1989 and currently operates Florida Keys Outfitters.

Rick Ruoff- Rick was a longtime Florida Keys fishing guide based in Islamorada, Florida and host of "The Orvis Sporting Life" on ESPN2. For the past 30 years he has built a reputation as a first-rate guide by helping pioneer new destinations like bonefishing on Christmas Island and other South-Pacific venues. In 1987 he was Fly Rod and Reel's Fishing Guide of the Year and is an avid tester and developer of rods, reels, and tackle.

Randolph "Bouncer" Smith- Bouncer has been running boats out of South Florida since he was 19 and has been working on them since he was 15. He has devoted his life to sharing fishing with others, through his radio shows, magazine articles, seminars, and on the water. Capt. Bouncer was recently inducted into IGFA's "Legendary Captains and Crews" designation.

Mark Sosin- You probably know him best as the host of the television show Mark Sosin's Saltwater Journal. Mark has always been on the forefront of the angling industry. Over 40 years ago he composed the regulations that became the rules by which saltwater fly catches were governed. He has been president of the Outdoor Writer's Association of America and is in both the IGFA Hall of Fame and the Freshwater Fishing Hall of Fame.



Science Abstracts

Talk #1 - Friday 8:30 – 8:45am Overview of BTT Florida Keys Initiative

Ross Boucek, Brooke Black, Aaron Adams

*Bonefish and Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146,
(ross@bonefishtarpontrust.org)*

In the Florida Keys, anecdotal and scientific evidence suggest that flats fishes have been in decline for decades. Numerous stressors that are operating at local, regional, international, and global scales could be responsible for these downward trends. At the local scale, the number of seagrass flats classified as severely degraded in the keys has doubled over the last 20 years, due in part to an exponentially growing South Florida population. Regionally, a legacy of freshwater mismanagement in South Florida has caused a 15 fold reduction of freshwater that reaches Florida Bay, resulting in periodic seagrass die-offs that exceed 70,000 acres. At the scale of the Caribbean Ocean, due to the prolonged larval stage of these species, particularly bonefish, habitat loss and excessive harvest in the Caribbean could be affecting larval supply and recruitment to Florida populations. Last, at the global scale, extreme weather events such as the 2010 cold spell, and now hurricane Irma, are causing whole ecosystem changes. The goal of Bonefish and Tarpon Trust's Florida Keys Initiative is to conduct and support the science necessary to understand what factors are causing flats fish to decline in the Keys. And importantly, BTT and collaborators work to restore flats fisheries through improvement of conservation and management, advocacy, stewardship and education. Here, we present a broad overview of the progress of the Initiative, highlighting projects with implications for management and for research moving forward in the Florida Keys.

Talk #2 - Friday 8:45 – 9:00am

Characterizing the Spatial Ecology of Permit in the Florida Keys Using Acoustic Telemetry

Jacob W. Brownscombe^{1,3*}, Lucas P. Griffin^{2,3}, Andy J. Danylchuk^{2,3}, Steven J. Cooke^{1,3}, Aaron J. Adams^{3,4}

¹ Fish Ecology and Conservation Physiology Laboratory, Ottawa-Carleton Institute for Biology, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6 Canada, (jakebrownscombe@gmail.com);

² Department of Environmental Conservation, University of Massachusetts Amherst, 160 Holdsworth Way, Amherst, MA, 01003 USA;

³ Bonefish & Tarpon Trust, Coral Gables, FL 33146, USA;

⁴ Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946

Permit (*Trachinotus falcatus*) is a highly popular gamefish for recreational anglers in many regions of the Caribbean Sea and western Atlantic Ocean, including south Florida. However, there is very limited knowledge on the ecology of this species, leaving major knowledge gaps that impede their conservation. We will discuss our ongoing permit tracking project in the Florida Keys funded by Bonefish and Tarpon Trust. The goal of this project is to characterize the spatial movements and habitat use of permit in the Florida Keys to better understand the connectivity between the flats, reefs, and shipwrecks. We are using acoustic telemetry to track permit throughout nearshore regions of the Florida Keys and beyond for three years. This involves tagging permit with acoustic transmitters that emit ultrasonic signals, which are detected by an array of over 1000 telemetry receivers placed throughout Florida's coastal ecosystems. We have observed some fascinating movement patterns by tagged permit, including very high fidelity to specific flats, and a high level of connectivity to nearshore reefs. We have also detected large scale movements (some over 70 miles) by permit from throughout the region to specific locations on the Florida Reef Tract to spawn. The findings of this study will play an important role in improving conservation strategies for permit in Florida, including assessing the efficacy of current Special Permit Zone regulations.

Talk #3 - Friday 9:00 – 9:15 am

Movement Patterns and Connectivity of Atlantic Tarpon in the Gulf of Mexico and Western Atlantic Using Acoustic Telemetry

Lucas Griffin^{1,2}, Aaron Adams^{2,3}, Jacob Brownscombe^{2,4}, Steven J. Cooke^{2,4}, Andy J. Danylchuk^{1,2}

¹Department of Environmental Conservation, University of Massachusetts Amherst, USA (lucasgriffin@gmail.com);

²Bonefish & Tarpon Trust, USA;

³Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946;

⁴Fish Ecology and Conservation Physiology Laboratory, Ottawa-Carleton Institute for Biology, Carleton University, Canada

The recreational fishery for Atlantic tarpon (*Megalops atlanticus*) has rapidly expanded since the fishery's origin in Charlotte Harbor, Florida in 1885. This fishery now encompasses the Chesapeake Bay, Gulf of Mexico, and the Caribbean and is worth hundreds of millions of dollars per year. To ensure healthy and vibrant populations of Atlantic tarpon, a better understanding of tarpon movements and habitat use across life history stages and seasons is needed to develop and implement a strong tarpon management plan. Acoustic telemetry provides a means to track tarpon movements across local and regional scales. The wide geographic range and variable migratory behaviors of tarpon require multi-institutional collaboration across jurisdictions. We report on the extensive collaboration of agencies, institutions, guides and anglers who have joined together to facilitate acoustic telemetry monitoring stretching from the Gulf of Mexico up the eastern seaboard of the USA. This collaboration provides us with the ability to determine the movement patterns and habitat use of tarpon, providing insight into the extent of population connectivity between regions, and if tarpon exhibit spawning site fidelity. We have observed diverse movement patterns including long distance migrations, as well as fine scale regional patterns, and extensive river system use. In addition, we highlight the importance of stakeholder engagement for guiding tarpon research and conservation priorities.

Talk #4 - Friday 9:15 - 9:30pm

Understanding How Tarpon and Snook Use Coastal Habitats in the Everglades: Relationships to Nutrient, Prey abundance and Abiotic Conditions

Cody Eggenberger¹, Rolando Santos¹, Tom Frankovich¹, Chris J. Madden², James Nelson³ and Jennifer Rehage¹

¹*Department of Earth and Environment, Florida International University, 11200 SW 8th Street ECS 119, Miami, FL 33199, (coeggenb@fiu.edu);*

²*Everglades Systems Research, South Florida Water Management District, W Palm Beach, FL 33411;*

³*Department of Biology, University of Louisiana at Lafayette, 410 E. St. Mary Blvd BLD 205-D, Lafayette, LA 70503*

Recreational angling is a core socioeconomic activity in Florida and the Everglades. These recreational fisheries depend on healthy fish populations, especially in coastal areas, yet our understanding of what makes these fisheries sustainable is very limited. The effects hydrological management actions will have on fish are uncertain, particularly in regards to the larger recreational species. The coastal lakes region in north-central Florida Bay is one of the most understudied areas in the Everglades, and has experienced major environmental changes since pre-drainage times. Reductions in freshwater inflows and increased nutrient levels have caused a state shift from a submerged aquatic vegetation-dominated state to that of a phytoplankton-dominated state in one of the two coastal lake systems we studied, providing an opportunity for comparison of recreational fish habitat use as a function of varying nutrient, prey and abiotic conditions. We compared the two lake systems by using acoustic telemetry to track the habitat use and movement of common snook (*Centropomus undecimalis*) and tarpon (*Megalops atlanticus*), as well as standardized seining techniques to assess prey dynamics, and stable isotope analysis to compare trophic interactions. We hypothesized greater prey diversity and abundance, as well as higher residence times and trophic levels of consumers in the less enriched, benthically-driven lake system. Ultimately, we seek to develop a predictive framework for the effects of hydrological variation, restoration, and climate change on large recreational fish species.

Talk #5 - Friday 9:30 - 9:45 am

Infectious Disease as a Potential Contributor to the Decline of Florida Keys Bonefish

Tony L. Goldberg¹, Andy Danylchuk^{2,4}, Steven Cooke^{3,4}, Brooke Black⁴, Jacob W. Brownscombe^{2,4}, Lucas Griffin^{2,4}, Christopher Dunn¹, Aaron Shultz⁵, and David P. Philipp⁶

¹*School of Veterinary Medicine and Global Health Institute, University of Wisconsin-Madison, 1656 Linden Drive, Madison, WI 53706 (tgoldberg@vetmed.wisc.edu);*

²*Department of Environmental Conservation, University of Massachusetts-Amherst, 160 Holdsworth Way, Amherst, MA 01003;*

³*Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada, K1S 5B6;*

⁴*Bonefish Tarpon Trust, 135 San Lorenzo Ave #860, Coral Gables, FL 33146;*

⁵*Cape Eleuthera Institute, Eleuthera, Bahamas;*

⁶*University of Illinois and Fisheries Conservation Foundation*

The decline in the Florida Keys bonefish population is generally attributed to habitat loss, reductions in water quality, and other environmental stressors. This study examines the possibility that infectious disease has contributed to the decline of Florida Keys bonefish. Bonefish were captured and released from the Upper, Middle and Lower Florida Keys, where declines have been marked. Bonefish were also captured and released from The Bahamas on the islands of Eleuthera and Inagua, where populations have remained relatively stable. Non-lethal biological samples (blood and swabs of gill and lateral line) are being analyzed for the presence of bacteria and viruses using next-generation DNA sequencing, which can detect both known and novel agents. The goal is to characterize the diversity of microbes and to search for particular agents that are present in the Florida Keys but absent or at lower concentration elsewhere, and that also have biological properties consistent a disease-causing agent. Samples are being analyzed at the time of this writing. If suspect agents are discovered, specific diagnostic tests can be developed and applied to larger samples and other locations. These tests and the information they provide have the potential to inform efforts ranging from improved management of wild populations to guidelines for captive propagation. In addition, they will provide important baseline information by which to assess the impacts of future environmental changes on bonefish health.

Talk #6 - Friday 9:45 – 10:00 am

What Drives Abundance of South Florida's Bonefish Stock?

Michael F. Larkin

National Marine Fisheries Service, Southeast Regional Office, 263 13th Avenue South, St. Petersburg, FL 33703, (Michael.Larkin@noaa.gov)

Florida's recreational bonefish fishery generates substantial economic benefits to the region. However, Florida's bonefish stock has only been assessed once, and it was evaluated using a single-species fisheries approach. A bonefish ecosystem based assessment (EBA) was completed using Ecopath with Ecosim software. The EBA incorporated bonefish prey, bonefish predators, and fishing mortality. The bonefish component of the model and fishing mortality information was parametrized using available data from the single-species assessment. Bonefish prey and predators' components of the model were parameterized from the literature. Model simulations were run to determine factors that have the greatest influence on bonefish abundance.

Talk #7 - Friday 10:15 – 10:30am

Combination of Fishery-dependent Data and Local-ecological Knowledge to Quantify Spatiotemporal Changes in Bonefishing Effort Dynamics in South Florida

Rolando O Santos, Emily Kroloff & Jennifer Rehage

Southeast Environmental Research Center, Florida International University, FL 33199, (rsantosc@fiu.edu)

There is evidence pointing to an accelerated decline of bonefish (*Albula vulpes*) populations and bonefishing quality in South Florida since the late 1990s. Examining the spatiotemporal dynamics of fishing effort is a key aspect to understand the WHYS and HOWs of recreational fish declines and fishing stability. Thus, this study was designed to assess the nature of the spatiotemporal trend of bonefish fishing effort in South Florida, a recreational fishery economically important for the region, using a combination of fisheries-dependent data (FDD) obtained from guides catch reports, and local-ecological knowledge (LEK) gathered from anglers and key informants. Both FDD and LEK assessments pointed to spatial shifts in bonefish fishing effort in South Florida since the early 1980s. Based on FDD cumulative effort anomalies, we observed a major shift (i.e., breakpoint) in fishing effort related to bonefish catches in both the inner and outer zone of Florida Bay; however, the shift in the inner zone started in 1988 and preceded the outer zone's shift in effort by almost a decade. Also, spatiotemporal analyses of the LEK suggested a spatial contraction of the preferred bonefishing locations from the 1970s to 2000s. In the 1970s, the number of bonefishing locations was equally distributed across different fishing zones, followed by a concentration of bonefishing preference in Florida Bay and Upper Keys from 1980s to 2000s. By the 2010s, the center of bonefishing preference drastically shifted southwest of Florida Bay caused by an increase preference in the Lower Keys. In sum, the spatiotemporal reconstruction of fishing effort trends using FDD and LEK suggested a shrinkage in the spatial distribution of bonefish and their optimal spatial range, with possible implications concerning fishing and hyper-stability effects. The reconstruction of these trends in conjunction with a time-series of disturbances also allowed for the development of hypotheses about other possible mechanisms behind the decline of bonefish abundance in Florida Bay.

Talk #8 - Friday 10:30 – 10:45am

Understanding Bonefish Dynamics in South Florida: Patterns, Drivers, Space and Time

Jennifer Rehage, Rolando Santos, Emily Kroloff & Christine Beck

*Earth & Environment Department, Florida International University, FL 33199,
(rehagej@fiu.edu)*

There is increasing evidence that, similar to commercial fisheries, recreational fisheries can be prone to severe declines. Yet these fisheries are often data-poor, particularly catch-and-release fisheries, making it a challenge to conduct stock assessments and quantify their resilience. In the past decades, recreational catches of bonefish (*Albula vulpes*) have decreased significantly throughout South Florida. The mechanisms driving these declines are unknown, yet concerning given the large socio-economic value of the fishery. Here we asked: 1) What are the spatiotemporal patterns of bonefish catches? and 2) What are the relationships and relative importance of water quality, climatic parameters, and habitat dynamics in driving these declines? We first reconstructed a time series using fisheries-dependent data and local ecological knowledge. We then employed analyses of periodicity using a “ratchet” decline model and wavelet analysis to assess the effects of climatic forcing, and a state-space reconstruction approach to link temporal trends to environmental drivers. Analyses point to a decline in catches since 1975, with an acceleration starting in the late 1990s. Analyses showed 42% reduction in bonefish catches, and 60% reduction in bonefishing quality. Results also show that the core of bonefishing significantly shifted southward over time, and to interacting drivers of decline.

Talk #9 - Friday 10:45 – 11:00am

A Computational Approach to Explore Multiple Impacts on Recruitment and Mortality of Bonefish in the Florida Bay

Geraldine Klarenberg, Michael Allen, Rob Ahrens

*Fisheries and Aquatic Sciences, School of Forest Resources and Conservation,
University of Florida (rsantosc@fiu.edu)*

To explore reported declines of bonefish in South Florida (Florida Bay) we use 34 years of annual CPUE data, calculated from fishery-dependent data and local ecological knowledge, as the starting point of a computational analysis. A detailed age-structured population is developed that specifically incorporates recruitment and adult mortality parameters. This model is calibrated on (the anomalies of) the observed CPUE under varying scenarios in which the emphasis on either recruitment or mortality is shifted. This provides several possible trajectories in recruitment and mortality that could have produced the observed CPUE (population dynamics). By comparing the trajectories to time series representing environmental, climatic or anthropogenic impacts, a picture of the most-likely scenario that combines some or all of these factors can be constructed – as well as their relationship with recruitment, mortality, or both. Factors that are included in the analysis are climate events (El Niño, Atlantic Multidecadal Oscillation and Pacific Decadal Oscillation), abiotic factors (salinity, temperature) and habitat changes (sea grass, algae).

Talk #10 - Friday 11:00 – 11:15am

Sea Level Rise, Everglades Restoration and the Health of Florida Bay

Stephen E. Davis

*Everglades Foundation, 18001 Old Cutler Rd., suite 625, Palmetto Bay, FL 33157
(sdavis@evergladesfoundation.org)*

As a flat, low-lying landscape, coastal regions around the Everglades are particularly vulnerable to sea level rise. This has been exacerbated by a chronic reduction in freshwater flow from Lake Okeechobee over the past century. Everglades restoration has been moving at a slow pace and the fundamental problem of dumping excess freshwater to the Caloosahatchee and St. Lucie Rivers impacts more than these important estuaries on the east and west coasts. To the south, the Everglades peat-based marshes are often subjected to extended periods of dry-down and exposure, resulting in soil oxidation and loss of ridge-slough landscape patterning. Nearer to the coast, freshwater marshes abutting the mangrove ecotone are being exposed to more frequent saltwater inundation, leading to peat collapse and a short-circuiting of landward mangrove transition. Finally, in Florida Bay, the impacts of chronically reduced freshwater inflows include more frequent bouts of hyper-salinity, seagrass die-off and algal blooms. The impacts of these changes on water quality, habitat and fisheries will be illustrated with data from a variety of academic and agency sources and discussed relative to the goals of Everglades restoration and in light of projects that have been recently authorized, planned or constructed.

Talk #11 - Friday 11:15 - 11:30am

Channeling New Clientele: Changes in the Organization and Work of Florida Keys Flats Guides in Response to Social and Ecological Variation

Timothy J. Adkins

Department of Sociology, University of Illinois at Chicago, 1007 W Harrison St, MC 312, Chicago, IL 60607 (tadkin2@uic.edu)

Although fishing guides have been integral to fisheries research and conservation efforts, little research has been done on the social and organizational environment that fishing guides themselves both help construct and respond to. There is even less understanding of how shifts in this social environment affect the labor and organization of fishing guides. Drawing on in-depth, semi-structured qualitative interviews with 60 flats and backcountry guides throughout the Florida Keys, I show how changes in the amount and demographics of tourism to the Keys, the growth of hotel and resort business, the increase in media exposure, and the decline in the quality of local flats fisheries have influenced changes in the profession of guiding in the Keys. Such changes have disproportionately burdened skiff guides who specialize in sight-casting for particular species and influenced many Keys guides to incorporate larger boats and different fishing types into their operations. I note disparities in the work, organization, and future outlook of “skiff” and “bay boat” charter operations in Florida Keys shallow water fisheries.

Talk #12 – Friday 11:30am – 12:00pm

Progress Toward the Development of Hatchery Production Techniques for Stock Enhancement of Bonefish in the Florida Keys

Paul S. Wills¹, Jon Shenker², Matthew Ajemian¹, Marty Riche¹, Sahar Mejri¹, Christopher Robinson¹, William Halstead¹, Cameron Luck¹, Aaron Adams^{1,3}

¹Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946, (pwills2@fau.edu);

²Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32901;

³Bonefish and Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146

The bonefish (*Albula vulpes*) is currently listed as “near threatened” on the IUCN Red List of Threatened Species, and in some locations the population status approaches “vulnerable.” In the Florida Keys where bonefish have long supported a catch and release fishery, the population has declined by an estimated 90% since the 1970s. Research is ongoing to determine the causes of the population decline to inform restoration efforts. Concurrently, we are conducting a long-term project to develop culture methods for bonefish to support potential stock enhancement in the Florida Keys. The goal is to provide stock enhancement as an available tool in the broader restoration “toolbox.” Research suggests that spawning may fail if spawning aggregation size does not exceed a minimum threshold, so stocking may be necessary to ensure spawning success. Our approach includes development of broodstock conditioning and induced spawning techniques, larval and juvenile husbandry, pre-release conditioning, and assessment of potential stock enhancement benefits with hatchery reared juveniles. Larval husbandry for this species is quite challenging given that they possess a leptocephalus larval stage. Project approach and preliminary data on spawning induction will be presented from data collected during the first year and a half of the project.

Talk #13 - Friday 11:45am - 12:00pm

Lipid and Fatty Acid Profiles During the Reproductive Cycle in Bonefish (*Albula vulpes*) Oocytes

Sahar Mejri¹, Cameron Luck¹, Marty Riche¹, Paul Wills¹, Rejean Tremblay², Matthew J. Ajemian¹, Aaron Adams^{1,4}, Jon Shenker³, Justin Lewis⁴, Christopher Robinson¹, and William Halstead¹

¹Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946;

²Institut des sciences de la mer;

Université du Québec à Rimouski (ISMER, UQAR);

³Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32901;

⁴Bonefish and Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146

Lipids and fatty acids (FA), particularly the highly unsaturated FA, 20:5n-3 (eicosapentaenoic acid, EPA), 22:6n-3 (docosahexaenoic acids, DHA) and 20:4n-6 (arachidonic acid, AA) have been shown to be crucial determinants of marine fish reproduction directly affecting fecundity, egg quality, embryogenesis, and hatching successes. The present study aims to describe, for the first time, lipid and fatty acid profiles in oocytes from wild Bonefish broodstock (*Albula vulpes*) throughout the reproductive season collected in Grand Bahama, Bahamas. The total lipid (TL) content was 26.6 ± 5.8 % of the wet mass (WM). The major lipid classes were wax and sterol esters (WE-SE; 48-55% of TL), acetone mobile polar lipid (AMPL; 0.4-25% of TL), phospholipids (PLs; 7-26% of TL), and triglycerides (TAG; 1-22%) and were significantly different depending on female origin. Bonefish oocytes were characterized by high levels of monoenes in the neutral lipid fraction (i.e. 16:1 and 18:1n-9) indicating their probable role as energy fuel. However, the most abundant fatty acids in the polar lipids were DHA, AA, and EPA (15, 13, and 4% of total polar FA, respectively), suggesting their importance as essential constituents of cell membranes in this species. Our results will help evaluate the dietary fatty acid requirements in Bonefish captive broodstock to increase spawning and produce high quality eggs.

Talk #14 - Fix Our Water Panel

Friday, November 10, 1:00 – 3:00pm, Amphitheater

Sponsored by The Everglades Foundation & Orvis

Moderator: Bill Horn, BTT

Florida's flats fishery and other coastal fisheries are suffering from poor water quality and habitat loss due to poor water management practices. Healthy recreational fisheries require healthy habitats, and healthy coastal habitats require healthy, natural freshwater flows. The goal of the Fix Our Water Initiative is to engage recreational anglers and the fishing industry in efforts to expedite revision of Florida's water management practices.

The Florida Everglades are the epicenter of Florida's water quality issues, where decades of poor water management have resulted in Florida Bay getting too little freshwater, and the Caloosahatchee River and St. Lucie River getting too much freshwater. The freshwater outflows also have high nutrient and contaminant loads. Large-scale seagrass, oyster, and fish die-offs have been the result. Similar stories play out in the Indian River Lagoon, Apalachicola, and elsewhere.

The goal of the Fix Our Water panel is to build upon the recent scientific findings of how human-caused changes in Florida's ecology are impacting recreational fisheries, and chart a course toward improved water and natural resource management that will benefit the fisheries and habitats.

Panel:

Aaron Adams – BTT

Daniel Andrews – Fishing Guide, Captains For Clean Water

Brooke Black – Recreational Angler, Scientist

Bob Branham – Fishing Guide, Florida Keys Fishing Guides Association

Mike Conner – Fishing Guide, Bullsugar

Stephen Davis – Scientist, Everglades Foundation

Mike Holliday – Fishing Guide, Costa

Luke Kelly – Fishing Guide, Lower Keys Guides Association

Jennifer Rehage – Scientist, Florida International University

Ed Tamson – Theodore Roosevelt Conservation Partnership

Talk #15 - Friday 3:30 – 3:45pm

Working with Recreational Anglers to Incorporate Habitat Evaluation into Management Strategies

JoEllen Wilson, Aaron Adams

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Habitat loss/degradation is a major threat to the coastal habitat mosaic that supports fisheries. Atlantic tarpon depend upon estuarine habitats as juveniles that suffer from anthropogenic degradation via flow alterations and high nutrient loads. Habitat loss on juveniles will have long-term negative impacts on the adult fishery that may not be realized for decades due to tarpon's slow maturation rate. Due in part to difficulties accessing these habitats, data on juvenile tarpon habitats have not been incorporated into management. To acquire non-fisheries habitat information, we worked with anglers as citizen scientists to identify and characterize juvenile habitats: anglers mapped specific locations and provided their assessment of the habitat quality. We then conducted a scientific field assessment of the locations; comparison of the angler and scientific data revealed the reliability of angler habitat assessments; the resulting map and habitat rankings were used to identify important habitats for protection or restoration. The information is provided to management agencies for incorporation into fisheries management plans and habitat protection plans, and to guide habitat restoration. As this approach is refined, the template can be used for other species and locations to address habitat quality issues that are not currently incorporated into fishery management plans.

Talk #16 - Friday 3:45 - 4:00pm

Mangroves in Campeche, Mexico: Mapping Twenty Years of Change Dynamics in an Important Tarpon Flats Fishery

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The mangrove forests of Campeche, Mexico, are critically important to the local ecology and economy. In addition to supporting commercially fished populations of pink shrimp (*Farfantepenaeus duorarum*), white shrimp (*Litopenaeus setiferus*), and octopus (*Octopus sp.*), the area's coastal mangroves and associated seagrass flats provide crucial habitat for juvenile tarpon (*Megalops atlanticus*), for which Campeche is a burgeoning destination for catch-and-release sport fishing. Although Campeche's coastal mangrove corridor is designated a UNESCO Biosphere Reserve, the protected area directly abuts the large and growing urban center of Campeche city, a UNESCO World Heritage Site. Mexico's total mangrove area has decreased by more than 20 percent throughout the past two decades, and Campeche's mangroves currently face pressures from disruption of freshwater flow, small-scale deforestation, and urban expansion. However, no previous study has specifically mapped mangrove change dynamics in Campeche. We analyzed Landsat satellite data from 1999 and 2016 to measure mangrove forest cover changes along Campeche's coast and conducted fieldwork in October 2016 to assess the accuracy of our remote sensing analysis and learn from local fishing guides about regional drivers of mangrove degradation within the study area. Results demonstrated a 14.10 percent decrease in mangrove area and a 17.76 percent increase in Campeche city's urban extent during the study period. Mangrove decline was concentrated in coastal fringes, with local informants indicating that much of the degradation resulted from localized alteration of mangrove channels' water flows due to road construction projects. Although our research found a decline of mangrove forest cover, local officials, residents, and researchers have worked to reverse disruptions in water flow, one of the main drivers of mangrove decline.

Talk #17 - Friday 4:00 – 4:15pm

Recruitment, Habitat Use, and Potential Survival of Early Life Stage Tarpon (*Megalops atlanticus*) in South Carolina Estuaries

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The ecology of early life stage tarpon (*Megalops atlanticus*) is well understood in tropical and subtropical regions, particularly around Florida. While larval and juvenile tarpon occur in estuaries along the southeastern US Atlantic coast north of Florida, little is known regarding their distribution, abundance, and survival in estuaries throughout this region. Therefore we examined early life stage tarpon recruitment, habitat use, and residency in coastal habitats in South Carolina near the northern limit of their distribution in the western Atlantic Ocean. Larval tarpon recruited to estuaries during June through November at sizes similar to other subtropical areas in the region. Soon after recruitment to the system, larval and juvenile tarpon were present in multiple habitats, including high marsh pools and marsh impoundments, from July to November. An increase in tarpon length over time during their residency in high marsh pools and the relatively large size they attained in marsh impoundments indicate these environments may function as favorable nursery habitats. As water temperatures decreased during October and November, juvenile tarpon emigrated from these estuarine habitats. Based on results from low temperature tolerance experiments, it is unlikely that tarpon could survive winter in most estuarine habitats in South Carolina, although some habitats may provide a thermal refuge during winter months. Early life stage tarpon appear to use a variety of estuarine habitats in coastal South Carolina from summer through late fall. The fate of these individuals after they leave estuarine habitats at the onset of winter in this region is currently unknown.

Talk #18 - Friday 4:15 – 4:30pm

Backcountry Habitat Dependence, Ontogenetic Habitat Shifts, and Foraging System Fidelity of Atlantic Tarpon (*Megalops atlanticus*)

Ben Kurth^{1,2}, Christopher Stallings¹, Ernst Peebles¹

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Fish can have complex life histories and use multiple habitats and resources. Consequently, their life histories are often poorly understood. Atlantic Tarpon (*Megalops atlanticus*) is an ecologically and economically important sport fish, yet little is known about its lifelong habitat and resource use. This study used stable isotope analysis of eye lens $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values to explore patterns in trophic history and habitat use of 16 Atlantic Tarpon from Florida and Louisiana. The stable isotope chronologies showed 100% use of backcountry habitats during the early life history and an ontogenetic shift to coastal waters at approximately 10 years of age and 140 cm total length. This study highlights the importance of backcountry habitats to the early life stages of Atlantic Tarpon, as well as the possibility that adults show fidelity to coastal systems for feeding and growth. This study represents the first use of the eye lens as a chronological recorder of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values to reveal patterns of trophic history and habitat use in a fish species, fills critical gaps in our knowledge of Atlantic Tarpon life history, and may aid in better management and conservation of the species.

Talk #19 - Friday 4:30 – 4:45pm

Ontogenetic Habitat Shifts and Biology of Juvenile Atlantic Tarpon (*Megalops atlanticus*) in Florida

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The Atlantic Tarpon (*Megalops atlanticus*), is a large, typically migratory, elopomorph fish that is both ecologically and economically important. Little is known about the juvenile biology and ecology of the species, but loss of natal and juvenile habitat is a major threat to the species. In this study, mark-recapture data from a multi-year genetic tagging program were used to investigate survival and growth rates, ontogenetic habitat use, and migration of juvenile Atlantic Tarpon in Florida. The study found that juveniles took approximately 10 years to reach the length associated with maturity, and appeared to have a high survival rate (~80%) due to use of habitats with reduced competition and predation. Atlantic Tarpon underwent several ontogenetic habitat shifts throughout the juvenile phase. In addition, juvenile Atlantic Tarpon displayed fidelity to coastal systems wherein only short movements occurred between habitat types. The data were used to identify four systems (Indian River Lagoon, Charlotte Harbor, Everglades, and Florida Keys), that harbored large numbers of juvenile Atlantic Tarpon and contained the complexity of habitats necessary for ontogenetic development. This work serves to fill critical gaps in our knowledge of Atlantic Tarpon life history and may aid in better management and conservation of the species.

Talk #20 - Saturday 4:45 - 5:00pm

Emigration of Juvenile Snook and Tarpon from a Mosquito Control Impoundment is Enhanced through a Draw-Down of Water Level in Summer

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Thousands of acres of marshland in the Indian River Lagoon (IRL) have been impounded for mosquito control. Most of these impoundments are under Rotational Impoundment Management (RIM), in which culverts connecting to the IRL are closed in the summer to control mosquito reproduction, and opened Oct-May to allow water exchange. We conducted a quantitative assessment of the emigration of juvenile snook and tarpon from the Bee Gum Point Nature Preserve impoundment in Vero Beach, Florida. 284 snook and 70 tarpon were marked with passive integrated transponder (PIT) tags and released back into the impoundment. Tag-detecting antennas around the culverts recorded minimal emigration when the culverts were open according to RIM in winter. Tagged juveniles remained trapped after the culverts were closed for the summer, but approached the antenna frequently. We therefore conducted an experimental summer draw down, opening culverts for 2 weeks in July. High rates of emigration were recorded for both juvenile snook and tarpon during the first two incoming tides of the draw down. This indicates that juvenile snook and tarpon are more likely to emigrate from impoundments during summer, when culverts are typically closed. These results suggest that impoundment management may be enhanced by including short term openings of culverts in summer to allow juveniles to emigrate, improving their value as nursery habitats.

Talk #21 - Saturday 8:30 - 8:45am

Genetic Population Connectivity of Atlantic Tarpon

Elizabeth M. Wallace

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Though the Atlantic Tarpon (*Megalops atlanticus*) supports a high value sport fishery, harvest still occurs and the species is IUCN Red List vulnerable due to population declines and habitat loss. Tarpon are long lived and slow to reach maturity, factors that contribute to their overall sensitivity to population declines. However vital information was lacking on genetic connectivity and population structure. This study assessed these population dynamics through robust genetic analyses. The dataset (N=23,210) consisted of fish collected from 25 locations across the region. Specimens were screened for a high diversity 9 locus microsatellite library. A multifaceted analytical approach was used to determine genetic population patterns and results revealed widespread connectivity. Tarpon from across the region displayed shared alleles, supporting a pattern of ongoing gene flow. The genetic structure analyses supported a single trans-Atlantic stock in tarpon. Adults are migratory, though the full extent of these seasonal migrations remain unknown. Tarpon larvae have high dispersal potential as they are carried on ocean currents. These life history features enable trans-Atlantic population connectivity in this species. Study results highlight the importance of interjurisdictional cooperation in management and conservation efforts. Harvest in upstream locations such as Brazil and Louisiana will negatively impact the fishery in downstream areas (such as Florida).

Talk #22 - Saturday 8:45 – 9:00am

Connectivity Mediated by Bonefish (*Albula vulpes*) Migration between the Caribbean Sea and a Tropical Estuary

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Bonefish (*Albula vulpes*) is an economically and ecologically important fish in the Yucatan Peninsula, Central America. Understanding bonefish (*Albula vulpes*) movements between Chetumal/Corozal Bay (CB) and the Caribbean Coast (CC) is important to informing fisheries management and tourism plans in Belize and Mexico. Since January 2016 we have used a mixed-method approach that includes traditional ecological knowledge (TEK) and tag-recapture to understand bonefish movements. Of 27 TEK interviews, 22.2% and 3.7% were commercial and subsistence fishers respectively, and the remaining 74.1% were fly-fishing guides. Twelve interviewees (44.4%) reported seeing bonefish moving “fast” during the so-called “runs.” In Mexico, 66.7% of interviewees indicated the migration occurs in a southern direction inside CB and 8.3% along the CC, in both cases during November. In northern Belize, 16.7% reported migration in a northerly direction in CB and 8.3% reported both a northern and southern movements along CC and also seeing bonefish displaying a “porpoising” behavior during September at Robles Point, a potential pre-spawning site on near the Mexico-Belize border on the CC of Belize. 0.9% of tags (47 of 5506) were recovered once so far. Of 85.1% of recoveries inside CB, 31.9% were south (distance: min=1.8 km, max =77.11 km), 21.3% north (distance: min=2.03 km, max =37.2 km), and 17% west (distance: min=15.2 km, max =19.9 km) from site tagged, while 14.9% were recaptured < 1 km from tagging location. The remaining 14.9% of recoveries were in the CC and 4.3% were recovered west (distance: min=13.1 km, max distance=19.9 km) and 2.1% (one recovery) 37.2 km north from tagging location, and 8.5% in < 2 km from tagging site. Bonefish were smaller in the CB than the CC (Two-Samples t-test, <0.001): CB (mean standard length=29.2 cm, min=21.4 cm and max=48 cm); CC (mean=34.8 cm, min=21.4 cm, max=56 cm). Both males and females were reproductively gravid in December and January, particularly at Robles Point. These results suggest a seasonal migratory connectivity between CB and the CC during December and January, likely for spawning near Robles Point. Ongoing and future work will examine possible additional prespawning sites near Robles Point, and possible early spawning in September.

Talk #23 - Saturday 9:00 - 9:15am

Status of Cuban fisheries: Implications for Recreational Fisheries

Jorge Angulo-Valdés¹, Laura Lopez Castaneda², Zenaida María Navarro-Martínez², Thomas K. Frazer¹, Aaron J. Adams³

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Cuba's coastal habitats are fairly well preserved, but fish populations are heavily exploited and presumed threatened by both commercial and sport fishing interests. Few data exist, however, to quantify the geographic extent and magnitude of fishing activities on most fish populations or coastal ecosystems more broadly. Nevertheless, some highly targeted species are known to have been negatively impacted, e.g., nassau grouper, mullets, lane snapper, and spiny lobster. The effects of fishing on other important species, including bonefish, tarpon, permit and snook, have not been evaluated. This presentation aims to shed some light on the status of several key Cuban fisheries and potential consequences for charismatic shallow water species, bonefish and tarpon in particular. Our assessment is informed, in large part, by recent findings from a collaborative partnership program that involves Cuban fisherman and scientists from both the US and Cuba.

Talk #24 - Saturday 9:15 - 9:30am

Jardines de la Reina National Park: A Success of Protection and Sustainable Tourism

Fabián Pina Amargós and Tamara Figueredo Martín

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Protected areas and tourism are frequently mutually exclusive. However, Jardines de la Reina National Park, a 2,000km² protected area in southern Cuba, is an example of how sustainable tourism and protected areas can be successfully combined. Hundreds of foreign catch and release fly fishing anglers and SCUBA divers visit Jardines de la Reina annually, experiencing the protected area's resources via liveboard vessels and fishing skiffs. While they enjoy the pristine habitats, they become de facto park rangers – their activities keep poachers away, thus protecting gamefish, sharks, groupers, snappers, queen conch, lobsters and marine. Fly fishing skiffs land an average two tarpon and five bonefish per day, based on >10 years of monitoring. Other large finfish are up to 2.4 times more abundant and of higher biomass in Jardines de la Reina National Park than in other protected areas in southern Cuba, and this gap has been increasing over the last decade. Sharks are up to 18 times more abundant inside the Jardines de la Reina than in similar habitats that are fished. Thanks to the spillover effect and other environmental goods and services provided by this large protected area, the Cuban economy and people have benefitted locally and nationwide. Due to its success, this model is worthy of being implemented around Cuba, a process that is already underway.

Talk #25 - Saturday 9:30 – 9:45am

Variation in Age and Growth of Bonefish, (*Albula*) Species Among Cuban Habitats

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Bonefish, *Albula* spp., have been shown to grow faster and reach larger sizes in the Florida Keys than in the Bahamas. These different growth patterns can affect the reproductive output of the populations, with implications for recruitment and population dynamics where larvae settle and metamorphose. Several different hypotheses have been proposed as a mechanism for varying growth rates of bonefish, but none have been directly investigated. To determine if varying growth rates occur outside of Florida and the Bahamas, bonefish (*Albula* spp.) in Cuba were sampled in different habitats. Fish were purchased from artisanal fishers at three different habitats along the north and south shores of Cuba. After removing the otoliths (sagittae) from each fish, and determining sex and gonadal condition, the fish were returned to the fishers for consumption. Because three morphologically indistinguishable species of *Albula* exist in Cuba, fin clips were collected and sent to the Genetics Laboratory at the Florida Wildlife Research Institute for identification. A total of 225 bonefish have been collected and processed to date. Comparisons of distribution patterns, von Bertalanffy growth curves and age at maturity of different species in different habitats will be presented.

Talk #26 - Saturday 9:45 – 10:00am

Surface Pathways and Variability of Bonefish Larval Dispersal in the Northwest Atlantic Ocean

Mitchell A. Roffer¹, Ruoying He², Aaron Adams³, and Xiangming Zeng²

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Surface trajectories of particles (“virtual larval”) released from 26 major spawning sites of bonefish (*Albula vulpes*) around the Caribbean Sea and Bahamas were simulated during the period of 2009-2015 using a realistic ocean circulation hindcast model coupled with an online particle tracking simulator to study larval transport variations in the Northwest Atlantic. At each site, 2600 surface particles were released twice per month (at full moon and new moon, respectively) for the months of October through next April in each year and tracked for a planktonic larval duration of 53 days. Model results and their corresponding statistical analyses show that these sites have significantly different dispersal characteristics. Generally speaking, sites at the Florida Straits, Yucatan, and Venezuela are more dispersive due to their close vicinity to the Western Boundary Current (WBC) system. In contrast, sites near the Bahamas and Cuba south coast are more retentive because of the relatively weaker surrounding circulation in these regions. Significant differences in particle dispersal are also identified between particles released during new and full moon phases as well as in winter and spring seasons, highlighting that it is of vital importance to resolve multi-scale temporal variability in the circulation transport when studying larval transport and connectivity.

In general, particles released from the Bahamas, Florida Straits and Yucatan areas have longer dispersal distance in the spring, whereas particles released from the Cuba south coast, Puerto Rico and Venezuela areas have longer dispersal distance in the winter. Overall, particles released from 26 major spawning sites around the Caribbean Sea and Bahamas travel to a vast area of North Atlantic within 53 days. Areas with high probability of particle occurrence are the Gulf Stream region in the South Atlantic Bight, the Bahamas, Florida south and east coast, northwest and southeast coast of Cuba, the Loop Current region in the Gulf of Mexico, the Yucatan southeast coast, northwest of Puerto Rico, and part of east Caribbean Sea. Significant inter-annual variations (2009-2015) in particle dispersal were apparent and quantified. The importance to the recruitment to the Florida Keys and throughout the fishes

Talk # 27 - International Panel

Saturday, November 11, 10:30am – 12:00pm, Amphitheater

Sponsored by *Frontiers Travel*

Moderator: Luis Menocal, BTT, Fly Shop of Miami, Owner

Although the Florida Keys are recognized as the ‘birth place’ of flats fishing, the flats fishery has become truly international. Anglers travel the world to fish the flats, and the amount of fishing knowledge that has been transferred across borders is amazing. As flats fishing has expanded, so have the challenges and successes in conservation. As we’ve learned over the past 20 years, there is a substantial connection among many locations, whether it is via adult migration or the transport of larvae – actions in one location might have implications in other locations. And we’ve learned that the threats to the flats fishery are nearly universal: habitat loss and degradation, pollution, overfishing, and lack of enforcement.

The goal of the International Panel is to provide a venue for guides and scientists from locations throughout the Caribbean to share some of their favorite fishing techniques and share their thoughts about the status of the fishery and conservation challenges and successes.

Panel:

Fabian Pina Amargos – Cuba: Scientist, Avalon Cuban Fishing Centers

Jorge Angulo – Cuba: Scientist, University of Florida, University Of Havana

Raúl Castañeda – Mexico: Owner, Tarpon Town Anglers, Campeche

Heizel Garcia – Nicaragua: SportFishing Development Office, INPESCA-Nicaragua

Guilherme Gondolo – Brazil: Scientist, Instituto Taratarugas Do Delta

Alejandro Hernandez – Mexico: Owner, Campeche Tarpon, Campeche

Addiel Perez-Cobb – Belize: Scientist, El Colegio De La Frontera Sur (ECOSUR), Mexico

Charly Rendon – Mexico: Fishing Guide, Palometa Club, Punta Allen

Lincoln Westby – Belize: Fishing Guide, Blue Horizon Fishing Lodge

Talk #28 - Saturday 1:15 - 1:30pm

An Overview of The Bahamas Initiative

Aaron J. Adams and Justin P. Lewis

Bonefish & Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146

The Bahamas Initiative is a collaborative, multi-year program to conduct and support research to better understand bonefish, their habitats, and the dynamics of the fishery, and to apply the information learned from this research to conservation, including habitat protection and education. The goal is to ensure the economically and culturally important bonefish fishery remains healthy and sustainable. Collaborators include science partners, non-profit organizations, government agencies, fishing guides, lodge owners, and anglers. Research, conservation advocacy, and education projects focus on addressing the top threats to the bonefish fishery: habitat loss and degradation, illegal harvest, and lack of public knowledge about the fishery. Projects to address information needs include: tag-recapture and acoustic tracking to identify important bonefish habitats; identification and description of pre-spawning aggregation sites and fish behavior; Traditional Ecological Knowledge interviews to identify habitats and describe the history of the fishery; the effects of catch and release; and habitat assessments. This information is directly applied to conservation, such as establishment of national parks as a means of habitat protection, as well as education, in the form of classroom lectures and field trips for students, educational videos, and instruction on proper catch and release practices for guides and anglers. This presentation will provide a framework for the presentations and panel discussion that follow in the Bahamas Session.

Talk #29 – Saturday 10:00 – 10:15am

A Comprehensive Approach to Assess Population Connectivity and Recruitment in the Atlantic Bonefish (*Albula vulpes*)

Elizabeth M. Wallace¹, Christopher R. Haak², Aaron D. Shultz³

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Flats habitat is patchily distributed across the global tropics, yet some flats species are able to maintain genetic connectivity across broad spatial scales. The Atlantic bonefish *Albula vulpes*, which supports the flats focused recreational fishery in the region, is one such species. Prior work identified high genetic connectivity across the Gulf of Mexico, Caribbean Sea, and western Atlantic Ocean. Concern exists due to *A. vulpes* population declines, habitat loss, and fragmentation. Yet recruitment sources and fine scale connectivity remain uncertain. An understanding of population connectivity and recruitment are vital for effective restoration efforts, and require an integrated approach. We addressed this void through a comprehensive assessment employing ecological, behavioral, molecular, and oceanographic data. Field data collection was targeted based on adult telemetry data, juvenile habitats, and oceanographic models of potential larval dispersal routes. Next generation sequencing based genetic data allowed examination of population connectivity and recruitment sources at local and regional scales. Study results will identify the sources of new recruits to the recreational fishery: local, regional, or a combination of these sources. Results will further determine the appropriate geographic scale for management actions as well as highlight factors important for conservation and restoration efforts.

Talk #30 - Saturday 1:15 – 1:30pm

Conservation Implications of Site Fidelity Patterns by Bonefish, (*Albula vulpes*), in the Bahamas: A Case Study

R.E. Boucek¹, J.P. Lewis^{1*}, A.D. Shultz², D.P. Philipp³, B.D. Stewart⁴, Z.R. Jud⁵, Z.C. Zuckerman², A.J. Adams^{1,6}

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The bonefish (*Albula vulpes*) is an economically important sport fish in the Islands of the Bahamas and throughout its geographical range, but until recently little was known about the species' movements. Information on bonefish habitat use and movements is essential for effective conservation. From 2009 through 2017, on the Bahamas islands of Abaco, Andros, Eleuthera, Exuma, Long Island and Grand Bahama, in collaboration with fishing guides and recreational anglers, we used mark-recapture to document bonefish movements and contribute information to ongoing conservation efforts in the Bahamas. A total of 12,590 bonefish was tagged, and 629 recaptured. Bonefish had high site fidelity, with 72% recaptured ≤ 1 km from the release site. However, some individuals also exhibited long distance movements that appeared to be associated with spawning migrations due to the association with full and new moons during spawning season; 17 fish were recaptured >30 km from release site; and 4 were recaptured >100 km away. Findings from this study will be used to guide bonefish conservation, and in designating areas for protection in the newly founded Bahamian Marine Protected Area (MPA) network.

Talk #31 - Saturday 1:30 - 1:45pm

Swirling, Jumping, Burping and Farting: Prespawning Aggregation Behaviors of Bonefish (*Albula vulpes*)

Andy J. Danylchuk^{1,2}, Justin Lewis², Zack Jud³, Jon Shenker⁴, and Aaron Adams^{2,5}

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Bonefish are typically thought of as 'flats fish' that reside in shallow, tropical and subtropical nearshore coastal waters. However, evidence from tagging and acoustic tracking studies indicate that bonefish migrate to staging areas, form large aggregations (>5000 individuals), and then move to deep-water drop-offs at dusk to spawn. Because the offshore spawning occurs under the cover of darkness, visual observations of the actual bonefish spawning events are not possible. Fortunately, behaviors during pre-spawning aggregations provide clues related to putative spawning bouts. For multiple locations in The Bahamas, we report on repeatable, predictable behaviors of bonefish in large prespawning aggregations. Just prior to moving from shallow to deeper waters, bonefish are observed breaking the water surface and then returning to the aggregation. Bubbles are then observed emerging from the swirling aggregation; potentially gas being released from the bonefish. Ventral nudging, or one fish rubbing its snout on the ventral region of another, has also been observed. Preliminary evidence from gonad histology provides support that the offshore movements are for spawning. Based on the depth profile of acoustically tagged fish, we hypothesize that some observed behaviors are related to pneumatic assist of egg release during spawning bouts.

Talk #32 - Saturday 1:45 – 2:00pm

Population Dynamics in the Bahamas: Assessing Sixty Years of Bonefish, Tarpon, and Permit Through Ethnography

Thomas Karrow¹, Brenna M. Sweetman², Jordan R. Cissell², Michael K. Steinberg²

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Recreational flats fishing for tarpon (*Megalops atlanticus*), permit (*Trachinotus falcatus*), and bonefish (*Albula vulpes*) is vital to Family Island Bahamian tourism. According to Fedler (2010), flat fishing in The Bahamas exceeds \$141 million USD annually, and on Andros alone, inshore angling comprises more than 80% of total annual tourism expenditures. As a result of logistical challenges facing quantitative assessments of game fish population dynamics, a growing body of research emphasizes the importance of qualitative local knowledge as a means to fill gaps in data-poor areas. In this study, we surveyed 60 professional Bahamian guides on Abaco (n=13), Andros (n=28), Bimini(n=4), Exuma (n=5), and Grand Bahama (n=10) in 2014, 2015 and 2016, to assess changes in fish populations and examine sustainability of local fisheries. We documented guide perceptions of gamefish population changes dating back to the 1950's, when some participants began guiding, up to 2010. Combined, these guides offer more than 1,700 years of direct, guiding experience in Bahamian fisheries, with a range of 10 to 60 years per person, and an average of 29 years per person. Qualitative formally structured, ethnographic interviews were conducted and results were then quantified to allow for statistical examination. Specific attention was directed toward assessing any significant differences in rates of population change among species and locations, as potential discrepancies and their underlying drivers, hold important implications for the prioritization and organization of ongoing management and monitoring efforts.

Talk #33 - Saturday 2:00 – 2:15pm

A Closer Look at a Mangrove Die-off: A Case Study from Abaco, The Bahamas

Ryann E. Rossi¹, Stephanie K. Archer², Craig A. Layman¹

¹*Department of Applied Ecology, North Carolina State University, Raleigh NC 27695 (ryann.rossi@gmail.com);*

²*Pacific Biological Station, Department of Fisheries and Oceans Canada, British Columbia*

Mangroves are foundation species in coastal ecosystems providing an estimated US \$1.6 billion in ecosystem services worldwide. Unfortunately, mangrove forests are declining because of myriad factors, many related to human activity. Although human activities are the driving cause of mangrove loss globally, natural factors result in mangrove loss. Here, we present a case study from Abaco, The Bahamas in which a die-off of dwarf red mangroves (*Rhizophora mangle*) was reported by local fishermen. Initial data suggest that prior to death these dwarf red mangroves are stressed by multiple factors, including a fungal pathogen, herbivory, and altered abiotic conditions (e.g., hyper-salinity). We used field experiments to better understand interactions between multiple stressors in this region while also using publicly available LANDSAT satellite imagery to map the die-off region and to determine the approximate year die-off began. We conducted two experiments to examine the role of herbivory and plant disease in the die-off region. First, we excluded herbivores from individual mangrove trees in the die-off region. We found that herbivory alone was not a major contributing factor to the die-off, but that grazed leaves were positively correlated with disease incidence. Second, we conducted a simulated grazing experiment to test the interaction between grazing and disease incidence on leaves. We found that grazed leaves had greater disease severity than control leaves and a positive correlation between grazed leaves and disease incidence. Annual LANDSAT images from 1984 to 2014 were transformed to normalized vegetative index (NDVI), a metric for greenness. We compared mean greenness across the die-off region and found a drastic decrease in mean greenness in 2010 that was not associated with a hurricane event.

Talk #34 - Saturday 2:15 – 2:30pm

Factors Influencing Post-release Predation for a Catch-and-Release Fishery with a High Predator Burden

Robert J. Lennox^{1,2}, Alexander Filous^{2,3}, Sascha Clark Danylchuk², Steven J. Cooke¹, Jacob W. Brownscombe¹, Alan M. Friedlander⁴, Andy J. Danylchuk^{2,3}

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³*Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, MA, 01003, USA;*

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Post-release predation is an increasingly recognizable component of post-release mortality across fisheries sectors. Although predators of all taxa have declined in abundance worldwide, emerging fisheries in remote parts of the world can be at odds with predators when there is significant risk of post-release predation on fish that are released. We studied bonefish *Albula glossota* in a remote Pacific atoll with dense blacktip reef sharks to quantify post-release predation and identify best practices. Our research on angled bonefish focused on identifying how air exposure influenced the probability of post-release predation by sharks. Recognizing and accounting for post-release predation in these remote fisheries is the key to sustainability in the fishery. Our findings and suggestions for future research will contribute to best practices for fishing in regions with high predator burden.

Talk #35 - Saturday 2:30 - 2:45pm

What's in the Angler's Control – Insights into Best Practices for Catch-and-Release of Bonefish, Tarpon, and Permit

Andy J. Danylchuk¹, and Steven J. Cooke²

¹*Department of Environmental Conservation, University of Massachusetts Amherst, 160 Holdsworth Way, Room 311, Amherst, MA 01003-9485 USA;*

²*Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6*

Some elements of an angling event are out of our control, however, when practicing catch-and-release there are a number of decisions anglers make that can influence the effectiveness of this conservation tool. Catch-and-release operates under the assumption that the angling event has little or no negative consequences on the fish, yet physical injury and stress associated with being captured and handled can influence the fate of fish upon release, particularly in predator-rich environments. Here, we present the current status of scientifically-based best practices that recreational anglers can use to aid in the conservation of bonefish, tarpon, and permit stocks. We will also highlight some recent campaigns (e.g. Keepemwet Fishing) that help inform anglers about best practices for catch-and-release, and how they can take more responsibility over the fate of their catch.

Talk #36 - Bahamas Panel

Saturday, November 11, 3:00 - 5:00 pm, Amphitheater

Sponsored by Bakers Bay Resort

Moderator: Aaron Adams

BTT has continued to expand its efforts in The Bahamas, with plans to further broaden its reach. Efforts thus far have resulted in identification of important bonefish habitat (home ranges, spawning migration pathways, and pre-spawning aggregation sites), contributing to the designation of six national parks, and developing, in collaboration with Bahamas National Trust, a flats ecosystem curriculum. The panel discussion during The Bahamas Session will address successes to date, ongoing challenges, and priorities for moving forward. Important topics that will be addressed include habitat protection, best catch & release practices, illegal netting, education, and management strategies.

Panel:

Shelley Cant-Woodside – Director of Science and Policy, Bahamas National Trust

Eric Carey – Executive Director, Bahamas National Trust

Markk Cartwright – Fishing guide, lodge owner - Long Island Bonefishing Lodge

Jason Franklin – Fishing guide, lodge owner H2O Bonefishing, Grand Bahama Island

Justin Lewis – BTT

Buddy Pinder – Fishing guide, Abaco; Abaco Fly Fishing Guides Association

Benjamin Prat – Senior Manager, Ministry of Tourism

Benry Smith – Fishing guide, Andros

Oliver White – Lodge owner - Abaco Lodge, Abaco; Bair's Lodge, Andros

Cindy Pinder – Abaco Fly Fishing Guides Association

Science Abstract Posters



6TH INTERNATIONAL SCIENCE
SYMPOSIUM

Poster #1 - Recruitment of Tarpon Leptocephali into South Carolina Marshes

Danielle L. Juzwick¹, Austen Zugel¹, Eric R. Haffey², Marvin M. Mace III²,
Matthew E. Kimball², Jonathan M. Shenker¹

¹Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32904, USA (djuzwick2016@my.fit.edu);

²Baruch Marine Field Laboratory, University of South Carolina, PO Box 1630, Georgetown, SC 29442, USA

Tarpon nursery habitat in the southeastern United States typically consists of coastal mangrove and marsh habitats, mainly in Florida. Larvae are transported north of Florida by the Gulf Stream to marsh habitats in South Atlantic Bight estuaries, including those in coastal South Carolina near the northern limit of their distribution in the western Atlantic Ocean. Although most of the juveniles presumably do not survive cold winters in these temperate habitats, examining the recruitment dynamics into South Carolina marshes can provide information on spawning biology of adults, larval transport processes, and the potential value of marsh habitats in coming decades as climate change alters the thermal regime experienced in estuaries in this region. We report here the collection of several hundred metamorphosing leptocephalus larvae and early juvenile tarpon during June–November 2016 during estuarine ingress and in high marsh pools in the North Inlet–Winyah Bay estuarine system in Georgetown County, South Carolina, USA. Tarpon leptocephali were captured during estuarine ingress from June through November. Soon after recruiting into the system, larval and small juvenile tarpon co-occurred in high marsh pools from July to November. Sagittal otoliths were removed from 36 leptocephali, and daily increments were counted to determine age at capture. These age data will be used to back-calculate presumed spawning dates and potential locations of the adult spawning populations. An increase in tarpon length observed during their residency in high marsh pools suggests that these and other similar small, shallow, and tidally-restricted marsh habitats function as initial nursery habitats in South Carolina estuaries. Continued monitoring will be performed in the North Inlet–Winyah Bay estuarine system to assess recruitment and survival of juvenile tarpon in a habitat that may become increasingly important for the species in the future.

Poster #2 - Diet Characterization and Gill Raker Morphology of Bonefish, (*Albula* sp. cf. *vulpes*), in the Indian River Lagoon, Florida

M. Christine Draghetti¹ and Jonathan Shenker²

¹Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Department of Natural Resources and Environmental Sciences, 1816 S. Oak Street, Champaign, IL 61821;

²Department of Biological Sciences, Florida Institute of Technology, 150 W. University Boulevard, Melbourne, FL 32901, (shenker@fit.edu)

Bonefishes support very valuable recreational fisheries in the Florida Keys, Bahamas, Caribbean Islands, and around the Gulf of Mexico. Recent genetic research has shown that the well-known *Albula vulpes* is actually a multi-species complex, with at least three morphologically similar species of bonefishes co-occurring throughout the region. In fall 2012, 50 juvenile bonefish were collected along the shoreline of the central Indian River Lagoon, far north of their typical habitat. Genetic analysis by D. E. Wallace identified these fish as the as-yet undescribed *Albula* sp. cf. *vulpes*. Gut content analyses of these juveniles showed that the 29–105 mm juveniles fed primarily on benthic harpacticoid copepods and opportunistically on larger invertebrates such as mysids, cumaceans, and cirriped larvae. Unusual gill raker morphology appears to influence their ability to winnow their prey from sandy substrate. Hypotheses about the reason for the occurrence of juvenile bonefish outside their traditional habitat include natural recruitment variability, variation in thermal regimes, and loss of sea grass in the Indian River Lagoon.

Poster #3 - The Artisanal Fisheries for Tarpon (*Megalops atlanticus*) in Brazil: Conflicts between Social and Ecological Applications

Cezar Fernandes¹, Guilherme Gondolo², Werllane Magalhães³ and Edna Cunha¹

¹Department of Fishing Engineering, Federal University of Piauí, 2819 Parnaíba, PI, Brazil 64202-020 (cezaraff@hotmail.com);

²State University of Piauí, Campo Maior, PI, Brazil 64280-200;

³Instituto Tartarugas do Delta, Parnaíba, PI, Brazil 64220-000

Tarpon *M. atlanticus* is commonly caught by artisanal fisheries in Delta of Parnaíba in Brazil, using gillnets and longline fishing gears, with records of around 40 adults average per year. A local design for TURF's (Territorial Unit Rights of Fisheries) for the management plans is getting built, but conflicts between social and ecological protocols decreases potential in efficiency. During the period between December 2013 and November 2014, fisherman logbooks were analyzed and we also applied traditional ecological knowledge (TEK) interviews. Daily catch data reports were obtained including production, effort, by-catch, and fish length and weight were measured (total length and total weight). Different life history stages of tarpon groups were observed in the fisheries: 458 juveniles in the lagoons (8-46 cm TL), 43 sub-adults and adults (88-228 cm TL) in the near coast off shore reefs (~14 nautical miles). Younger catches have been occurring by very poor families living around lagoons and with no other occupation or any mitigation measures from local government. Adults have another ecological strength in Delta, due to fisheries landings showed correlation with specimens in actively spawning condition (hydrated gonads), and in this last case, due to the high local market prices (~100 dollar per gonad-kg). Efficiency in the local management plans and fisheries regulation exhibited a conflict between social and ecological paradigms, and no changes occur without local governance, fisheries control and strategies for social opportunities.

Poster #4 - Age and Development of Tarpon, (*Megalops atlanticus*), Leptocephali Collected from a Northern Gulf of Mexico Estuary

Patrick Graham, James Franks, Jason Tilley, John Anderson

The University of Southern Mississippi, School of Ocean Science and Technology, Gulf Coast Research Laboratory, Center for Fisheries Research and Development, 703 East Beach Dr., Ocean Springs, MS 39564 (Patrick.m.graham@usm.edu)

The biology and ecology of Atlantic Tarpon (*Megalops atlanticus*), including early life stages, in the northern Gulf of Mexico (nGOM) are poorly known. Tarpon possess a unique larval form (leptocephalus) transported on ocean currents from offshore spawning grounds to inshore nursery areas. Atlantic Tarpon leptocephali (n=104) collected from the Mississippi Sound estuary between 2006 – 2017 are thought to be the product of suspected Tarpon spawning activities in offshore waters of the nGOM. All leptocephali were collected July – October from nearshore waters adjacent to sandy beaches and fringing marshes using a beam plankton (BPL) trawl. Specimens ranged 16.0 – 27.8 mm SL (mean 23.2 mm SL) and were identified as being in pre-metamorphic and metamorphic stages of development. Preliminary age estimates based on otolith (sagittae) microstructure analysis ranged 20 – 48 days. Hatch dates range from late June – mid-September and correspond temporally with recent findings of spawning capable Atlantic Tarpon collected from the nGOM. Ongoing studies focus on determining the geographical source of the larvae using ocean current models coupled with age (daily) to hindcast transport pathways and identify spawning areas of Atlantic Tarpon in the nGOM.

Poster #5 - Natural Feeding of Juvenile Individuals of (*Megalops atlanticus*) Valenciennes, 1847 (Elopiformes: Megalopidae) Caught by Fishing Operations in the Delta of the Parnaíba River, Brazil

Amanda Grazielle Araújo Resende¹, Maria Amélia Guimarães do Passo Gondolo^{2,3}, Cezar Fernandes⁴, Werlanne Magalhães³ Guilherme Fernandez Gondolo^{3,5}

¹Universidade Federal Rural de Pernambuco – UFRPE. Serra Talhada, Pernambuco, Brazil;

²Centro de Ciências Agrárias – CCA, Campus Poeta Torquato Neto, Universidade Estadual do Piauí – UESPI, Teresina, Piauí, Brazil;

³Instituto Tartarugas do Delta, Estrada PI 116, km 7,5, Luís Correia, Piauí - Brazil;

⁴Department of Fishing Engineering, Federal University of Piauí, 2819 Parnaíba, PI, Brazil;

⁵Centro de Referência em Aquicultura e Recursos Pesqueiros (CERAQUA). Praia da Pedra do Sal, Ilha Grande de Santa Isabel. Parnaíba – PI, Brazil (gondolo@gmail.com)

Studies on the feeding habits of species contribute to understanding and determining their relationships with the surrounding environment and other species with regard to sharing natural resources. The aim of the present study was to determine the diet of juvenile individuals of *Megalops atlanticus* caught by commercial fishing operations in the delta of the Parnaíba River in the state of Piauí, Brazil. Collections were performed between June 2014 and April 2015. Eighteen to thirty-six individuals were sampled on a monthly basis. Processing of the sample was performed in the following order: morphometric measures of total length, standard length and weight of the individuals and removal of the stomachs for the analysis of the contents. Among the stomachs sampled, the degree of fullness, degree of digestion of the food items encountered and identification of food items (when possible) were determined. An analysis of the importance of food items to the diet was also performed using the relative importance index (RII). Two hundred seventy-one individuals were sampled, 103 of which had stomach contents. In the overall sample, length ranged from 89 to 460 mm. The diet of the juveniles had 17 different items, predominated by insects and fishes, which together accounted for 97.6% of the RII. Insects constituted the most consumed items based on frequency of occurrence and numeric frequency and fishes constituted the most important items by weight. The juveniles of this species can be characterized as specialists, since only two groups of organisms constituted nearly the entire diet. The other items in the stomachs can be considered the result of incidental or accessory ingestion. The feeding habits of this species in the juvenile phase can exert a negative influence on the already fragile preservation of this species in the study area, due mainly to the capture of small individuals that have not reached size at first sexual maturity, which affects the reproductive capacity of the population and, consequently, the replacement of the stock. This species is threatened with local extinction and objective criteria are needed to regulate fishing activities, especially with regard to catch size, to avoid the capture of individuals before entering the adult phase.

Poster #6 - Developing Bonefish Aquaculture: Egg and Larval Development

Bob Halstead¹, Paul Wills¹, Jon Shenker², Aaron Adams^{1,3}, Matt Ajemian¹, Chris Robinson¹

¹Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946

²Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32901

³Bonefish and Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146

Due to reported declines in bonefish (*Albula vulpes*) stocks throughout the Caribbean, but specifically the Florida Keys, new research is needed to determine causes and mitigate further declines. One method to mitigate further losses is through aquaculture. By developing a culture model for bonefish, managers would be able to temporarily maintain and boost wild populations until these populations can recover independently. To begin this process, broodstock were collected from the Florida Keys. Data from the collection, transport, acclimation to a captive environment, and feeding will be presented. Since volitional spawning in captivity is not expected, hormone injections will be used to induce spawning. Preliminary data from these trials will be presented as well. After a successful spawn attempt, the development of fertilized eggs and larvae need to be described. Eggs and larvae are difficult to collect from the wild, so there is incomplete knowledge of these life stages. This will provide valuable information about early bonefish ontogeny and provide development benchmarks for future spawns (e.g. when hatching occurs). Preliminary data from larvae development will be presented.

Poster #8 - Recruitment of Tarpon Leptocephali into South Carolina Marshes

Danielle L. Juzwick¹, Austen Zugel¹, Eric R. Haffey², Marvin M. Mace III²,
Matthew E. Kimball², Jonathan M. Shenker¹

¹Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32904, USA (djuzwick2016@my.fit.edu);

²Baruch Marine Field Laboratory, University of South Carolina, PO Box 1630, Georgetown, SC 29442, USA

Tarpon nursery habitat in the southeastern United States typically consists of coastal mangrove and marsh habitats, mainly in Florida. Larvae are transported north of Florida by the Gulf Stream to marsh habitats in South Atlantic Bight estuaries, including those in coastal South Carolina near the northern limit of their distribution in the western Atlantic Ocean. Although most of the juveniles presumably do not survive cold winters in these temperate habitats, examining the recruitment dynamics into South Carolina marshes can provide information on spawning biology of adults, larval transport processes, and the potential value of marsh habitats in coming decades as climate change alters the thermal regime experienced in estuaries in this region. We report here the collection of several hundred metamorphosing leptocephalus larvae and early juvenile tarpon during June-November 2016 during estuarine ingress and in high marsh pools in the North Inlet-Winyah Bay estuarine system in Georgetown County, South Carolina, USA. Tarpon leptocephali were captured during estuarine ingress from June through November. Soon after recruiting into the system, larval and small juvenile tarpon co-occurred in high marsh pools from July to November. Sagittal otoliths were removed from 36 leptocephali, and daily increments were counted to determine age at capture. These age data will be used to back-calculate presumed spawning dates and potential locations of the adult spawning populations. An increase in tarpon length observed during their residency in high marsh pools suggests that these and other similar small, shallow, and tidally-restricted marsh habitats function as initial nursery habitats in South Carolina estuaries. Continued monitoring will be performed in the North Inlet-Winyah Bay estuarine system to assess recruitment and survival of juvenile tarpon in a habitat that may become increasingly important for the species in the future.

Poster #9 - Socioeconomic Characterization of Cuban Recreational Fisheries

Laura López Castañeda¹ and Jorge Angulo Valdés²

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²School of Natural Resources and Environment, University of Florida, Gainesville, Florida, FL 32611, USA (jorgeangulo@ufl.edu)

Often, studies on the fisheries focus heavily on biological and ecological information. While it is important to ascertain the conservation or characteristics of coastal areas according to such indicators, equally important is assessing conditions towards socio-economic factors. Socio-economic information can provide resource managers essential information regarding perceived socio-economic trends and changes as they relate to these conservation areas. In Cuba, the fishery studies have been fundamentally about industrial fisheries. The study of Cuban recreational fisheries is quite important too because of the catch levels in some regions, the economic role in the subsistence of some coastal communities and the lack information about it. This study characterizes recreational fisheries in Cuba, which is a mixture of subsistence fishing, recreational fishing and harvest for sale. It draws on a socioeconomic study of recreational fisheries in general and some selected sport-fishing ports. Indicators such as catch levels, main species, fisher gears, sale prices, legal system and others were collected. We conducted scoping trips in north-central, northeast, south-central and southeast of Cuba and visited some ports. Information was collected using a survey with sport fishermen and the government enterprises' staff. A total of 29 sport fishing ports were visited during the last two years. Preliminary results suggest that continuous socio-economic and biologic monitoring and educational outreach are necessary to ensure the success of these conservation areas in achieving human well-being and management objectives.

Poster #10 - Characterizing Habitat Preference and Steroid Hormones During the Reproductive Cycle of Bonefish (*Albula vulpes*)

Cameron Luck¹, Sahar Mejri¹, Matthew J. Ajemian¹, Paul Wills¹, Aaron Adams^{1,2}, Justin Lewis²

¹Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL 34946

²Bonefish and Tarpon Trust, 135 San Lorenzo Avenue, Suite 860, Coral Gables, FL 33146

Bonefish (*Albula vulpes*; Elopiformes, Teleostei) in Grand Bahama, Bahamas, form pre-spawning aggregations seasonally and with lunar periodicity. Aggregations occur repeatedly in several locations uniquely selected for staging and passage to spawning sites, however, little is known about the drivers of these events. Abiotic factors such as salinity and sea surface temperature may act as cues for migration to pre-spawning sites. We evaluate known home range, corridor, and pre-spawning aggregation sites against spatial and geophysical data to determine suitable sites for pre-spawn movement and aggregation to be able to inform spawning behavior. In conjunction, we will determine primary steroid hormone levels. Cyclical changes in the reproductive hormones of teleost fishes are known to occur during reproductive cycles and help understand reproductive behavior and gametogenesis. However, there are no data available on primary steroid hormone levels that are linked to spawning in Bonefish. Thus, quantifying gonadal steroid hormones will provide an indication of the hormone dynamics within Bonefish aggregations. In this study, whole blood was collected from Bonefish at multiple stages of aggregation during spawning and non-spawning seasons. Samples were analyzed via immunoassay for estradiol-17 β (E2), testosterone (T), 17 α -hydroxyprogesterone (17 α -OHP), and 17 α , 20 β -dihydroxy-4-pregnen-3-one (17 α , 20 β -DHP). Preliminary data for both components will be presented.

Poster #11 - Integrating Remote Sensing, Citizen Science, and Statistical Methods to Assess Seagrass Die-off in Florida Bay

Cynthia McGinnis¹, Matt Patterson², Jordan Cissell³, Michael Steinberg⁴

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³Department of Geography, University of Alabama, 739 University Boulevard, Tuscaloosa, Alabama 35487;

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In tropical estuaries, seagrass beds are ecologically and economically critical resources. They are especially important as feeding and foraging areas for sportfish including *Albula vulpes* (bone fish), *Megalops atlanticus* (tarpon) and *Trachinotus falcatius* (permit). In 2015-2016, Florida Bay, within Everglades National Park (ENP), experienced an unprecedented seagrass die-off. The park has estimated over 16,000 hectares of the seagrass beds have been affected by the die-off. The sportfish supported by Florida Bay's seagrass beds are all highly sought after by anglers, with the local fishing industry contributing more than \$6 billion in revenue to the state of Florida each year (Johns et al., 2001). Worldwide seagrass beds are disappearing due to stress from land-use changes, improper anchoring and mooring practices, boat propeller scarring, global climate change, disease, invasive species and algal blooms. This project examined the extent of Florida Bay's seagrass die-off using three complementary methods. First, high-resolution drone imagery was classified to map changes in seagrass extent over time. Second, we measured seagrass densities at sample locations in Florida Bay basins during fieldwork campaigns in the summers of 2016 and 2017. This imagery gave us the ability to analyze the die-off using an unsupervised classification approach to monitor the changes over time. We also measured seagrass density at multiple locations. Nearest neighbor analysis conducted in a geographic information system (GIS) was used to extrapolate these *in situ* observations to larger spatial scales. Third, we mapped and calculated the perceived extent of the die-off using citizen science, consulting local knowledge keepers through the Key Largo Fishing Guides Association and Florida Keys Fishing Guide Association. These three methods allow us to gain a better understanding of the impacts of the die-off, and develop a baseline data set that will inform future assessments of change and recovery in these important habitats.

Poster #12 - Juvenile Tarpon and Bonefish Habitat Characterization in Isle of Youth, Cuba

Zenaida María Navarro-Martínez¹, Lisandra García-Córdova², José Miguel Febles-Díaz¹, Jorge Angulo-Valdés³, Mindy J. McLarty⁴, Daniel Gonzalez-Socoloske⁴

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²Biology Faculty, University of Havana, Havana, Cuba, Calle 25 # 455 e/ J e I, Plaza Vedado, CP 10400, Habana, Cuba;

³School of Natural Resources and Environment, University of Florida 103 Black Hall, Gainesville Florida 32611, United States of America;

⁴Department of Biology, Andrews University, 4280 Administration Dr., Berrien Springs, Michigan 49104, United States of America

Current knowledge about tarpon and bonefish habitats and ecology in Cuba is very poor. As part of a long-term collaboration effort between BTT, University of Florida, and University of Havana, a Tarpon Habitat Characterization Project has started. The study site selected is the Lanier Swamp area at the Isle of Youth, Cuba. The Lanier Swamp is a RAMSAR site and a Faunal Refuge. Juvenile tarpon and bonefish have been observed in the area and local fishermen have confirmed their abundance. Preliminary results have shown that the area contains features suitable for juvenile tarpon such as: high salinity (34 to 40 ppt.), high water temperature (22 to 27 degrees Celsius), low dissolved oxygen (0.02 to 2.51 g/ml), and murky waters. Side Scan Sonar technology allowed the identification of six different bottom types. Tarpon catches yielded an average fork length of 66.64 cm (mid-size juvenile) in deeper waters and 20 cm fork length in shallower areas. The presence of the invasive species *Clarias* sp. was documented, so its possible impact as predator of small juvenile tarpon should be taken into consideration for conservation actions.

Poster #13 - Cuba Leptocephali

Montana Steell¹, Elizabeth Wallace², Mitchell Roffer³, Jonathan Shenker¹

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²Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 8th Ave. SE, St. Petersburg, FL 33701;

³Department of Marine and Environmental Systems, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32901 and Roffer's Ocean Fishing Forecasting Service, Inc. 60 Westover Drive, West Melbourne, Florida 32904

Bonefish populations in Cuba potentially have significant influences on the recruitment dynamics of populations throughout the Caribbean, Bahamas and Florida. Little is yet known, however, about the production and transport of larvae within and out of Cuban habitats. We collected 150 metamorphosing bonefish leptocephali in June 2016 in light traps deployed along a sandy shoreline on the southwest coast of the Isla de Juventud, south of the main island of Cuba. These larvae could potentially be derived from three species of bonefish that have overlapping ranges in the tropical Western Atlantic. Therefore, a DNA sample from each larva was analyzed to determine species identity. Larval otoliths were analyzed to age each larva, and used to back-calculate the presumed spawning dates. Data on species identity, spawning dates, larval durations and potential larval transport pathways will be presented.

Poster #14 - Analysis of Water Quality in the Port Honduras Marine Reserve, Belize: A Case Study of Human Impacts on a Diverse and Critical Marine Landscape

Brenna Sweetman¹ and Michael K. Steinberg²

¹Department of Geography, University of Alabama, Tuscaloosa, Alabama (bsweetman@crimson.ua.edu);

²Department of Geography, Tuscaloosa, Alabama (mksteinber@ua.edu)

Understanding water quality in the Port Honduras Marine Reserve (PHMR) of Southern Belize is critical because of its importance as habitat for *Megalops atlanticus*, *Centropomus undecimalis* and *Trachinotus falcatus* fisheries. It is also an important economic landscape for sport fishing in Belize, and a destination zone for permit angling. This analysis was a case study to examine spatial and temporal changes in water quality in the PHMR region and surrounding watersheds. Over the past few decades the watersheds that flow into PHMR have been severely impacted by human activity such as agricultural-driven deforestation and shrimp farming, increasing the risk of poor water quality that enters the PHMR ecosystem. Water quality data collected from 41 sites over a 15-year time period was analyzed and trends in dissolved oxygen, nutrients, salinity, temperature and turbidity were analyzed for statistically significant relationships. The purpose of this study was to facilitate a greater understanding of the area's natural resources, assist in developing climate change mitigation strategies, and demonstrate the importance of water quality for sustaining healthy sport fisheries and the local economy.

Poster #15 - Olfactory Sensing in Leptocephalus Larvae

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Leptocephali are an unusual type of larvae that characterize the Elopomorph fishes: eels, bonefish, tarpon, and ladyfish. These larvae all share certain characteristics including a compressed transparent body composed primarily of glycosaminoglycan, forward-pointing teeth and a tubular gut. Previous studies have shown that the retinas of these larvae are rod-dominated, which does not permit the high daytime visual acuity of the cone-dominated larvae of most other teleost fishes. Leptocephali eat marine snow and other transparent gelatinous materials. Because of their lack of visual acuity, we hypothesize that they have enhanced olfactory capabilities that enable them to locate and consume the transparent gelatinous structures. SEM imaging of ladyfish leptocephali has shown very large olfactory pits, nearly the diameter of their eyes, suggesting that chemical odorants from gelatinous materials are important cues for locating food. SEM, and tissue-specific fluorescent stains and confocal microscopy, was used to further characterize and compare the olfactory apparatus of a variety of leptocephalus larvae and of other teleost larvae that are visual feeders.

Poster #16 - A Key Informant Analysis of Local Ecological Knowledge and Perceptions of Bonefish Decline in South Florida

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Local ecological knowledge (LEK) is a valuable method to capture environmental and/or resource changes when there is an absence of biological data. Since the bonefish fishery in South Florida is data limited, a goal of this study was to understand the temporal dynamics of bonefish decline over the last 40 years using LEK as a primary source. Another goal of this study was to assess whether varying fisher demographics, experience, and type may have an influence on stakeholder perception of bonefish decline. These goals were addressed through a series of 25 key informant interviews conducted with expert angler and fishing guides in South Florida. The results of this study suggest that the use of LEK when trying to understand population trends in data-poor ecological systems can be beneficial in addressing gaps in our ecological understanding, including temporal and spatial dynamics. This study also emphasizes the value of social science research methods in conjunction with ecological research to expand our understanding and the history of complex ecological systems as well as trends in natural resource use in south Florida.

Poster #17 - Juvenile Permit Size-class Structure and Population connectivity

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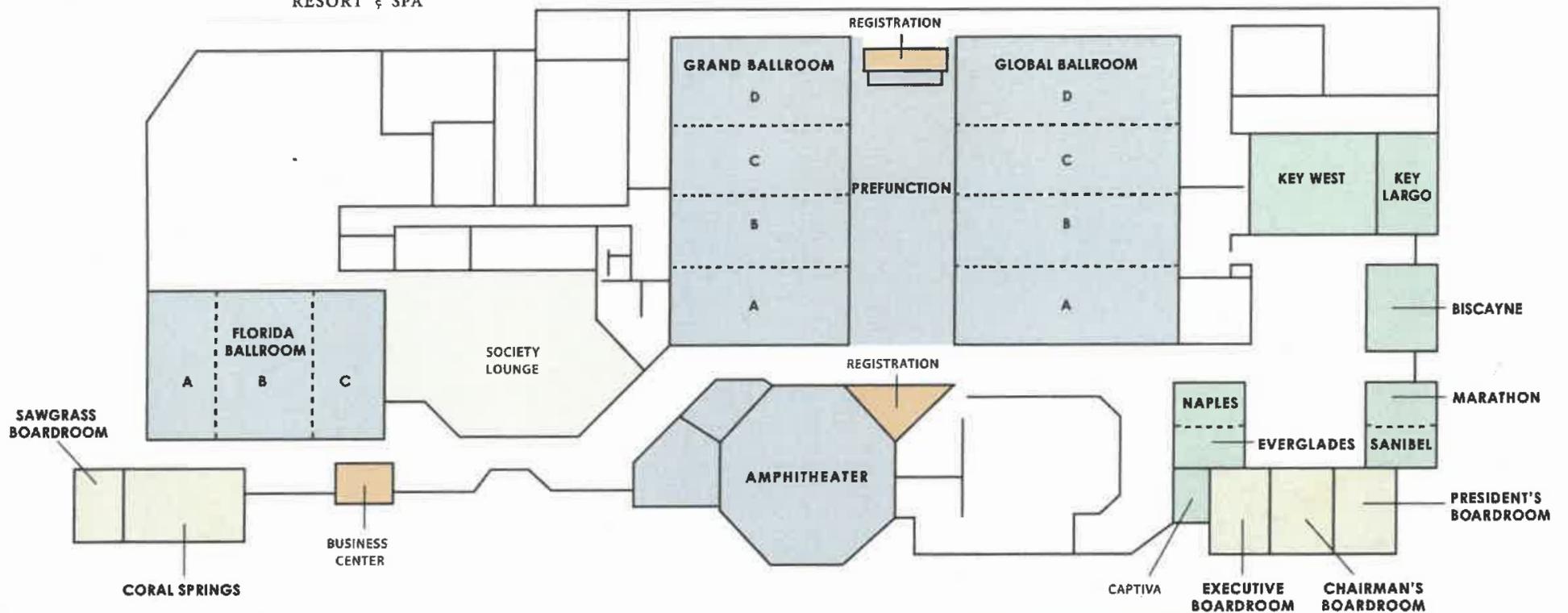
Knowledge about the biology and ecology of Permit fishes (*Trachinotus falcatus*) is very limited. Permits are key species targeted by the sport fishing industry in the Western Atlantic region, contributing greatly to the local economy of coastal communities such as Belize, Mexico and Florida. Understanding the abundance and size-class structure of juvenile Permits is vital for fisheries managers and the sport fishing industry. Nine sites were assessed for abundance and their size-class structure in the Turneffe atoll in Belize using a 15 x 1.5 m x 3mm mesh size beach seine during the years 2014 – 2017. A total of 1,477 juvenile Permits ranging from 5 – 180 mm in Standard Length (SL) were caught during those years, with the highest abundance observed in the summer of 2016 with a total catch of 608. Overall, Calabash Caye, South of Calabash, and the Grassy Range-Cockroach Caye sites had the greatest abundance of juvenile Permits. Abundance varied from year to year and within sites. No juvenile Permits were caught in sites with mangrove shorelines. Size class structure varied from year to year and among sites but significant differences were observed between some of these sites. A total of 205 fin clips were also collected to assess regional connectivity of the Permit fish population in the Western Atlantic region using the DLOOP and Cytochrome-b mitochondrial markers. Fin clip samples were collected from Belize (Turneffe atoll and near coastal islands in the north), Mexico (Ixcalak and Ascension Bay), Florida Atlantic, and North Carolina.

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