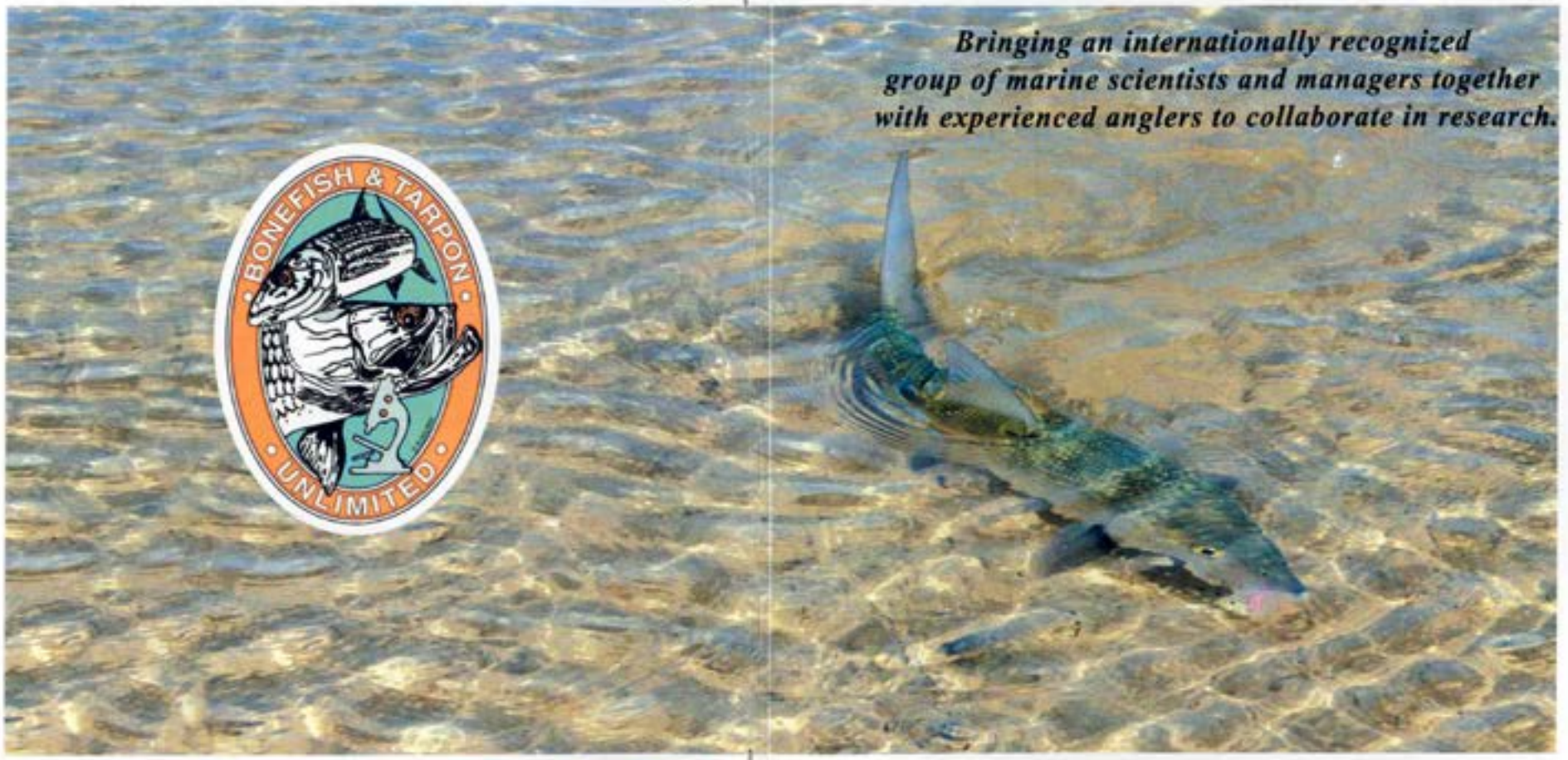
"If I fished only to capture fish,
my fishing trips would have ended long ago."

Zane Grey
from "The Silver King"

2nd International Bonefish & Tarpon Symposium



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January 9, 2006
IGFA Fishing Hall of Fame & Museum
Dania Beach, Florida USA

2nd International Bonefish & Tarpon Symposium

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2nd International Bonefish & Tarpon Symposium

BACKGROUND TO SYMPOSIUM:

Bonefish and tarpon, some of the most spectacular game fish in terms of speed and power, support economically-important recreational fisheries in warm temperate, subtropical and tropical coastal waters throughout the world. Both fishes share an ancient lineage with seemingly disparate fishes like ladyfish and eels. Despite the wide popularity and ecological importance of bonefish and tarpon, there is currently insufficient biological and population dynamic data to base management strategies for sustainable fisheries.

This is a cause for concern. The Texas coast used to be home to a healthy world-class tarpon fishery, which today is all but non-existent. Similar patterns of decline have also been noted in Florida. Florida is now being promoted as fishing capital of the world, particularly for prized game fish like bonefish and tarpon. In fact Florida accounts for more than half of the standing world records published by the International Game Fish Association in 2001. South Florida fisheries alone represent an $8 billion dollar economy annually. However, Florida's marine fisheries are undergoing extensive changes due to rapidly growing human population size, significant fleet growth, and environmental changes and increasing exploitation effects.

This is a particular concern because growing human populations are escalating pressures from non-directed fisheries, incidental mortality from catch-and-release, unreported harvests, habitat degradation, loss of key spawning and nursery areas, and indirect fishery ecosystem effects that threaten the viability and longer-term sustainability of these fisheries. Concomitantly, much of the critical population-dynamic information needed for sound fishery management decision-making is virtually lacking. For example, as tarpon are still killed for roe and meat for food in various parts of their range, knowledge of their migration pattern is key to their protection. Even more distressing is the fact that little attention has been paid to the design of scientific and management programs to support conservation of these incredibly important species.

Because of the ever increasing relationships in scientific and sport fishing interests, this Symposium will be organized to provide discussion and broad communication between scientists, managers, professional guides, anglers and the public about these magnificent sport fishes.

2nd International Bonefish & Tarpon Symposium

GOALS AND OBJECTIVES:

The 2nd International Bonefish and Tarpon Symposium being held at IGFA Headquarters in Dania, January 9 & 10 will bring scientists from around the world together providing a forum to present their research. Much work has been accomplished since the first Symposium in 2003. The goal is to present new thoughts, provide synthesis and consensus on appropriate scientific research approaches, and develop mechanisms to disseminate that knowledge that helps guide fishery management and conservation efforts to build sustainable fisheries for bone fish and tarpon. To accomplish this goal, the symposium's objectives will focus on a series of comparative synthesis sessions providing historical perspectives on fisheries and their status, facets of early life histories, recruitment, population biology, environmental effects, behavior, movements and migration, and fishery exploitation effects. The symposium will bring together world-class experts to discuss issues in fishery management such as scientific knowledge gaps, concerns of professional guides and anglers, and then focus on research necessary to support evolving conservation and management strategies.

ORGANIZATION OF TECHNICAL SESSIONS & SYMPOSIUM PUBLICATION:

Presentations will summarize original scientific research or knowledge on bonefish and tarpon biology, population dynamics, stock assessment, modeling and management. Papers covering aspects of bonefish, tarpon and permit life history, age and growth, behavior, physiology, genetics, reproduction and recruitment, movements and migrations, fishing and fishery exploitation, habitat-animal relationships, mariculture and stock enhancement, stock assessment, ecosystem management and fisher management experiences from various areas of the world have been submitted. The Symposium science program will be organized into three basic components: two sessions of oral presentations followed by Poster presentations. The morning session will cover Tarpon and the afternoon Bonefish, with a section on Permit. Following those approximately 11 Poster presentations will be made by their authors on various topics related to the three species.

2nd International Bonefish & Tarpon Symposium

Program
Monday, January 9, 2006

INTRODUCTIONS

8:30 – 8:40am	Tom Davidson – Chair Bonefish and Tarpon Unlimited Dave Philipp – Chair Fisheries Conservation Foundation

CONSERVATION FOUNDATION

8:40 – 8:45am	*Symposium Overview* – Russ Fisher, Bonefish and Tarpon Unlimited

Tarpon

8:45 – 9:20 am	*What do we know about Juvenile Tarpon? A Synthesis* – Jonathan Shenker, Florida Institute of Technology
9:20 – 9:40 am	*Conservation Genetics of Tarpon* – Larry McKinney, Texas Parks & Wildlife
9:40 – 10:00 am	*Mining Historical Data on the Recreational Tarpon Fishery in Southwest Florida* – Steve Bortone, Sanibel-Captiva Conservation Foundation
10:00 – 10:20 am	*Distribution and Seasonal Abundance of Tarpon in The Coastal Waters of Western Nigeria* — Patricia Anyanwu, African Regional Aquaculture Center
10:20 – 10:40 am	BREAK
10:40 – 11:00 am	*Trends in Northwestern Gulf of Mexico Recreational Tarpon Fishery* — William Dailey, Texas A&M University

11:00 – 11:20 am	*Estimates of Catch-and-Release Mortality Rates for Tarpon in Boca Grande Pass, Florida* — Kathryn Guindon, Florida Fish & Wildlife Research Institute
11:20 – 11:40 am	*Otolith Microchemistry of Juvenile Tarpon in Florida and Cayman Islands* — John O'Connell, Florida Institute of Technology
11:40 – 12:00 pm	*Satellite Pop-up Archival Tags to Study Migratory Patterns of Atlantic Tarpon* — Jiangang Luo, University of Miami RSMAS
12:00 – 12:30 pm	*Atlantic Tarpon Population Dynamics & Regional Fishery Management Strategy: A Synthesis* – Jerry Ault, University of Miami RSMAS
12:30 – 1:20pm	LUNCH

Bonefish

1:20 – 1:50 pm	*Aspects of the Biology, Ecology and Recreational Fishery for Bonefish at Palmyra Atoll National Wildlife Refuge, with comparisons to other Pacific Islands* — Alan Friedlander, NOAA & Oceanic Institute
1:50 – 2:10 pm	*Resolving Evolutionary Lineages of Bonefishes* — Steve Karl, University of Hawaii
2:10 – 2:30 pm	*Comparative Population Dynamics of Atlantic Bonefish: Florida and Los Roques Archipelago*— Juan Posada & Jerry Ault, Denise Debrot and Mike Larkin
2:30 – 2:50 pm	*Defining Juvenile Habitats: Filling a Critical Information Gap* — Todd Kellison, Aaron Adams, Kirby Wolfe, Mike Tringali and Liz Wallace
2:50 – 3:10 pm	BREAK

3:10 – 3:30 pm	*Handling Practices Effecting Mortality in Catch and Release Angling* — Sascha Danylchuck, Cape Eleuthera Institute, Bahamas
3:30 – 3:50 pm	*Tagging of Bonefish to Study Population Movements and Dynamics* — Mike Larkin, University of Miami RSMAS
3:50 – 4:10 pm	*Implications of Fishing on Management of Pacific Bonefish* — Being Yeeting, Secretariat of the Pacific Community, Noumea, New Caledonia
4:10 – 4:25 pm	*State of Knowledge – Permit* – Aaron Adams, Mote Marine Laboratory
4:25 – 4:40 pm	*Recent Findings Provide a Research Framework for Albula SPP in the Caribbean* — Aaron Adams, Kirby Wolfe, Mike Tringali, Liz Wallace and Todd Kellison
4:40 – 5:00 pm	*Bridging the Gap Between Research and Education in the Conservation of Coastal Flats* — Andy Danylchuck, Cape Eleuthera Institute, Bahamas

5:00 – 7:00 pm POSTERS

Genetic Species Determination of Bonefishes, Liz Wallace
Genetic Tracking of Atlantic Tarpon, Mike Tringali
Juvenile Tarpon Population Genetics, Jonathan Shenker
Evaluation of Juvenile Tarpon Feeding Habits, Matthew Scripter
Juvenile Permit Habitats, Kirby Wolfe
Acoustic Tracking of Line Caught Tarpon, Chris Powell & Kathy Guindon
Do Circle Hooks Reduce Mortality, Steven Cooke
Connectivity of Bonefish in the Bahamas & Belize, Eugenia Naro-Maciel
Bonefish Management Turks and Caicos, David Wilson
Florida Keys Bonefish Population Census, Jerry Ault & Sandy Moret
Classification of Nearshore Marine Habitats Used by Tarpon and Bonefish in the Wider Caribbean Basin, Phil Kramer & Mike Palmer

SILENT AUCTION

COCKTAILS

7:00 – 10:00 pm DINNER, LIVE AUCTION, "FISH STORIES"

Jonathan Shenker

WHAT DO WE KNOW ABOUT JUVENILE TARPON (*Megalops atlanticus*)?: A SYNTHESIS

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Despite the vaunted status of Tarpon, the Silver King, as one of the premier marine sportfishery species in the southern United States, the Caribbean, Bahamas, Central America, and eastern Africa, remarkably little is known about many aspects of its biology, ecology and population dynamics. This paper presents a brief summary of previous research on tarpon, and points out some of the major deficiencies in our understanding of this magnificent species. Research papers and posters presented during this symposium will help fill in these gaps, and will help set the direction of research priorities for the near future. The life history of tarpon starts with spawning, which occurs at unknown locations and has never been directly observed. Gonadal data and larval otolith data suggest that spawning occurs throughout much of the year in the lower latitudes, but is seasonal around Florida, with peak activity occurring around full moons during the summer. Planktonic leptocephalus larvae enter into coastal nursery habitats at around 20-25 days of age. Hurricanes and storm-driven oceanographic events may assist in driving larval recruitment into upper marsh nurseries. These nurseries include stagnant coastal mangrove marshes and lagoons where juveniles use their vascularized physostomus swim bladder to obtain oxygen by gulping air at the surface. As juveniles grow, they switch from a planktivorous/insectivorous diet to small fishes and crustaceans, and move from stagnant marshes into progressively larger bodies of water. We discuss these linkages in relationship to adult biology and migrations. We conclude on the vulnerability of life stages and discuss the top priorities for successful management.

Larry McKinney, Ivonne Blandon and Rocky Ward*

CONSERVATION GENETICS OF ATLANTIC TARPON

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Declines in tarpon, *Megalops atlanticus*, recreational fisheries have prompted proposals to artificially culture and stock this elite gamefish into marine waters. This study is one of a series designed to investigate stock structure in tarpon, providing the data necessary to design stocking strategies which respect the genetic integrity of enhanced populations. Tarpon samples were taken from across the distribution of the species including populations off Africa in the bay of Guinea and from the Pacific Ocean off Panama. A set of 15 polymorphic microsatellite DNA loci were identified from a genomic DNA library and from these 6 were chosen for inclusion in this study. Moderate to high levels of heterozygosity and other measures of genetic diversity were observed, including in the peripheral African and Pacific samples. Observed genetic divergence among sampling sites was limited with little indication of geographically coherent patterning except for peripheral populations which were genetically differentiated. Enhancement strategies are recommended which include 1) choice of collection sites for broodfish is probably not critical due to the lack of meaningful population structure across much of the range of this species and 2) the number of broodfish contributing to stocking cohorts must be large, to protect the genetic diversity observed in tarpon from the western Gulf of Mexico.

Stephen A. Bortone

MINING HISTORICAL DATA ON THE RECREATIONAL TARPON FISHERY IN SOUTHWEST FLORIDA

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The tarpon fishery along Florida's southwest coast has, and continues, to provide recreational anglers with a fishing opportunity. Questions regarding sustainability of this fishery have been asked in other regions of the world where the species has been intensely fished for an extensive time period. The data recorded on tarpon scales were examined to provide a perspective on the long-term changes (or stability) of this fishery. Historically, fishers captured tarpon and subsequently recorded information regarding their catch directly on the scale. Nearly 1,000 tarpon scales housed in the Olde Marco Inn on Marco Island, the Tarpon Bar and Collier Inn on Useppa Island, and the Gasparilla Inn on Gasparilla Island were examined. While the information recorded on each scale was often incomplete, nevertheless there was sufficient information on date of capture and size (i.e., total length in inches and/or weight in pounds) to be useful in providing insight into the historical population structure. Data from fish captured between 1902 and 1998 were tallied relative to abundance, season of capture, size and condition. Fish from this area were generally caught during March, April, and May with modal sizes between 140 and 160 cm Fork Length. There were no apparent declines in fish length over this time as large tarpon still comprise a significant portion of the recreational catch. As was noticed in another study conducted in Texas, there was some indication of a decrease in condition after the 1950's. These data are invaluable in giving perspective to the species' long-term status.

Patricia E. Anyanwu[1] and K. Kusemiju[2]

DISTRIBUTION AND SEASONAL ABUNDANCE OF *TARPON ATLANTICUS* IN THE COASTAL WATERS OF WESTERN NIGERIA

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[2]Department of Marine Sciences, University of Lagos, Akoka – Lagos, Nigeria.

The distribution and seasonal abundance of Atlantic tarpon, *Tarpon atlanticus* in the coastal waters of Western Nigeria were studied. The species moved in shoals and exhibited both marine and estuarine phases during the life cycle. Five stages of the life cycle of *T. atlanticus* were encountered namely fertilized eggs, fry, fingerlings, sub-adults and adults. The adults occurred at sea while the fry, fingerlings and sub-adults occurred in the estuaries (creeks and lagoon systems). The fertilized eggs were seen attached to floating vegetation at sea and near the shoreline of Atlantic Ocean in the study areas. They were most abundant between December and January. Of the 2545 specimens of *T. atlanticus* collected during the period of study, fry constituted 42.39%, fingerlings 45.07%, sub-adults 10.73% and adults 1.81%. Adult tarpon occurred throughout the year at depths ranging from 5.0 – 39.0m off the Atlantic Coast in areas with abundance of crayfish (*Nematopaleamon hastutus*) and Bonga (*Ethmalosa fimbriata*). The peak periods of abundance ranged from June – July and November to December. The species were pelagic and absent in the catches of fishing trawlers in Nigeria who carry out bottom trawling. The fry and fingerlings on the other hand were caught in the brackish water system and most abundant from February to July. The sub-adults were found in the estuaries with peak abundance from August to September and migrated back to sea between September and October. Rainfall patterns were found to affect the seasonal abundance and migratory patterns of *T. atlanticus*. The juvenile stages were very abundant in the coastal areas of Ondo State constituting an important fishery resource.

William Dailey and André M. Landry, Jr.

THE INTERNATIONAL GRAND ISLE TARPON RODEO: TRENDS IN THE RECREATIONAL TARPON (MEGALOPS ATLANTICUS) FISHERY IN THE NORTHWESTERN GULF OF MEXICO

Texas A&M University, 5007 Avenue U, Galveston, TX 77551

Anecdotal evidence suggests tarpon, *Megalops atlanticus*, populations have declined in the northwestern Gulf of Mexico since the 1960s; however, quantifying and qualifying this decline is complicated by a lack of federal and state landings data. In contrast, landings at Louisiana's International Grand Isle Tarpon Rodeo (IGITR), are well documented during this period and tend to contradict anecdotal evidence. Average weight of winning entries during 1957 - 1974, 1975 - 1992, and 1993 - 2003 was 59.7 ± 18.2, 78.0 ± 7.1 and 81.2 ± 7.1 kg (mean ± SD), respectively, with these weights differing significantly (ANOVA: $F_{2,43} = 19.04$, $p < 0.01$). Post hoc testing determined mean winning entries for 1975 - 1992 and 1993 - 2003 were significantly greater than its 1957 - 1974 counterpart (Bonferroni: $p < 0.05$). A 93.4 kg (206 lb.) tarpon landed in 1973 holds the record for the eighty-four year old tournament, and six of the 10 largest entries since 1957 were landed between 1993 and 2003. The 691 tarpon landed at Grand Isle during these three datasets were comprised of 309, 279, and 103 individuals. Mean annual number of landings during these intervals was 17.2 ± 13.2, 15.5 ± 7.0 and 9.4 ± 3.5, respectively. Analysis of variance indicated no significant statistical difference in number of landings for the three periods ($F_{2,44} = 2.44$, $p > 0.05$). Landings of trophy tarpon, fish in excess of 140 lb (63.5 kg) at the IGITR suggest a robust recreational fishery in the Louisiana delta.

Kathryn Guindon*, Christopher Powell, and Luiz Barbieri

ESTIMATES OF CATCH-AND-RELEASE MORTALITY RATES OF TARPON IN BOCA GRANDE PASS, FLORIDA, USA

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Florida regulations require anglers to purchase a $50.00 tag to harvest or possess a tarpon, *Megalops atlanticus*. The number of tarpon tags (permits) sold and used each year in Florida has been used to estimate annual tarpon fishing mortality due to harvest; however, calculating annual fishing mortality from the number of tarpon tags reported as used in a predominantly catch-and-release fishery is unrealistic and can be misleading. In this study, we used ultrasonic telemetry to obtain current estimates of catch-and-release mortality rates for tarpon in Boca Grande Pass, and we evaluated the potential effects that tackle used, hook placement, and fight time might have on fishing mortality. The first tarpon landed per fishing charter was tagged with an ultrasonic transmitter, released, and tracked with a portable receiver by observers in a boat for up to 6 hours. Of the 41 tagged tarpon, three were visually confirmed to have died as a result of shark attacks and four were visually unconfirmed mortalities inferred from their lack of movement and behavior. The catch-and-release mortality rates evaluated for this study thus ranged between 7.3% (3 out of 41) and 17.1% (7 out of 41). Statistical comparison showed no significant difference between jig- and live-bait fishing methods on catch-and-release mortality rates in Boca Grande Pass. No association between tackle used, hook placement, or fight time and tarpon catch-and-release mortality could be detected; however, the condition of the fish at time of release and angler handling may affect survival. The tarpon that died were significantly smaller in total length than the survivors. Tagging studies can be a valuable tool for estimating post-release mortality of game fish, especially for large species that might be difficult to maintain in floating pens or tanks.

John O'Connell and Jonathan Shenker

OTOLITH MICROCHEMISTRY SIGNATURES OF JUVENILE TARPON (*Megalops atlanticus*) COLLECTED FROM NURSERY HABITATS IN FLORIDA AND THE CAYMAN ISLANDS

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Identifying the Essential Nursery Habitats utilized by juvenile tarpon will enable habitat and fishery managers to focus protection efforts on regions vital to the population dynamics of the species. Known nursery habitats include mangrove marshes and coastal lagoons along the Florida coastline, ranging from the Indian River Lagoon to the Everglades and Florida Keys, and along the southwest coast north to Tampa Bay. Similar habitats throughout the Caribbean and Central America have also been identified as nursery habitats for juvenile tarpon. Do all of these marshes significantly contribute to the adult population, or are certain habitats more important than others?

Ongoing genetic analyses and adult tracking studies suggest that long-distance migration and genetic mixing may limit the utility of genetic markers for assessing the contribution of various nursery habitats to the overall population. Otoliths, however, have been shown to incorporate habitat-specific chemical signatures that persist in the otolith throughout the life of the fish. This project tests the hypothesis that juvenile tarpon from different nursery marshes have characteristic otolith chemical signatures that vary among habitats, and persists over time within a habitat. If the hypothesis is verified, the juvenile cores of adult otoliths should contain chemical signatures that can identify the origin of individual fish.

Juvenile tarpon were collected from a variety of habitats over several years: Indian River Lagoon (east coast barrier island brackish mangrove marshes; 2001, 2004 and 2005); No Name Key (Florida Keys saline mangrove marsh; 2005), Terra Ceia (mainland west coast brackish mangrove marsh; 2004), and the Cayman Islands (hypersaline lagoons; 2003 and 2005). The otoliths (sagittae) were removed and morphometrics and weights were quantified for use in identification of the juvenile core in future analyses of adult otoliths.

At the conclusion of the 2005 sampling season in October, all juvenile otoliths will be prepared for chemical analysis by dissolution in ultrapure nitric acid. Chemical composition of the dissolved otolith matrix will then be assessed using Inductively-Coupled Plasma Mass Spectrometry. Trace elements will be quantified as ratios to the predominant calcium component of otoliths, and multivariate statistical techniques will be used to determine if chemical patterns vary among habitats and persist within habitats over time.

Jiangang Luo, Jerald S. Ault, Michael F. Larkin, Robert Humston and Donald B. Olson

SATELLITE POP-UP ARCHIVAL TAGS TO STUDY MIGRATORY PATTERNS OF ATLANTIC TARPON

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To better understand tarpon migratory patterns, habitat preferences and population connectivity in the southeastern US and Gulf of Mexico, we have been using "pop-up" archival transmitting (PAT) tags. PAT tags are the most intelligent and complex tag used for study of fish movements and dynamic behaviors. These space-age PAT tags, containing sensors, memory chips and transmitters, when deployed on tarpon can collect and archive minute-by-minute data on depth of the animal, water temperatures, and light levels (specific data needed for determining location of the tagged fish). The PAT tags are preprogrammed to release from the tagged fish at a specified time and date, and the pop-up to the ocean surface where they will transmit their stored data to an ARGOS satellite network passing overhead. This data retrieved by the satellites is then forwarded to us here on earth for analysis. Since 2001 we have tagged and released 33 relatively large tarpon fitted with PAT tags in Florida, Louisiana, Mexico and the Carolinas. We have documented substantial migrations of inter-State (e.g., South Carolina to Florida, Texas to Louisiana, Florida to Louisiana, and Louisiana to Key West, Florida) and international (Veracruz, Mexico, to Texas and Louisiana) dimensions. Of the 8 of 15 tarpon PAT-tagged tarpon in Veracruz, Mexico, during late spring of 2003-2005, 5 of these fish migrated northward to Texas, and 3 to Louisiana over a few months post-release. Several of these individual migrations were in excess of 1,300 miles! Notably, our research was the first to document that tarpon use specific ocean temperature ranges during migrations, and that tarpon dive to depths of 275 feet. We plan to expand the tarpon PAT tagging network to quantitatively establish regional migration patterns and "connectivity" of stock(s) because Florida may serve as the "jumping off" point for international tarpon migrations forays into the northern Caribbean Sea where Tarpon are slaughtered for their roe and flesh.

Jerald S. Ault

ATLANTIC TARPON POPULATION DYNAMICS AND REGIONAL FISHERY MANAGEMENT STRATEGY: A SYNTHESIS

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The biology of tarpon *(Megalops atlanticus)* relevant to fishery management has not been well characterized despite their popularity and economic importance as premier gamefish. In this talk I will review the state of our knowledge of the tarpon and its biology in such critical aspects as life history, fishery dynamics and individual behavior, and further outline important gaps in that knowledge. Important problems remain whose solution is important to management of this important fishery resource. These are examined and it is proposed that some can be solved by invoking new technologies in cooperation with the sports fishing community, along with integrated regional fishery assessment and management initiatives.

Alan Friedlander[1], Jenn Caselle[2], Jim Beets[3], Chris Lowe[4] and Brian Bowen[5]

ASPECTS OF THE BIOLOGY, ECOLOGY, AND RECREATIONAL FISHERY FOR BONEFISH AT PALMYRA ATOLL NATIONAL WILDLIFE REFUGE, WITH COMPARISONS TO OTHER PACIFIC ISLANDS

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A comprehensive research and monitoring program for bonefish was conducted at Palmyra Atoll National Wildlife Refuge (NWR) to investigate the biology and ecology of bonefish and assess the impact of the small recreational catch-and-release fishery for bonefish in the NWR. Biological investigations have documented nearly pristine conditions of the relatively unexploited bonefish population. Genetic analysis has identified a single species of bonefish (*Albula glossondonta*) at Palmyra with limited connectivity among other locations. Some biological parameters of Palmyra bonefish (size structure, sex ratio) were dramatically different than populations under greater exploitation at other Pacific locations (Tarawa Atoll, Christmas Island, and Hawaii).

Catch rates and size classes of bonefish at Palmyra were significantly different among tidal flats. Bonefish movement patterns between tidal flats and deep lagoons were strongly influenced by tidal fluctuations. Food habits differed between tidal cycles with the diet dominated by crabs during foraging periods on tidal flats and acorn worms when foraging in the deep lagoon. Bonefish physiological stress response to angling showed signs of elevated cortisol, glucose, and lactate.

The relatively unspoiled condition of Palmyra renders it one of the few places on earth to be able to examine the biology and ecology of bonefish in as natural a state as possible. Palmyra's limited catch-and-release bonefish fishery offers the unprecedented opportunity to monitor all the fishing effort and catch for a single stock. This program provided a unique opportunity for scientists to work with anglers and resource managers to develop a viable catch-and-release fishery for bonefish that was compatible with the Palmyra Atoll NWR and better understand how unaltered ecosystems are structured, how they function, and how they can most effectively be preserved. Palmyra can provide a unique baseline against which to gauge the effects of fishing effort elsewhere in the world and contribute to our understanding of management in tropical marine ecosystems.

Stephen A. Karl and Brian W. Bowen

RESOLVING EVOLUTIONARY LINEAGES OF BONEFISHES (*ALBULA SPP.*)

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For most of the previous century, bonefish were classified as a single, pantropical species, *Albula vulpes*. The only exception was the morphologically distinct *A. nemoptera* in tropical Central and South America. Allozyme data identified two additional species in Hawaii, *A. forsteri* and *A. glossodonta*, (Shaklee and Tamaru, 1981). In the course of a global survey of bonefish with mitochondrial DNA (mtDNA) sequence data, five more putative species (species A through E) of bonefish were identified (Colborn et al. 2001). In total, there currently exist nine distinct and geographically localized mtDNA lineages within the genus *Albula*. Morphological characters to distinguish these species are few, and some species are indistinguishable. At present the only sure way to identify these species is through mtDNA sequence. At the Hawaii Institute of Marine Biology, we have surveyed three introns (non-coding regions) in the nuclear genome to confirm the evolutionary partitions observed in the mtDNA survey. The results of this investigation help clarify species boundaries, and define the depth of evolutionary separations among *Albula* species.

Juan M. Posada[1], Jerald S. Ault[2], Denise Debrot[1] and Michael Larkin[2]

COMPARATIVE POPULATION DYNAMICS OF ATLANTIC BONEFISH (*Albula vulpes*): FLORIDA (USA) AND LOS ROQUES ARCHIPELAGO (VENEZUELA)

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[2]University of Miami, Rosenstiel School of Marine and Atmospheric Science, 4600 Rickenbacker Causeway, Miami, FL 33149

Bonefish, *Albula vulpes*, is a highly valuable game fish that supports economical important recreational fisheries throughout the wider Caribbean Sea. Despite this, studies on its biology and population dynamics throughout the region have been limited, Florida and Los Roques are two areas receiving most of the scientific effort. The Florida bonefish fishery represents an $1 billion dollar economy, with a participation of more that several hundred guides and hundreds of thousands of anglers annually. In contrast, the recreational fishery in Los Roques is emerging, with an average of 400 recreational fishers visiting the archipelago each year. In both places the number of anglers peaks from January to June. Fisheries independent data collections showed that bonefish in Florida range from 300 to 940 mm TL, while it vary in Los Roques from 188 to 742 mm TL. According to fishing guides, most bonefish caught in Florida weigh 3 to 6 kg, while in Los Roques this weigh oscillate between 1.5 to 2.5 kg. Reproduction of bonefish in Florida occurs from November to June, while in Los Roques it extends from June to January. Size at maturity of females is similar in both places, been 358 and 351 mm FL in Florida and Los Roques, respectively. Preliminary results of age and growth showed that bonefish in Florida more than 20 years (n = 1200), while longevity has been estimated in Los Roques up to 18 years (n = 91). However, bonefish appeared to grow faster and attain larger sizes in Florida than in Los Roques (L_∞= 797.8 mm, K = 0.2209, t_0 =-1.61; L_∞= 602.8 mm TL, K=0.343, t_0 =-1.61 respectively). We discuss the ecological implications of these differences and why knowledge synthesis of bonefish population dynamics is critical to building sustainable fisheries for these precious resources.

G. Todd Kellison[1], Aaron J. Adams[2] and R. Kirby Wolfe[2]

ARE CHEMICAL SIGNATURES IN OTOLITHS OF JUVENILE BONEFISH DIFFERENTIABLE BY SITE? A TEST CASE FROM JUVENILE HABITATS IN FLORIDA

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Bonefish (*Albula* spp.) are ecologically and economically important in Florida and throughout tropical and subtropical areas worldwide. Unfortunately, while sound management and conservation strategies are typically based on knowledge of the ecology of a species, scant information exists regarding the ecology of juvenile bonefish, particularly in terms of habitat utilization and the identification of areas critical to the support of adult populations. At present we cannot determine whether there are specific nursery sites or regions that drive abundance and biomass in the fishery in Florida. The ability to assess site-specific contributions to the adult stock would enable managers to better (1) predict trends in year-class strength entering the fishery, and thus to assess trends over time in the adult population, and (2) identify areas for conservation and restoration.

Ongoing advances in otolith research enable researchers to use the chemical signatures recorded in the otoliths as natural tags. This methodology allows assessment of the contribution of area-specific juvenile habitats to adult populations. For such work to occur, it is necessary to determine whether site-specific chemical signatures recorded in juvenile otoliths are differentiable. The objective of our research is to determine if differences between site-specific otolith signatures are detectable between four potential nursery areas in Florida coastal waters (upper Keys, middle Keys, lower Keys, and peninsular west coast) for *Albula* species B. This ongoing research will provide a baseline for future work to assess nursery habitat and effective juvenile habitats for *A. species B.* The ultimate goal is to facilitate adaptive management of bonefish fisheries through improved knowledge of ecological processes.

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HANDLING PRACTICES INFLUENCE THE SHORT-TERM POST-RELEASE MORTALITY OF BONEFISH (*ALBULA* SPP) IN ELEUTHERA, BAHAMAS

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Bonefish (*Albula* spp) inhabit shallow tropical and subtropical environments worldwide and are economically important due to their popularity among recreational anglers. Despite their importance as sportfish, very little is known about the biology and ecology of bonefish. In particular, little information is available on how voluntary catch-and-release angling practices affect the behavior and survival of individual fish and the fishery as a whole. The purpose of this study was to examine how different angling, handling, and release techniques affect the short-term post-release survival of bonefish inhabiting nearshore flats in Eleuthera, Bahamas. A total of 87 fish encompassing four handling treatments were angled, released, and visually tracked for up to one hour using small surface floats affixed to their dorsal fin. Predation attempts and behavioral patterns of bonefish after release were recorded. Either lemon sharks (*Negaprion brevirostris*) or barracudas (*Sphyraena barracuda*) preyed upon 14 (16%) of the released bonefish within the first hour. Fish that lost equilibrium subsequent to release experienced six times the risk of predation compared to fish released that did not lose equilibrium (t=-2.285; p=0.022). Air exposure and duration of handling affected the likelihood that a released fish would experience disequilibrium (t=-3.768; p<0.001 and t=-2.395; p=0.024, respectively). Interestingly, fish released near protective cover did not experience decreased predation risk, regardless of whether or not the fish experienced disequilibrium at the time of release. These results indicate that handling practices and release strategies can significantly affect the short-term survival of bonefish. Angler education and management plans that encourage conservative handling can help to sustain this important fishery.

Michael F. Larkin, Jerald S. Ault, Jiangang Luo, Natalia Zurcher and Robert Humston

TAGGING OF BONEFISH TO STUDY POPULATION MOVEMENTS AND DYNAMICS

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Bonefish support a large recreational fishery in south Florida that is a significant component of south Florida's economy. Despite the relevance of south Florida's bonefish fishery, the stock has never been adequately assessed, and bonefish have received little attention from the scientific community. Bonefish conventional anchor tag and acoustic telemetry experiments were conducted in south Florida from 1998 to 2005 to evaluate growth, determine movements, spawning migrations, habitat use, site fidelity, environmental preferences, characterize the stock structure, and estimate mortality. A total of over 3,500 bonefish were tagged with conventional anchor tags and over 100 bonefish were recaptured. Forty bonefish were fitted with acoustic transmitters and released in an array of 38 receivers in the northern Florida Keys. Results reveal that bonefish display a frequent shift in their movements but commonly return to the same foraging areas. Long distance movements (>30 km) were recorded for the larger and sexually mature bonefish during the spawning months suggesting spawning migrations. Further evidence of bonefish spawning was seen from bonefish moving offshore to the reefs during the bonefish spawning season and during the full moon phases. Schooling behavior was also observed with bonefish of different sizes. The information collected from the bonefish tagging projects is necessary for the design of spatial management alternatives to ensure the sustainability of the fishery.

Being M. Yeeting[1]

THE IMPLICATIONS OF FISHING AND HANDLING OF THE BONEFISH, *Albula glossodonta* (ALBULIDAE), ON THEIR MORTALITY: A MANAGAMENT CONSIDERATION

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The tourist-based bonefish fishery in Kiritimati Island (Christmas Island) of the Republic of Kiribati is one of the main bone fishing destinations in the world. Unfortunately, bonefish is a popular food fish species traditionally in most of the other islands of Kiribati and as more people migrate to Kiritimati Island from the other islands; more bonefish are also being caught for food. This became a concern to local communities who depended on tourism as their main source of income and therefore in 2002, the Tourism Department and the Fisheries Department based in Kiritimati Atoll, requested the Secretariat of the Pacific Community (SPC) for technical assistance in developing a sound and effective management regime for this fishery.

SPC have since been conducting research and biological sampling in Kiritimati Island in order to improve the scientific understanding of the biology and behavior of the bonefish *Albula glossodonta*, stock on the atoll in order to come up with effective management measures. This presentation describes the results of one of the studies to investigate the effects of two fishing methods (gillnets and light tackle hook and line) and handling on the fish. A total of 160 bonefish individuals were subjected to 4 fishing and handling treatments (40 fish each). These fish were then put under observation for a month in a caged part of their natural habitat. All bonefish caught with gillnets died within a week. The other bonefish caught with light tackle gear showed no signs of stress immediately and a few days after treatment. It was only after the first week that some of the bonefish started showing signs of stress, and started developing skin infections and bruises leading eventually to death. Some management guidelines and recommendations are presented here for consideration that should help in mitigating these effects.

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RETHINKING THE STATUS OF *ALBULA* SPP. IN THE CARIBBEAN AND WESTERN ATLANTIC

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Until recently, bonefish in the Western Atlantic and Caribbean were assumed to be a single species, *Albula vulpes* but an additional species (*Albula* sp.B) has been genetically identified. Little is known about the biology and ecology of either species, and the majority of knowledge of *A. vulpes* is from adults in the Florida Keys. Knowledge of bonefish basic biology and ecology is necessary for effective management and conservation. In 2003, a multi-faceted, multi-investigator research program was initiated in the Florida Keys and portions of the Caribbean to determine: (1) patterns of habitat use by juveniles; (2) species composition of the juvenile populations; (3) species composition of the recreational fishery; and (4), age and growth of Caribbean *A. vulpes* as compared to the Florida Keys. Ninety-two percent of leptocephalus and juvenile bonefishes captured in the Florida Keys were identified as *Albula* sp.B based on genetic analysis of tissue samples, and the few *A. vulpes* were captured in only three (of 637) samples, all in July 2004. All juveniles were caught along nearshore sandy bottom with sparse seagrass or along sandy beaches. No juvenile bonefish were captured during sampling in Belize. In contrast, genetic analysis of tissue samples from adults captured in the recreational fishery at seven locations in the Caribbean and in the Florida Keys revealed 100% *A. vulpes*. Age estimates of adult *A. vulpes* captured in the Caribbean indicate that growth rates are twice as high in the Florida Keys as in the insular Caribbean. These findings suggest previously published results on *A. vulpes* should be re-examined, conservation and management strategies might need to be restructured, and there is an urgent need for additional research. These findings are especially intriguing given similarities to findings of bonefish research in the Pacific.

Andy J. Danylchuk, Sascha A. Danylchuk and Christopher B. Maxey

BRIDGING THE GAP BETWEEN RESEARCH AND EDUCATION TO PROMOTE THE CONSERVATION OF COASTAL FLATS

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Despite the importance of flats ecosystems to the tourism-based economies of coastal communities, there is often a lack of attention given to these environments in local and regional management and conservation efforts. Effective conservation, however, is founded upon a 'sense of wonder' and some understanding of the connection between humans and the environment. Increasing the awareness of our dependency on flats environments and their resident species can, in turn, foster a sense of stewardship that leads to successful conservation efforts. One approach to empowering stakeholders is to develop interactive programs that physically connect individuals to the environment. A major goal of the Cape Eleuthera Institute's Flats Ecology and Conservation Program (FECP) is to integrate primary scientific research with education and outreach at multiple levels in an effort to instill a conservation ethic for subtropical and tropical flats. Specifically, high school students at The Island School, Cape Eleuthera, Bahamas, become active participants in FECP research, i.e., working with professional researchers to collect and analyze data, write a collaborative research paper and then disseminate their results to local community members, government officials, and scientists during a special symposium held at the end of each semester. In addition, as part of a continuing community outreach program, Island School students also share the need for conservation of the flats ecosystem with local primary and middle school students. To date, 32 high school students have participated in FECP research, focusing on the potential impacts of catch-and-release angling on bonefish, the movements of adult bonefish, and the distribution and abundance of juvenile bonefish in shallow flats off Cape Eleuthera. Through this work, students from the US, Canada, and The Bahamas alike are developing collaborative research and teamwork skills, while helping to disseminate information on the importance of nearshore flats. The goal is that this program will serve as a model for connecting research and education in a way that fosters the development of conservation minded stewards of the flats environment, including recreational anglers.

Elizabeth M. Wallace and Michael D. Tringali

GENETIC SPECIES DETERMINATION OF BONEFISHES (*ALBULA* SPP.) IN THE CARIBBEAN: METHODOLOGY AND PROGRESS TO DATE

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Bonefishes, which are highly prized gamefish, are circumglobally distributed in tropical seas. The extended larval cycles common in bonefish species are among the longest reported for any marine species and allow for geographically widespread dispersal. In Florida waters, previous and current work has shown the presence of two morphologically cryptic species – the nominal *A. vulpes*, and the provisional *A. "garcia"*. However, the species composition of the fishery is presently unknown.

Data to date suggest juveniles of the two species utilize the same inshore nursery habitat. However, some sorting of the adults may occur. As no morphological measurements have been identified to distinguish between *A. vulpes* and *garcia*, genetic assays are presently the only method of positive identification. The use of genetic markers to distinguish cryptic marine species has been well demonstrated. In order to determine the distribution of bonefish species in Florida and the Caribbean for management, we are utilizing a diagnostic marker based on the cytochrome b gene. Additional mitochondrial and nuclear genetic markers are also under development. Here we describe our methods and present results to date. Historical and current data collected thus far indicate a temporal shift in species abundance in Florida. The vast majority of recent collections have been identified as *A. garcia* (N=293), while archival specimens (N=34) have been identified as *A. vulpes*. Previous investigations on age and growth, morphology, and spawning dynamics in the region were conducted under the assumption that all collected specimens were *Albula vulpes*. As current collections indicate that is unlikely to have been the case, the findings of previous investigations may need to be revisited.

Michael D. Tringali*, Seifu Seyoum, Maryanne Higham, and Elizabeth Wallace

GENETIC TRACKING OF ATLANTIC TARPON (*MEGALOPS ATLANTICUS*)

Florida FWC Fish and Wildlife Research Institute, St. Petersburg, FL
*Presenter

DNA fingerprinting is a commonly employed forensic method used to see if two or more genetic samples belong to the same individual. Whereas current techniques for physically marking fish (e.g., dart tags) beget practical challenges in tarpon, a fin clip can often be obtained without harming the fish or needlessly delaying release. Therefore, DNA fingerprinting offers an alternative means for tagging/tracking individual tarpon (individual movements, recapture rates) in the fishery. Multilocus fingerprint data can be further mined for fine-scale population-genetic analyses of stock structure. Here, we report on the development of genetic markers for tarpon DNA fingerprinting and population genetic studies, including the evaluation of the *genetic suitability* and *information content* of the new loci for fingerprinting applications. We demonstrate that the new markers are inherited in a Mendelian fashion, and are not 'linked' – i.e., that the transmission probabilities of gametes are not affected by recombination. Because the occurrence of 'null alleles' and mistakes during scoring can negatively impact analytical results, we show that alleles at all loci are consistently amplifiable and 'scorable' for reliable typing. Finally, we show that a threshold number of loci (markers) required for fine-scale applications, which is dictated by marker variability, allele frequencies, and levels of coancestry (relatedness) within tarpon assemblages, has been met. We are now working in concert with other FWRI scientists to procure non-destructive genetic samples from the tarpon fishery in Florida waters. We are maintaining a genomic DNA library and an electronic database of tarpon DNA-fingerprint profiles and associated information. We are also working to coordinate the archiving, sharing, and integrating of this information into common FWRI databases and are pursuing the development of a public web-based 'genetic-tag return' database.

Matthew J. Scripter and Jonathan Shenker

FATTY ACID ANALYSIS OF JUVENILE ATLANTIC TARPON (*Megalops atlanticus*) CAN BE USED TO EVALUATE THEIR FEEDING HABITS

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Dietary studies are important for fish life history research, energy flow and ecosystem connectedness investigations, and fishery management plans. Two experiments were designed to test whether FA profiles could be used to identify tarpon on different diets, tarpon in a time series following a diet change, and prey types. Juvenile tarpon were collected from man-made mosquito impoundments in Brevard and Indian River counties. Fifteen tarpon were provided mosquitofish (*Gambusia affinis*) and 15 tarpon were provided grass shrimp (*Paleomonetes pugio*) for a 3-week minimum feeding period, then both tarpon and prey groups were sacrificed for FA analysis. For experiment two, 36 tarpon consumed *P. pugio*, and were then switched to *G. affinis*. Nine tarpon were sacrificed on 0, 3, 6, and 9 days following the prey switch. Tarpon and prey FA profiles from both experiments were determined using whole-body homogenization, lipid extraction/methylation, and gas chromatography. Tarpon and prey group FA profile differences were statistically significant for experiment one (MRRP, $\delta = 3.17$, $p < 0.0001$) and experiment two (MRRP, $\delta = 2.97$, $p < 0.0001$). The FAs selected by classification tree algorithm analyses (e.g., CART, QUEST, and CRUISE) were those involved in the essential fatty acid biosynthesis pathway, which indicates that these FAs are more sensitive to diet change than storage lipids.

Tarpon and prey groups can be differentiated based solely on the FA profile, and diet heavily influences the tarpon FA profile. Future research will determine the internal distribution patterns of FAs within a fish's body, reduce the tissue quantity needed for analysis, examine how combining multiple prey influence the predator's resultant FA profile, and test the effectiveness of FA profile analysis in an open ecosystem. Sampling predator and prey FAs continuously during routine fisheries management sampling programs could provide a non-lethal, dynamic ecosystem assessment for researchers and fishery managers.

R. Kirby Wolfe[1], Aaron J. Adams[1], G. Todd Kellison[2] and Benjamin C. Victor[3]

PATTERNS OF JUVENILE HABITAT USE AND SEASONALITY OF SETTLEMENT BY PERMIT, TRACHINOTUS FALCATUS

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Permit, Trachinotus falcatus are economically and ecologically important throughout their range of the Caribbean, subtropical and tropical western Atlantic, and Gulf of Mexico. Despite their economic importance, little is known about the biology and ecology of permit, and most existing information is from Florida. While sufficient information is available to paint a general picture of permit life history, details are lacking for most life stages. For the juvenile life stage, nursery habitats, and size and age at settlement have not yet been defined. Although six distinct habitat types (medium energy and low energy windward beaches, leeward beaches, and windward, leeward, and lagoon interior mangrove shorelines) were sampled to determine spatial patterns of habitat use by early juvenile permit at Turneffe Atoll, Belize, Central America, and the Florida Keys, USA, 98% of juvenile permit were found along medium energy windward beaches, indicating their role as nursery habitat for this species. A sub-sample of juvenile permit from Florida was examined to estimate spawning date and age at settlement from otoliths. Size-frequency distributions and otolith age analysis indicate that larval duration is approximately 15 – 18 days, and settlement occurs year-round. Since permit in Florida spawn March through July, from March through September in Cuba, and from February through October in Belize, year-round settlement indicates population connectivity via larval transport. These results lay the foundation for future research on larval supply, population connectivity, and juvenile ecology, and will aid in the ongoing formulation of a conservation plan toward a sustainable fishery for permit.

Christopher Powell and Kathryn Guindon

ACOUSTIC TRACKING TECHNIQUES FOR HOOK-AND-LINE CAUGHT AND RELEASED TARPON, *MEGALOPS ATLANTICUS*, FROM BOCA GRANDE PASS, FLORIDA, USA

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Biological telemetry is a valuable tool that can allow the study of fish and wildlife in their natural environment. For a large pelagic species such as tarpon acoustic tracking can be used to assess their movement and ultimately their fates after hook-and-line events. Our objective is to describe the short-term movements of tarpon caught on hook-and-line in Boca Grande Pass and to describe the techniques we used to help confirm movement and survival. A total of 41 tarpon were tagged with an ultrasonic transmitter. Tagged tarpon were tracked by boat for a maximum of six hours (avg=160 min) using a directional hydrophone. Boat position and bearing to signals and the tagged tarpon's relation to current and other schools of tarpon were recorded every 15 minutes in order to determine fish movement. Vector maps were created to show temporal movements related to tidal currents and bottom contours. Underwater cameras were used in situ to visually confirm mortality of the tagged tarpon in cases of stationary signals. In general each tarpon did one of three things: swam to the Gulf (offshore towards open water or along the beaches), swam into Charlotte Harbor, or remained in the pass. Excluding mortalities (n=7) or signals that were never heard (n=1), approximately 46% (15/33) remained in the pass or were observed back in the pass on a subsequent day(s). This confirms a more long-term post catch-and-release survival and supports temporal site fidelity of tarpon to Boca Grande Pass. Acoustic telemetry can be used as a tool to assess movement patterns and help estimate mortality rates due to fishing pressure and is especially valuable for catch and-release fisheries.

Steven J. Cooke and C.D. Suski

DO CIRCLE HOOKS REDUCE INJURY AND MORTALITY? A REVIEW FOR RECREATIONAL FISHERIES

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Circle hooks have rapidly become popular among recreational anglers based largely on the assumption that their use aids in the conservation of fisheries resources by reducing gut hooking, and hence, mortality. We surveyed literature databases and also used questionnaires to solicit information from unpublished or in progress circle hook research. Among studies, results have been quite disparate. However, overall mortality rates were consistently lower for circle hooks than J style hooks. In addition, circle hooks were more frequently hooked in the jaw, and less frequently hooked in the gut than conventional hook types. There is no doubt that in some marine fisheries such as tuna, billfish, and striped bass, capture efficiency remains high and injury and mortality rates are drastically reduced. However, in other species (e.g., bluegill), injury can actually be more severe from circle hooks relative to some other hook types. In other species such as largemouth bass, circle hooks have minimal conservation benefit, but have reduced capture efficiency relative to conventional hook designs. At present, there has been no research that has formally evaluated the potential role of circle hooks in recreational bonefish fisheries. However, circle hooks are being increasingly used for tying bonefish flies and may be particularly useful for bait fisheries (e.g., shrimp) where bonefish are more likely to deeply ingest the hook. Factors such as hook size, fishing style, fish feeding mode, and mouth morphology all appear to influence the effectiveness of circle hooks. The recent interest in circle hooks has been beneficial for stimulating interest and research on the role of hook designs in reducing hooking related injury and mortality. We encourage tackle manufacturers to continue to develop new hook designs that have the potential to provide conservation benefit to caught and released fish.

David T. Wilson[1], Carrie Simon[1] and Kate Holmes[2]

UNDERSTANDING BONEFISH (*ALBULA VULPES*) ECOLOGY AND BIOLOGY FOR THE PURPOSES OF FISHERY MANAGEMENT IN THE TURKS AND CAICOS ISLANDS, BAHAMAS ARCHIPELAGO, BRITISH WEST INDIES

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The Turks and Caicos Islands supports a large tourism industry including a rapidly expanding bonefish sports fishery. At present there only nine guide businesses consisting of approximately 20 active local guides. In addition, the harvest of bonefish for local consumption is common, with local fisherman using seine nets to take many hundreds, probably thousands of bonefish each year. Unfortunately, other than a few under managed Marine Protected Areas (MPAs) that fringe the 1500 km^2 area of the Caicos Bank, and regulations on net mesh size, there is no legislation to specifically manage this economically important fishery. As such, we have embarked upon a research program which aims to develop a Fishery Management Plan (FMP) for *Albula vulpes* that will assist the local Department of Environmental and Coastal Resources (DECR) in managing the bonefish sports and extraction fisheries. The project has four main objectives. To determine the size of the bonefish population by carrying out a stock assessment using mark/release/recapture techniques; To determine the connectedness of TCIs bonefish populations using genetic techniques, both within the TCI and regionally; To examine the availability of suitable habitat for the various ontogenetic life history stages of bonefish and assess whether current no-take MPAs in the TCI are sufficiently protecting essential habitat for this valuable sportsfishing species; and to determine the site fidelity of bonefish in selecting foraging areas around South Caicos using acoustic telemetry. Progress to date includes a TCI wide tagging program involving half of the local guides who have tagged almost 500 fish. Acoustic tagging has just begun with the aim of determining the feeding site fidelity and small scale migration patterns.

Jerald S. Ault, Sandy Moret*, Jiangang Luo, Mike Larkin and Natalia Zurcher

FLORIDA KEYS BONEFISH POPULATION CENSUS

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A visual population census method to assess Florida Keys bonefish (Albula vulpes) population abundance was developed using professional guides and statistical sampling theory. The annual census was started in 2003 to determine a population baseline for scientifically evaluating changes. The annual bonefish census involves about 50 professional fishing guides split up among 19 clearly defined zones and visually and relatively methodically, count bonefish throughout the day, covering 1,575 square miles. The volunteers, who ranged from fisherman to scientists and graduate students, covered well-known, popular bonefish territory, which ultimately resulted in a population estimate this year of 329,303 bonefish (+/- 47,318 for a 14.4 percent coefficient of variation) or about 209 bonefish per square mile. Bonefish are valuable for several reasons. They are a great indicator of ecological change. Second, long-time bonefish anglers often remark on the dramatic decreases they've observed in this popular sport fish's population. Finally, for south Florida, bonefish are valuable for another reason. They bring in a significant amount of tourism. Bonefish sport fishing contributes approximately $1.0 billion annually to the Florida economy, making sport fishing more valuable than commercial fishing in today's market. Estimates of the 'visible' population makes each bonefish in the water worth about $3,500 per year to the industry, and about $75,000 per fish over its lifetime. The census framework provides a quantitative baseline that protects industry interests by allowing changes to be referenced, thereby improving the basis of regional fishery management.

Philip Kramer and Mike Palmer

CLASSIFICATION OF NEARSHORE MARINE HABITATS USED BY TARPON AND BONEFISH IN THE WIDER CARIBBEAN BASIN

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Many biophysical factors shape nearshore marine habitats through time and directly influence their suitability in supporting recreational sportfish species including Tarpon and Bonefish. These natural differences need to be better understood and accounted for before meaningful comparisons can be made between these populations and management actions informed. Nearshore areas were defined as including bays, estuaries, tidal creeks, and other "back reef" environments. Five of the most important biophysical factors affecting these nearshore areas include geology, tidal amplitude, circulation, depth, and exposure. Overlays of each of these factors was developed within a geographic information system (GIS) for the wider Caribbean basin and broad bigeographic subdivisions identified. Within this framework, we examined the amount and type of coral reef and mangrove habitat as both are essential for bonefish and tarpon respectively. Coral reef locations were derived from the Millennium Reef Mapping Project at the University of South Florida and Mangroves were derived from the Geocover Global Landcover classification effort (both efforts utilize Landsat 7 satellite imagery). The amount of nearshore habitat containing mangroves and coral reefs was compared to known populations of bonefish and tarpon at different spatial scales to better understand their habitat requirements. Threats to these habitats include coastal development, unsustainable overfishing, and land based sources of pollution were examined within our Geospatial database in an effort to identify critical areas for restoration or protection actions.

Eugenia Naro-Maciel, Katherine E. Holmes, Rob DeSalle, and Daniel R. Brumbaugh

CONNECTIVITY OF BONEFISH (Albula vulpes) IN THE BAHAMAS AND BELIZE

Bonefish (Albula spp.) are enigmatic from an evolutionary perspective, and valued by recreational and commercial fishers worldwide. In The Bahamas, an interdisciplinary initiative is integrating insights from the biophysical and social sciences into the design and analysis of marine protected areas (MPAs) and MPA networks. Research components include multifaceted studies of key marine organisms, including Albula vulpes. Little is known about population connectivity of bonefish within the Bahamian archipelago or between these islands and the wider Caribbean. As a first step in addressing this issue, A. vulpes from four sites throughout The Bahamas (n=73), and from Belize (n=12), were sequenced at the mitochondrial cytochrome b gene (600 base pairs). Eight haplotypes were detected, and haplotype diversity was 0.5188 (+- 0.0493). At this locus, there was no significant subdivision revealed overall (F_{st} = -0.05612; p=0.97812), or in any pairwise comparisons (F_{st} < -0.0228; p> 0.6255). Even so, an allele that was rare in The Bahamas was more frequent in Belize, suggesting some populations may not be entirely panmictic. In future research, the possibility that structure was not detected due to insufficient marker resolution will be explored by sequencing the more variable mitochondrial control region.

Jonathan Shenker, Captain Bruce Unger, Rocky Ward and Captain Gary Giles

POPULATION GENETICS OF JUVENILE AND ADULT TARPON FROM COASTAL AND ESTUARINE HABITATS OF FLORIDA – PROGRESS REPORT

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Genetic characterization of the population structure of fishes often relies on relatively small numbers of animals collected over the broad habitat range of the species. Previous studies on tarpon show hints of genetic differences around the Gulf of Mexico and Caribbean Sea. However, the magnitude of genetic variability within a region has not been fully characterized, and analysis of this variability will help determine the degree of panmixia and possible metapopulation structure of tarpon.

Intensive sampling of tarpon around Florida has generated a very large number of tarpon DNA samples that are presently undergoing analysis. Fishing guides and local anglers in and around the Indian River Lagoon participated in the "Tarpon Fishing for Science" tournaments in 2004 and 2005 collected fin clips of over 200 tarpon ranging from 10 cm juveniles to 50 kg adults. Researchers and anglers from other regions in Florida proved another 150 fin clips from juveniles and adults from the Tampa Bay region, southwest Florida and the Florida Keys. Mitochondrial and microsatellite DNA extracted from these fin clips is presently being sequenced for analysis of the genetic structure of inter- and intra-cohort variability throughout the geographic region.

An evaluation of the changes or stability of the genetics of Florida tarpon populations over a 50 year time span has been made possible by discovery of an archived series of scales collected by R.A. Wade during the mid-1950s from the Florida Keys and the west coast of the state. These scales were utilized for his initial study of the age structure of tarpon populations in the region. Scales from 340 adults contain dried epithelial tissue, and efforts are under way to extract and analyze the DNA of these historical samples.