



First International Symposium on
Mangroves
as **Fish Habitat**

Rosenstiel School of Marine and Atmospheric Science
University of Miami
Miami, Florida
19–21 April 2006

Scientific Program and Abstracts



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DEDICATION



Donald Perrin de Sylva (1929–2004)

Our longtime collaborator and dear friend, University of Miami Professor Donald P. de Sylva, passed away in Brooksville, Florida on January 28, 2004. Over the course of his diverse and productive career, he worked closely with mangrove expert and colleague Professor Samuel Snedaker on relationships between mangrove wetlands and fish communities. Don made major scientific contributions to this area of research close to home in south Florida and as far afield as Southeast Asia. He was the world's leading authority on one of the most ecologically important inhabitants of coastal mangrove habitats — the great barracuda. His 1963 book *Systematics and Life History of the Great Barracuda* continues to be an essential reference for those interested in the taxonomy, biology and ecology of this species. Don shared his extensive knowledge, experience and insight with great enthusiasm and unique humor. He is sorely missed by all those he befriended, educated, and inspired.

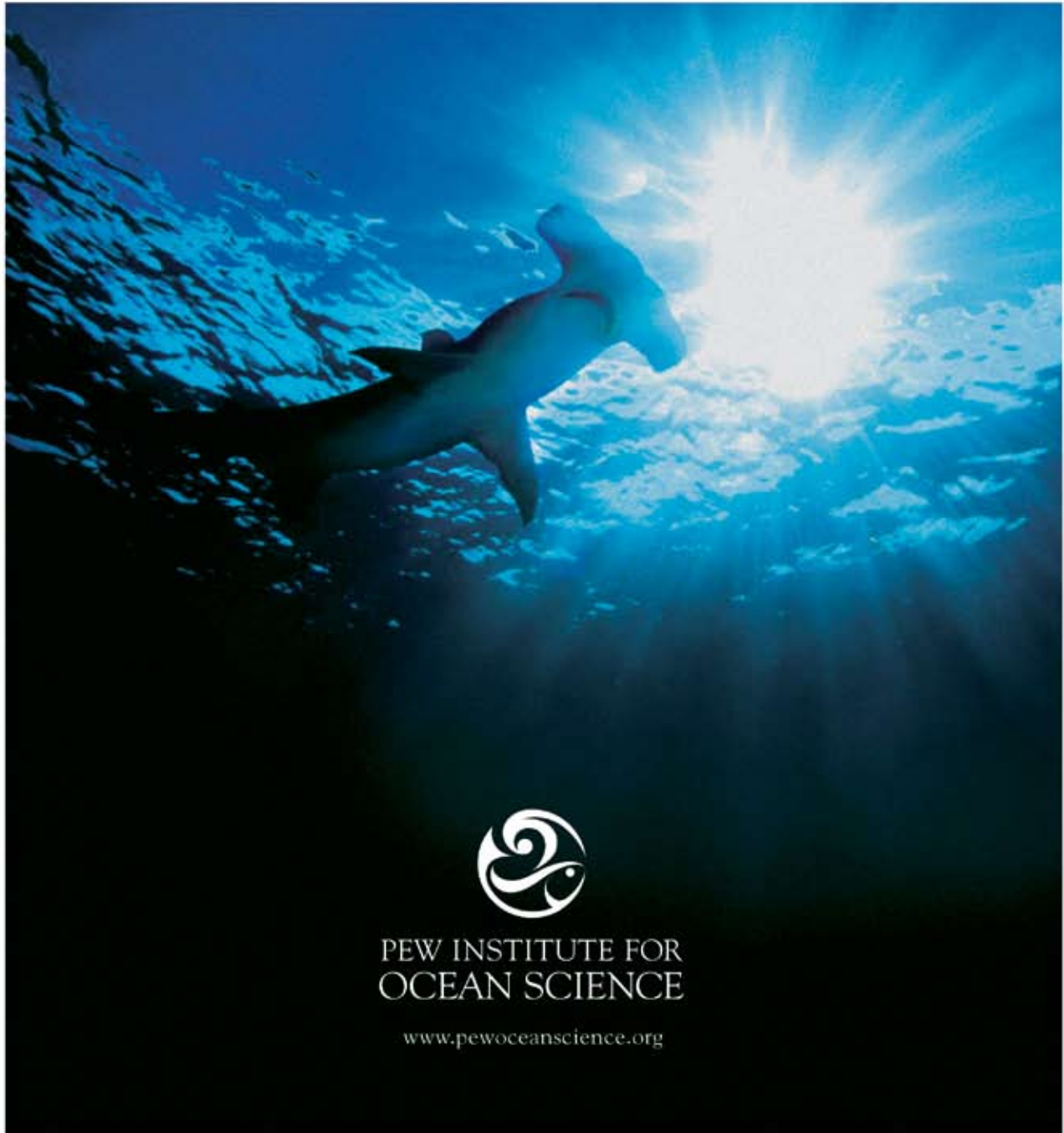


Samuel C. Snedaker (1938–2005)

Professor Samuel Curry Snedaker passed away on March 21, 2005 in Yakima, Washington, after an eminent career on the faculty of the University of Florida and the University of Miami. A world authority on mangrove ecosystems, he authored numerous books and publications on topics as diverse as tropical ecology, global climate change, and pollutants in marine organisms and sediments. One of his most enduring contributions to marine sciences was the publication in 1974 of "The ecology of mangroves" (coauthored with Ariel Lugo), a paper that set the high standard by which contemporary mangrove ecology continues to be measured. Sam's studies laid the scientific bases for the protection of mangroves in Florida. His enduring legacy lives in each and every one of those preserved forests. Within the Rosenstiel School property, a small mangrove stand containing all species of Florida mangroves is dedicated to his memory. A commemorative inscription marks the place and it is a testament to Sam's legacy of research, teaching, and scholarship.



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Photo: Neil Hammerschlag



Photo Jiangang Luo

It is our privilege to welcome you to Miami and to the “First International Symposium on Mangroves as Fish Habitat”. The meeting was convened to provide an oral and written forum for the exchange of ideas, approaches, methods, and pertinent data on the linkages between mangrove forests and the fishes and fisheries associated with them.

We are very fortunate to have several great sponsors. Sincere appreciation goes to all of them as well as to our conference organizer, the Florida Center for Environmental Studies.

Joseph E. Serafy and Rafael J. Araújo
MFH Symposium Conveners

WELCOME

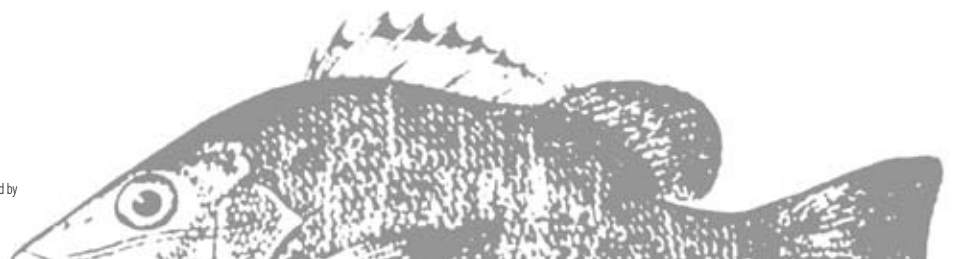


Organizing Committee

Joseph E. Serafy (NOAA's Southeast Fisheries Science Center)
Rafael J. Araújo (University of Miami)
Shauna Slingsby (NOAA's Coral Reef Conservation Program)
Doreen DiCarlo (Florida Center for Environmental Studies)

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<http://www.rsmas.miami.edu/conference/mangrove-fish-habitat>

“Assessing the State of the Science”



Background

Mangroves are conspicuous components of tropical and subtropical ecosystems around the globe. Because they occur along marine, estuarine, and riverine shorelines, a wide variety of fishes can be found among their inundated root systems. As a result, these habitats play a variety of roles in the lives of associated fishes —feeding areas for some, daytime refugia for others, and nesting or nursery areas for yet more. Questions, therefore, regarding the contribution of a given mangrove habitat to the diversity, productivity, and stability of broader fish communities and their exploited components

MANGROVE



Photo Jiangan Luo

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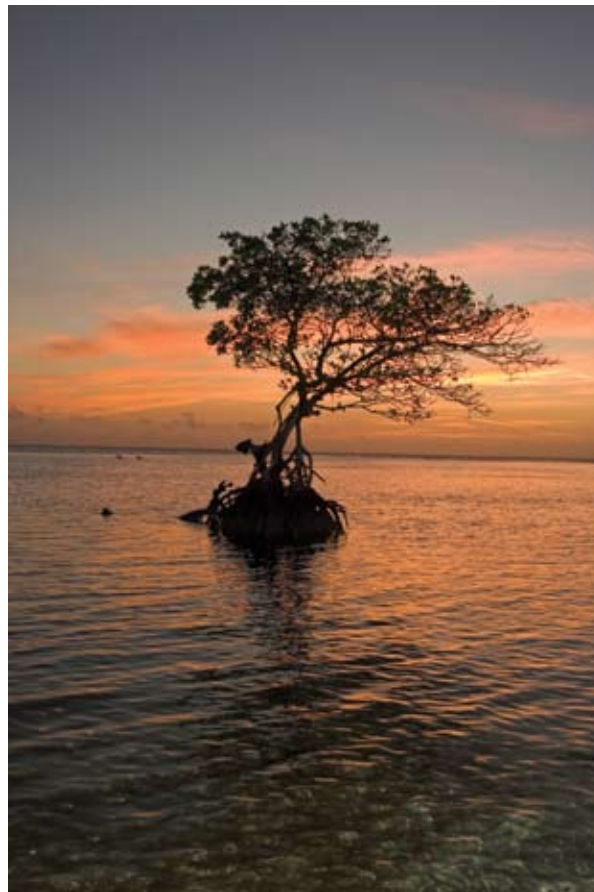


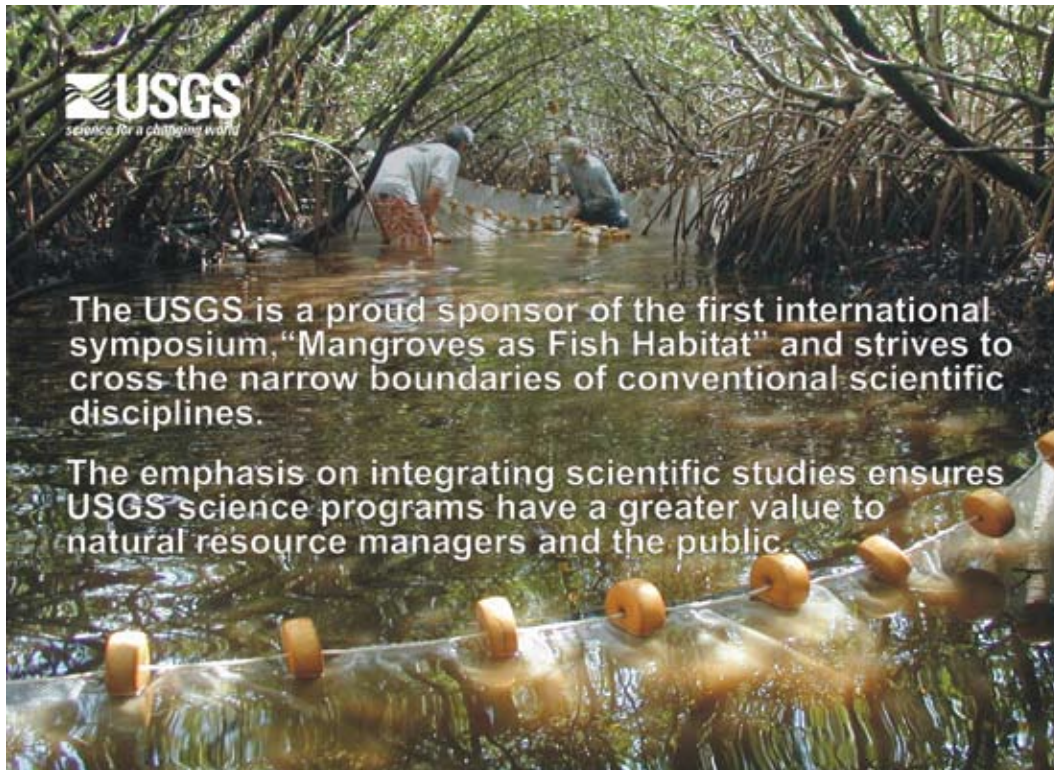
Photo Evan D'Alessandro

2002

must be carefully qualified. Unfortunately, mangroves have only recently received focused attention from the international scientific and conservation communities as potentially important fish habitats —habitats which are rapidly shrinking worldwide.

Our intent is to capture the present state-of-knowledge of mangroves as fish habitat, identifying critical information gaps, and charting a course for future research. Ultimately, we want to advance the current understanding of fish utilization of mangrove habitats and their importance in the systems that they occupy.

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Symposium Agenda

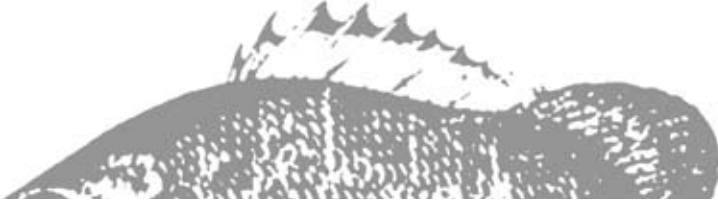
W e have a full program of presentations for the symposium. The main venue will be the Auditorium of the University

of Miami Rosenstiel School of Marine and Atmospheric Science. Most symposium presentations will take place here, but the symposium will break into a concurrent session at the RSMAS Library on April 19th (afternoon session). Enjoy yourselves and take time to catch up with colleagues from all over the world by attending our welcome reception at The Breezeway on Wednesday evening.

On April 20th we will reconvene at the Auditorium, with a poster reception planned at The Commons in the late afternoon. Presentations on April 21st will all take place in the Auditorium.

Photo Evan D'Alessandro





Wednesday, April 19, 2006 Opening Session — Auditorium

8:25–9:00 am Welcome and introduction
J.E. Serafy & R.J. Araújo (MFH Symposium conveners)

9:00–9:30 am **Keynote:** Mangroves and fishes: issues of diversity, dependence, and dogma
S.J.M. Blaber

“Nursery and Trophic Function” / Moderator: Samuel H. Gruber — Auditorium

9:30–9:50 am Variations in juvenile fish density along the mangrove–seagrass–coral reef continuum in southwestern Puerto Rico
A. Aguilar-Perera & R.S. Appeldoorn

9:50–10:10 am Ontogenic use of coastal vegetated seascapes by two reef fishes
C.H. Faunce & J.E. Serafy

10:10–10:30 am Spiny lobster and fish in multiple backreef habitats in the lower Florida Keys, U.S.A.
D.B. Eggleston, G.W. Bell, E.G. Thompson, & G.T. Kellison

10:30–10:50 am Refreshment break

10:50–11:10 am Spatial-temporal patterns of island mangrove creek habitats: a characterization as related to size, energetics, and feeding mode of fishes
K. Sullivan-Sealey, V.L. Nero, & S. Constantine

11:10–11:30 am Utilization of mangroves by juvenile lemon shark (*Negaprion brevirostris*) in their primary nursery areas
B.R. Franks & S.H. Gruber

11:30–11:50 am The relative importance of mangroves as feeding habitat for juvenile fish
B.R. Lugendo, I. Nagelkerken, G. Kruitwagen, M. Christianen, M. Dorenbosch, G. van der Velde, & Y.D. Mgaya

11:50–12:10 am Spatial variations in mangrove nursery-bound juvenile lemon shark (*Negaprion brevirostris*) prey items, Bimini, Bahamas
S.T. Kessel, S.H. Gruber, & S.P. Newman

12:10–1:30 pm Lunch at The Commons

“Nursery and Trophic Function”

Moderator: Samuel H. Gruber

Auditorium

- 1:30–1:50 pm What can stable isotope ratios reveal about fish utilization of Bahamian mangrove-lined tidal creeks?
C.A. Layman & D.A. Arrington
- 1:50–2:10 pm Evaluating trophic linkages in mangrove-based food webs using stable isotopes of carbon and nitrogen
D. Mazumder, R. Szymczak, N. Saintilan, & R.J. Williams
- 2:10–2:30 pm Use of carbon and nitrogen stable isotopes to infer food sources in Belize offshore mangroves
C.C. Mclvor, M.L. Fogel, D.S. Taylor, W. Davis, & E. Reyier
- 2:30–2:50 pm Variation of otolith elemental signatures among three species of juvenile snappers inhabiting nursery regions within south Florida
D.L. Jones, M.R. Lara, & J.T. Lamkin
- 2:50–3:10 pm Refreshment break
- 3:10–3:30 pm Spatio-temporal variation in mangrove and sea-grass communities, and their dietary importance to lemon sharks
S.P. Newman, R.D. Handy, & S.H. Gruber
- 3:30–3:50 pm Food habits of fish associated to coastal habitats in San Andrés Island, Colombian Caribbean
V. Ochoa, A. Acero, A. Santos, & J. Polanía
- 3:50–4:10 pm Predation rates vary with water depth and other biological factors in mangrove-lined tidal creeks
A.L. Rypel, C.A. Layman, D.A. Arrington, & L.M. Valentine
- 4:10–4:30 pm Mangroves and seagrass beds as diurnal feeding habitats for juvenile French grunts, *Haemulon flavolineatum*
M.C. Verweij, I. Nagelkerken, S.L.J. Wartenbergh, I.R. Pen, & G. van der Velde
- 4:30–4:50 pm Recruitment of juvenile blue crab (*Callinectes sapidus*) to natural tidal creeks and altered ditches in mangrove wetlands
L.A. Yeager, J.M. Krebs, A.B. Brame, & C.C. Mclvor
- 4:50–7:00 pm Welcome Reception at The Breezeway

“Conservation, Management, and Socio-Economics”

Moderator: Rafael J. Araújo

Library

- Economic value and social dimensions of mangrove fisheries in villages affected by the 2004 tsunami
R.J.E. Mamiit
- Interrelations between mangroves, local economy and social sustainability: an example from a case study in North Brazil
U. Saint-Paul
- Adoption rate of silvofisheries innovations as an option for mangrove conservation; challenges and research opportunities along the east African coastline
D.O. Obura, H.O.D. Mirera, & E.M. Arriego
- Integrated approaches for mangrove conservation and fisheries resources development
P. Eganathan, H.M.S.R. Subramanian, & M.S. Swaminathan
- Refreshment break
- Mangroves as essential nursery habitat for Goliath grouper (*Epinephelus itajara*)
C.C. Koenig, F.C. Coleman, A.-M. Eklund, J. Schull, & J. Ueland
- Special management needs of the Goliath grouper (*Epinephelus itajara*), in the western Atlantic Ocean
S. Frias-Torres
- Variability in Caribbean mangrove creek fish populations and communities: impacts of human threats and environmental factors
C.P. Dahlgren, P. Kramer, C.A. Layman, D.A. Arrington, L. Burke, & L.M. Valentine
- The chronic absence of cumulative impact analyses in coastal construction permitting
K. Lindeman
- The Mangrove Action Project: its genesis, mission, and challenges
A. Quarto



Thursday, April 20, 2006 — Auditorium

8:25–8:30 am

Introduction
J.E. Serafy & R.J. Araújo

8:30–9:00 am

Keynote: Are non-estuarine mangroves and coral reefs connected through fish migration? A mini-review
I. Nagelkerken

“Community Ecology and Connectivity” / Moderator: Carole Mclvor — Auditorium

9:00–9:20 am

Spatial and temporal variation in fish community structure of a marine embayment in Zanzibar, Tanzania
B.R. Lugendo, A. de Groene, I. Cornelissen, A. Pronker, I. Nagelkerken, G. van der Velde, & Y.D. Mgaya

9:20–9:40 am

Distribution and abundance of great barracuda (*Sphyraena barracuda*) and gray snapper (*Lutjanus griseus*) along a subtropical mangrove shoreline
J.E. Serafy, M. Valle, C.H. Faunce, & J. Luo

9:40–10:00 am

Connectivity controls mangrove-fish assemblage structure: evidence from 12 mangrove-lined wetland ponds in Tampa Bay, Florida
C.C. Mclvor, J.M. Krebs, & A.B. Brame

10:00–10:20 am

The insular ecology of the diamondback terrapin (*Malaclemys terrapin*), on the mangrove keys of south Florida
B.K. Mealey, G.B. Mealey, J.D. Baldwin, G.D. Bossart, & M.R. J. Forstner

10:20 - 10:40 am

Refreshment Break

10:40–11:00 am

Seasonal variation in fish abundance in mangrove ecosystems: comparing forested and unforested habitats
H.O.D. Mirera, J.G. Kairo, N.E. Kimani, & F.K. Waweru

11:00–11:20 am

Seasonal fish-community patterns in upstream reaches of mangrove creeks in Everglades National Park, Florida, U.S.A.
J.S. Rehage & W.F. Loftus

11:20–11:40 am

Patterns in tidal migration of mangrove fish: a hydroacoustic approach
U. Krumme & U. Saint-Paul

11:40–12:00pm

An evaluation and comparison of dual-frequency sonar and stereo video for estimating fish abundance and size structure in mangrove habitats
T. Kellison, J. Luo, J. Javech, P.S. Rand, P. Johnson, & J.E. Serafy

12:00–1:20 pm

Lunch at The Commons

1:20–1:40 pm

Larval, juvenile and adult fishes in mangrove tidal creek habitats: spatiotemporal changes in a Brazilian tropical estuary
M. Barletta, A. Barletta-Bergan, & U. Saint-Paul

1:40–2:00 pm

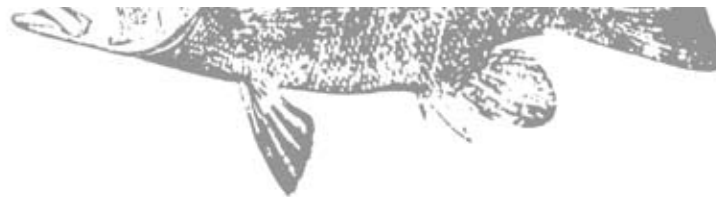
Local juvenile fish densities in Florida Keys mangroves correlate with regional landscape characteristics
C.A. Drew & D.B. Eggleston

2:00–2:20 pm

Diel patterns in mangrove fish assemblages in northeastern Australia estuaries
J.A. Ley

2:20–2:40 pm

Refreshment break



“Mangrove-Fishery Linkages” / Moderator: Craig Faunce — Auditorium

- 2:40–3:00 pm Mangroves and fisheries linkages — the Malaysian perspective
C.V. Chong
- 3:00–3:20 pm Relationship between estuarine habitats and coastal fisheries in Australia
J.-O. Meynecke, S.Y. Lee, & J. Warnken
- 3:20–3:40 pm Changes to fish assemblages visiting estuarine wetlands following the closure of commercial fishing in Botany Bay, Australia by *N. Saintilan, D. Mazumder, & K. Cranney*
- 3:40–4:00 pm Mangrove myths and reality — their connectivity to fisheries production
D. Couchman, J. Beumer, & J. Kirkwood

Poster Reception

4:00–6:00 pm

The Commons

- Pit-tags and remote antennae: effective tools for studying juvenile fish use of mangrove creeks by *A.J. Adams & R. Kirby Wolfe*
- The International Marine Shrimp Environmental Genomics Initiative (IMSEGI): monitoring ecosystem, animal, and public health — current status and perspectives for the future by *A. Alcivar-Warren, J. Keating, L. Maranda, M. Delaney, D. Meehan-Meola, W. Moomaw, C. McClennen, J. Echevarria, A. Alvarado, C. Serrano, C. Valarezo, L. Mejia, M. Saavedra, L. A. Alcivar, M. Alcivar, M. Palmieri, S. Panutrakul, W. Senanan, P. Barnette, N. Tangrock-Olan, J. Enright, B. Brown, & J. Xiang*
- Declining mangroves and fisheries in the Batan Estuary, Panay Island, central Philippines by *J. P. Altamirano*
- Grackles foraging may enhance feeding success of mangrove fishes by *L.E. Bavaro, L.M. Szelistowski, & W.A. Szelistowski*
- Spoil dredge mangrove forestation as a potential support for fisheries in a Mexican coastal lagoon by *D. Benitez-Pardo, F.J. Flores-Verdugo, & M. Casas-Valdéz*
- Catch-and-release angling in mangrove creeks: survival and behavior of bonefish (*Albula* spp.) in Eleuthera, Bahamas by *S.A. Danylchuk, A.J. Danylchuk, S.J. Cooke, T.L. Goldberg, J. Koppelman, & D.P. Philipp*
- Do four intertidal mangrove creeks in a homogenous salinity zone have the same habitat value for juvenile fish assemblages? by *T. Giarrizzo & U. Krumme*
- A meta-analysis of snapper and grunt data from mangrove shoreline habitats in the Greater Caribbean by *C.H. Faunce*
- Biological, fishing, and socioeconomic studies within the Cayapas-Mataje Mangrove Ecological Reserve in the Province of Esmeraldas, Ecuador by *N. Gaibor, L. de Cajas, M. Prado, D. Coello, J. Cajas, R. García, & J. Moreno*
- Adult survival, probability of capture, and abundance estimates for mangrove diamondback terrapins (*Malaclemys terrapin*) in Everglades National Park, Florida by *K.M. Hart, C.A. Langtimm, & C.C. McIvor*
- Fish assemblages in the causeway margins by *J.I. Hernández-Albernas*
- Ecological effects fo the extensive Bimini Bay resort development on the juvenile lemon shark (*Negaprion brevirostris*) populations of Bimini, Bahamas by *J.E. Jennings, S.H. Gruber, S.T. Kessel, B.R. Franks, & A.L. Robertson*
- Ecological characterization of mangrove ecosystem as a fish habitat in Terminos Lagoon, in the southern Gulf of Mexico by *A.L. Lara-Dominguez, D.Z. Lomeli, G. Villalobos-Zapata, & A. Yañez-Arancibia*
- Publication of a 2nd edition of the *World Mangrove Atlas* by *M. Loyche Wilkie, S. Baba, M. Kainuma, S. Johnson, M. Clusener-Godt, E. Corcoran, & Z. Adeel*
- Connections between root epibionts and fish communities in mangrove habitats by *J. A. MacDonald & J.S. Weis*



EPSCoR Phase II: future directions — land-sea interactions by A. McCammon, R. Nemeth, M. Whitaker, & N. Idrisi

Variability of stable isotope ratios of mangrove glassfish (*Ambassis jacksoniensis*) from southeast Australia and the implications for ecosystem studies by D. Mazumder, R.J. Williams, R. Szymczak, D. Reid, & N. Saintilan

Explaining patterns of abundance for fish using mangroves: a multi-scale seascape approach by S.J. Pittman, C. Caldow, S. Davidson Hile, & M.E. Monaco

Nutrient dynamics in a closed system with mangrove seedlings and poeciliid fishes by C.L. Moroyoqui-Rojo, L. Moroyoqui-Rojo, F.J. Flores-Verdugo, D. Escobedo-Urías, & M.N. Herrera-Moreno

Mangrove cover, fisheries and environmental perturbations in the Ciénaga Grande de Santa Marta (CGSM), Colombian Caribbean by J. Restrepo, J. Blanco, C. Villamil, E. Viloria, J.C. Narváez, & M. Rueda

Ichthyologic dynamics in the mangrove of Térraba, Costa Rica: tools for mangrove management by J.R. Rojas Morales

The importance of mangroves as nursery habitat for smalltooth sawfish (*Pristis pectinata*) by C. Simpfendorfer

An assessment of ichthyofaunal assemblages within the mangal of the Belizean offshore cays by D.S. Taylor, E.R. Reyier, C.C. Mclvor, & W.P. Davis

A hybrid maximum-likelihood method for deriving large-scale mangrove distributions in Florida from Thematic Mapper data by J. Ueland

Developing shallow-water acoustic telemetry methods for juvenile snapper habitat studies in the Florida Keys National Marine Sanctuary by S.R. Whitcraft, B. Richards, J. Lamkin, T. Gerard, T. Carlson, G. McMichael, J. Vucelick, G. Williams, & L. Pytka

We are pleased to welcome author Lynne Cherry to the Poster Reception where she will be signing copies of her children's book *The Sea, the Storm, and the Mangrove Tangle*.



Friday, April 21, 2006 — Auditorium

8:25–8:30 am Introduction
J.E. Serafy & R.J. Araújo

8:30–9:00 am **Keynote:** Integration of aquaculture and mangroves
J.H. Primavera

“Disturbance and Restoration” / Moderator: Roy “Robin” Lewis — Auditorium

9:00–9:20 am Distinguishing the effects of anthropogenic and natural (hurricane) disturbances on mangrove creek fishes
A.J. Adams & R.K. Wolfe

9:20–9:40 am Hurricane impacts on fish communities associated with mangroves
S.A. Bortone, A.J. Martignette, B. Klement, J. Guinn, & E. Milbrandt

9:40–10:00 am Hurricane-induced conversion of mangrove forest to mudflat: impacts on nekton, Big Sable Creek, Florida, U.S.A.
N.L. Silverman, C.C. Mclvor, J.M. Krebs, & V.A. Levesque



10:00–10:20 am	Damaged versus undamaged mangroves as fish habitat following a major hurricane in southwest Florida, U.S.A. <i>M.F.D. Greenwood, C.F. Idelberger, & P.W. Stevens</i>
10:20–10:40 am	Refreshment Break
10:40–11:00 am	Important considerations to achieve successful mangrove forest restoration with optimum fish habitat <i>R.R. Lewis III & R.G. Gilmore</i>
11:00–11:20 am	Altered mangrove wetlands as habitat for estuarine nekton: are dredged channels and tidal creeks equivalent? <i>J.M. Krebs, A.B. Brame, & C.C. McIvor</i>
11:20–11:40 am	Shrimp ingress into mangrove forests of different age stands, Matang Mangrove Forest Reserve, Malaysia <i>N. Affendy & V.C. Chong</i>
11:40–12:00 pm	Restoring essential fish habitat in southeast Florida: mangrove and seagrass habitat design components and success monitoring <i>G.R. Milano, N. Hammerschlag, J. Barimo, & J. Serafy</i>
12:00–1:20 pm	Lunch at The Commons
1:20–1:40 pm	The impacts of natural disturbance on the nekton community structure in Micronesian mangrove forests <i>R.A. MacKenzie & N. Cormier</i>
1:40–2:00 pm	Larval and zooplankton communities: comparing intact and cleared mangrove areas in Bocas del Toro, Panama <i>E.F. Granek & K.E. Frasier</i>
2:00–2:20 pm	Response of fish secondary production to tidal creek fragmentation and restoration <i>L. Valentine, D.A. Arrington, & C. Layman</i>
2:20–2:40 pm	Mangrove removal in the Belize Cays: effects on fish assemblages in the intertidal and subtidal <i>D.S. Taylor, E.R. Reyier, W.P. Davis, & C.C. McIvor</i>
2:40–3:00 pm	Enhancement of fisheries for mud crabs (<i>Scylla</i> spp.) in the mangroves of Naisud and Bugtong Bato, Ibaday, Aklan, Philippines <i>M.J.H.L. Leбата, J.H. Primavera, M. Walton, J.B. Biñas, & L. Le Vay</i>
3:00–3:20 pm	Adjourn

Photo Evan D'Alessandro



Rosenstiel School of Marine and Atmospheric Science

Campus Map



ABSTRACTS

Presentations and Posters (in alphabetical order by first author's last name. Name of presenter indicated with section sign "\$")

[🗣️] Oral presentation

[📄] Poster presentation

Photo Evan D'Alessandro



[🗣️] DISTINGUISHING THE EFFECTS OF ANTHROPOGENIC AND NATURAL (HURRICANE) DISTURBANCES ON MANGROVE CREEK FISHES

Aaron J. Adams [§] & R. Kirby Wolfe

Mote Marine Lab., Charlotte Harbor Field Station, Pineland, FL, U.S.A.

Disturbances are considered important factors influencing biological organization. Hurricanes are disturbances of particular importance in warm latitude coastal ecosystems. However, disturbance effects are often modified by interactions with anthropogenic disturbances, which tend to have different ecological effects than, and often alter the ecological response to, natural disturbances. Four creeks (two "natural", two "degraded") had been sampled for 22 months prior to, and 14 months after hurricane Charley. Prior to the hurricane, fish assemblages were different between creek types, with more species and higher densities in natural creeks. Species richness and density in natural creeks declined precipitously post-hurricane, and species generation times and isolation from likely source populations has resulted in a delayed recovery in abundance, but species richness is similar to pre-hurricane levels. Fish assemblages in degraded creeks appeared less impacted by the hurricane, likely because they had already experienced a phase shift.

[📄] PIT-TAGS AND REMOTE ANTENNAE: EFFECTIVE TOOLS FOR STUDYING JUVENILE FISH USE OF MANGROVE CREEKS

Aaron J. Adams [§] & R. Kirby Wolfe

Mote Marine Lab., Charlotte Harbor Field Station, Pineland, FL, U.S.A.

Mangroves are purported nurseries for many marine and estuarine fishes, but information on density, growth, and survival is necessary to define nursery habitats. Recent technological advances have made large-scale tagging efforts a viable approach to studying juvenile fishes by increasing recapture rates and enabling the use of individual-identification tags. Passive Integrated Transponder (PIT) tags and autonomous antennae, used extensively in freshwater environments, have been successfully adapted to estuarine mangrove creeks to study juvenile snook, *Centropomus undecimalis*. Tag retention rate in juveniles > 120 mm standard length was 100%, with no mortality. The antenna detected approximately 67% of tagged fish that swam through, and the overall "recapture" rate by the antenna was > 40%. The high recapture rate allowed population model estimates of survival and population size, and physical recaptures allowed direct measures of growth. This is a viable approach to examining the nursery function of difficult-to-sample mangrove creek habitats.

[🗣️] SHRIMP INGRESS INTO MANGROVE FORESTS OF DIFFERENT AGE STANDS, MATANG MANGROVE FOREST RESERVE, MALAYSIA

N. Affendy & V. C. Chong [§]

Institute of Biological Sciences, University of Malaya, Kuala Lumpur, Malaysia.

Although the importance of mangrove forests as nursery areas for shrimps has been well documented, why shrimps are associated with mangroves is not fully understood. This study investigates the relationship between shrimp abundance and mangroves of different age stands. Shrimp abundance in a cleared area and four different age stands of mangroves (5, 17, 24 and > 30 years) were compared. These forest stands are silvicultured, varying in tree densities as well as structural complexity of the root system. Shrimps were sampled using baited shrimp pots. A total of 3609 penaeid, caridean, and alpheid shrimps belonging to 10 species were sampled over a 12-month period. The majority of prawns moved at least 56.4 m into the mangrove forest at

Photo Evan D'Alessandro



high tide. The highest mean catch of prawns recorded in the 24-year old age stand was 51.08 prawns per hour and the lowest was 2.52 prawns per hour in the clear-felled mangrove site. Prawn catch increased with increasing distance from the mangrove river fringe into the forest. More prawns were caught among prop roots than in the open spaces between trees. The role of mangroves as nursery areas and implications for forestry management are discussed.



📍 VARIATIONS IN JUVENILE FISH DENSITY ALONG THE MANGROVE–SEAGRASS–CORAL REEF CONTINUUM IN SOUTHWESTERN PUERTO RICO

Alfonso Aguilar-Perera [§] & Richard S. Appeldoorn

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Despite extensive study of the fish community off southwestern Puerto Rico, little information is available on the relative importance of mangroves, seagrass beds, and shallow-water coral reefs as nursery areas. We investigated the extent to which 20 selected, reef-associated fish species use the mangrove and seagrass as nurseries in contrast to the use of shallow-water coral reefs. Stratified sampling was applied to quantify the variability of juvenile fish densities along the mangrove–seagrass–coral reef continuum following an inshore-offshore gradient. We recorded 28,758 individuals (in 7 families), with juveniles accounting for 80%. Significant variations in juvenile densities were evident. The importance of mangroves and seagrass for harboring juveniles was found to be relative and species-specific. In the majority of cases shallow-coral reefs showed higher densities than mangroves and seagrass. Ontogenetic migration of juveniles through the continuum was evident. Results highlight the importance of including this continuum within coastal management through marine reserves.

📄 THE INTERNATIONAL MARINE SHRIMP ENVIRONMENTAL GENOMICS INITIATIVE (IMSEGI): MONITORING ECOSYSTEM, ANIMAL, AND PUBLIC HEALTH — CURRENT STATUS AND PERSPECTIVES FOR THE FUTURE

Acacia Alcivar-Warren ^{§ 1,2,3,5}, John Keating ^{1,6}, Louise Maranda ^{1,3,4,5}, Martha Delaney ^{1,2,5}, Dawn Meehan-Meola ^{1,2,5}, William Moomaw ^{1,7}, Caleb McClennen ^{1,7}, Jorge Echevarria ^{1,8}, Adan Alvarado ^{1,9}, Cecilia Serrano ^{1,10}, Cesar Valarezo ^{1,10}, Luis Mejia ^{1,11}, Marco Saavedra ^{1,11}, Luis A. Alcivar ^{1,11}, Miriam Alcivar ^{1,11}, Margarita Palmieri ^{1,12}, Suwanna Panutrakul ^{1,11}, Wansuk Senanan ^{1,13}, Praparsiri Barnette ^{1,13}, Nongnud Tangrock-Olan ^{1,13}, Jim Enright ¹⁴, Benjamin Brown ¹⁵, & Jianghai Xiang ^{1,16}

¹ IMSEGI. ² Environmental & Comparative Genomics Section. ³ Center for Conservation Medicine. ⁴ International Program. ⁵ Department of Environmental and Population Health. ⁶ Pathology Laboratory, Department of Biomedical Sciences, Cummings School of Veterinary Medicine at Tufts University, N. Grafton, MA, U.S.A. ⁷ The Fletcher School of Law and Diplomacy, Tufts University, Medford, MA, U.S.A. ⁸ Departamento de Biología y Bioquímica, Facultad de Ciencias de la Salud, Universidad Nacional de Tumbes, Peru. ⁹ Departamento de Acuicultura, Facultad de Ingeniería Pesquera, Universidad Nacional de Tumbes, Peru. ¹⁰ Escuela de Acuicultura, Universidad Técnica de Machala, Ecuador. ¹¹ Clínica de Especialidades Médicas, Santo Domingo, Ecuador. ¹² Universidad del Valle de Guatemala, Guatemala. ¹³ Department of Aquatic Science, Faculty of Sciences, Burapha University, Chonburi. ¹⁴ Mangrove Action Project, Amphur Muang, Trang, Thailand. ¹⁵ Mangrove Action Project, Yayasan Akar Rumpit Laut, Yogyakarta, Indonesia. ¹⁶ Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China.

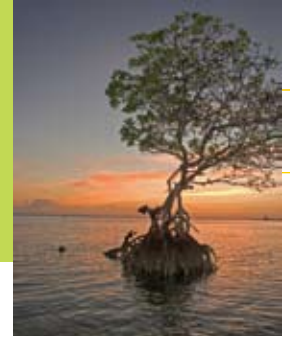
Marine shrimp populations in their natural habitat are threatened by a variety of pressures including habitat destruction, pollution (i.e., pathogens, heavy metals, PCBs, antibiotics) and gene pool depletion. To conserve penaeid shrimp species and develop a sustainable shrimp aquaculture industry, the IMSEGI was initiated with the purpose of yearly monitoring (1) the structure of the meta-population of wild penaeid shrimp species, (2) the levels of genetic differentiation of selected species, and (3) pollutant load (pathogens, heavy metals, PCBs, etc.) in penaeid shrimp populations along their natural range. Using GIS, we study the association between genetic differentiation/pollutant load with ecosystem health (i.e. condition of mangrove forests and intensity of shrimp farming and other agro-industries). A database is being compiled with data on biological and environmental parameters such as shrimp length, weight, sex, prevalence of viral diseases, allele diversity, salinity, temperature, status of mangrove forests, among others. In addition, we take this opportunity to create Gene Banks of tissues, nucleic acids and genomic and cDNA libraries in each country. Genomics tools will be applied to test hypotheses on population structure, evolutionary and quantitative genetics, and genetic epide-

Aguilar-Perera

Alcivar-Warren

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Photo Evan D'Alessandro



miology. So far, we have (1) cloned genomic and cDNA libraries from *Penaeus vannamei*, *P. monodon* and *P. chinensis*; (2) developed RAPD, SSR/microsatellite and SNP markers for studies on population genetics and genome mapping and address food safety and biosecurity issues; (3) examined microsatellite allele diversity and prevalence of viral diseases such as IHNV and WSSV in wild shrimp of Philippines, Thailand, Indonesia, China, Peru, Ecuador, Panama, El Salvador and Mexico; (4) began an EST database with a goal of sequencing 60,000 ESTs for microarrays and marker development. Genomics tools such as DNA microarrays and linkage and quantitative trait loci (QTL) mapping will be used to compare global levels of gene expression, identify genes that respond to environmental cues, identify fitness traits, determine segregation of fitness-related alleles, study how the genetic composition of a population changes in response to selection pressures, and gain insights into the effects of transgenes on individuals and populations. (5) A medium-density linkage map for shrimp (ShrimpMap) is being constructed, funded by the USDA-CSREES, and will be used to investigate the molecular genetic pathways through which animals respond to environmental stressors. (6) IHNV prevalence is associated with condition of mangrove forests in Philippines and Ecuador. (7) Heavy metal levels vary among geographic regions and species. Levels of some metals in wild *P. merguensis*, *P. monodon* and *P. vannamei* are generally low and do not appear to represent a risk to public health. Cadmium levels may affect reproductive, developmental and immune system function of shrimp and bioassays have been established to begin testing this hypothesis under laboratory conditions. As new countries join such as India, Sri Lanka and Bangladesh, Mexico, and other Central American countries, this initiative will gather additional information across the full natural range of the penaeid species. We invite academic and industry groups as well as governmental and non-governmental organizations to join IMSEGI.

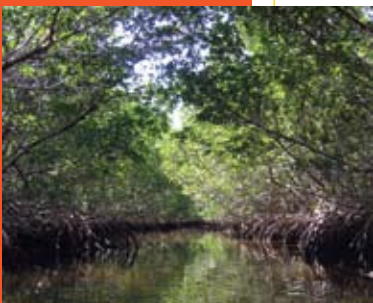
DECLINING MANGROVES AND FISHERIES IN THE BATAN ESTUARY, PANAY ISLAND, CENTRAL PHILIPPINES

Jon P. Altamirano

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In the Philippines, being an archipelago of 7100 islands with a vast 184,000 km² continental shelf area, fishing is a major means of livelihood. With recent trends, coastal fishing grounds that were once abundant with fishery resources and vast coral reefs, seagrasses and mangrove belts, have been becoming increasingly depleted. Mangrove cover has dramatically declined and these important ecosystems were converted to other uses. About 279,000 ha were lost from 1951 to 1988 in the Philippines, 50% of which were attributed to aquaculture. Population increase that led to a more intense fishing pressure and alongside the loss of these important mangrove ecosystems is the noticeable decline in municipal capture fisheries in coastal fishing grounds. One important fishing ground in central Philippines is the Batan Estuary in Panay Island where about 10,000 households are dependent upon its fisheries, especially on shrimps. Shrimp catch in the Batan Estuary showed that especially the high-priced tiger shrimp *Penaeus monodon* composition declined from 61.9% of the total shrimp landings in 1976–80 to only 6.22% in 1990–91. It is important to note that mangrove cover along the estuary decreased from 4800 ha in 1953 to only less than 300 ha of scattered patches in the 1990s. There are also extensive (4,596.81 ha) culture ponds in the area. In recent interview and sampling data, fishers who used to catch 10–25 kg/d of shrimps and fish in the 1970s only catch an average of 1.5 kg/d at present. These trends and status of mangroves and fisheries of the Batan Estuary in central Philippines are presented in this paper.

Photo Evan D'Alessandro





[📍] LARVAL, JUVENILE, AND ADULT FISHES IN MANGROVE TIDAL CREEK HABITATS: SPATIO-TEMPORAL CHANGES IN A BRAZILIAN TROPICAL ESTUARY

Mário Barletta ^{§1}, Audrey Barletta-Bergan ², & Ulrich Saint-Paul ²

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Mangroves, open water channels, and adjacent marine areas are considered important spawning grounds and nursery areas for riverine, estuarine, and marine fishes. This study describes the seasonal changes of fish species composition in relation to biomass, density, and biodiversity in the mangrove tidal creeks and in different reaches of the main channel of the estuary. The fish fauna of each habitat was different in density, biomass, and species composition. Seasonal salinity fluctuation is the main factor which structures the fish assemblages in the different habitats of the estuary. The results are also discussed in relation to the different levels of estuarine dependence from the most important species captured in Caeté Estuary. At least 85% of the species captured by the artisanal and subsistence fisheries in the coastal areas of this region require estuarine conditions to complete their life cycle.

[📍] GRACKLES FORAGING MAY ENHANCE FEEDING SUCCESS OF MANGROVE FISHES

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Positive interactions (mutualism, commensalism) are widespread in tropical environments such as coral reefs, but are not well known in mangroves. This study presents evidence that in the Gulf of Nicoya, Costa Rica, mangrove fishes use disturbances made by foraging grackles to locate and consume tree crabs. Historically, artisanal fishermen in the gulf were known to mimic grackle disturbances to attract snappers and catfish. We found that: (1) four common snappers, *Lutjanus colorado*, *L. aratus*, *L. jordani*, and *L. argentiventris*, and the catfish *Hexanemataichthys seemanni* feed on the grapsid crabs *Aratus pisonii* and *Goniopsis pulchra*; (2) fishes frequently prey on tree crabs which enter the water to escape grackles; and (3) snapper and catfish attack rates on submerged crabs are increased following experimentally-produced disturbances resembling those of grackles. The difficulty of making visual observations in mangroves may contribute to the paucity of positive interactions known to occur there.

[📍] SPOIL DREDGE MANGROVE FORESTATION AS A POTENTIAL SUPPORT FOR FISHERIES IN A MEXICAN COASTAL LAGOON

D. Benitez-Pardo ^{§1}, F. J. Flores-Verdugo ², & M. Casas-Valdéz ³

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The main problem in most coastal lagoons in Mexico is the silting of tidal channels. In the Bay of Navachiste (northwest coast of Mexico) a dredging program was developed by the Federal Fisheries Ministry with the purpose to restore the natural tidal hydrodynamics. The spoils were used for the construction of islands and forested with mangroves from a nursery with 25,000 seedlings of *Rhizophora mangle* and *Avicennia germinans*. Mangrove plantation was carried out considering flooding period for each species, according to their tidal ranges and soil salinities. After a year the survival rate was from 68% to 59% for *R. mangle* and from 80% to 85% for *A. germinans*. The growing rate for *R. mangle* was 1.4 cm mo⁻¹ compared to 0.8 cm mo⁻¹ for seedlings in the natural forest. For *A. germinans* growing rate was 3.2 cm mo⁻¹ vs 1.5 cm mo⁻¹ in the natural forest.

Barletta

Bavaro

Benitez-Pardo

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Photo Evan D'Alessandro



KEYNOTE PRESENTATION:

MANGROVES AND FISHES: ISSUES OF DIVERSITY, DEPENDENCE, AND DOGMA

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Tropical estuarine fishes are inextricably linked with mangroves, which are the dominant vegetation of tropical and subtropical estuaries. Among the most productive of aquatic areas and heavily exploited, their future may depend upon ecosystem understanding. This paper reviews diversity, dependence, and connectivity between mangroves and fisheries in the light of data from previously unstudied systems in developing countries and new approaches in developed countries. Fish diversity in mangroves varies at global, latitudinal, regional, local, and habitat scales, and species composition in any one system represents the combined influences of factors operating at each of these scales. Mangrove dependence paradigms require critical evaluation as new data become available and as catches and mangrove areas decline. Although it is a widely held dogma that mangroves are essential for fish populations, most evidence is circumstantial. Therefore experimental and quantitative studies are needed to support arguments that the value of retaining mangroves exceeds that of their destruction.

[📍] HURRICANE IMPACTS ON FISH COMMUNITIES ASSOCIATED WITH MANGROVES

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Hurricane Charley (Category 4) hit the southwest Florida coast in August 2004 and had a significant impact on mangrove structure. Ongoing surveys on fishes and mangroves presented the opportunity to investigate changes in the mangrove-associated fish community relative to the impact of the hurricane. Presumably, waters and substrates proximate to the mangrove shoreline were altered relative to increased exposure to sunlight with concomitant increases in temperature and decreases in oxygen. Consequently, a scenario was provided to examine the effects that these physical features of the mangrove community had on the associated fish community. Three replicate seine hauls, using a 21.3-m × 1.8-m (3.2-mm mesh) net, were deployed to sample the mangrove-adjacent fish community at numerous locations before and after the hurricane. Analyses of community structure (Bray-Curtis dissimilarity index) in simultaneous comparisons with associated environmental variables using CCA (Canonical Correspondence Analysis) indicated changes in the basic community structure were detectable but short lived, and were overwhelmed by other “catastrophic” events, such as red tide. Mangrove re-vegetation continues with concomitant evaluation of the fish community.

[📍] MANGROVE AND FISHERIES LINKAGES: THE MALAYSIAN PERSPECTIVE

V.C. Chong

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Malaysia's existing 577,558 ha of mangrove forests are believed to sustain more than 50% of its annual offshore fishery landings of 1.28 million tonnes. This paper reviews research works that relate the contribution of Malaysian mangroves to coastal food chains and fisheries. It examines salient features of mangrove

Photo Jiangang Luo





productivity, nutrient release, water parameters, food resources, refugia, and fish nursery ground values of selected mangrove areas. The review shows the large contribution of mangroves to coastal fisheries in terms of providing trophic and refuge support, larval retention and possibly coastal outwelling of nutrients. Various anthropogenic effects such as aquaculture and coastal development on the carrying capacity of mangroves are discussed.

[👤] MANGROVE MYTHS AND REALITY: THEIR CONNECTIVITY TO FISHERIES PRODUCTION

Dawn Couchman[§], *John Beumer*, & *John Kirkwood*

Queensland Department of Primary Industries and Fisheries, Brisbane, QLD, Australia.

Mangrove protection in Queensland, Australia, has a long history (ongoing for 100 years) and is unique in the developed world. Considerable resources have been invested in recent years to map and identify the extent, diversity, structure, and function of mangrove communities and their productivity, based on leaf-fall and nutrient export to coastal food webs. However, the linkages between fish and fisheries production and mangroves remains poorly understood. This presentation explores the current evidence for and against the reliance of fisheries productivity on mangrove communities and highlights the challenges resource managers face in an era of high development pressure in Queensland's coastal cities. New legislation supporting development threatens to erode the protection afforded to Queensland's mangroves. The pressure is on to provide hard evidence to support the continuing conservation of these marine plants.

[👤] VARIABILITY IN CARIBBEAN MANGROVE CREEK FISH POPULATIONS AND COMMUNITIES: IMPACTS OF HUMAN THREATS AND ENVIRONMENTAL FACTORS

C. P. Dahlgren^{§1}, *P. Kramer*², *Craig A. Layman*³, *D. A. Ibrey Arrington*⁴, *L. Burke*, & *Lori M. Valentine*⁴

¹ Perry Institute for Marine Science, Jupiter, FL, U.S.A. ² National Science Foundation, Washington, DC, U.S.A. ³ Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT, U.S.A. ⁴ Loxahatchee River District, Jupiter, FL, U.S.A. ³ University of Alabama, Tuscaloosa, AL, U.S.A.

Mangrove fringes of tidal creeks serve as important habitats for juvenile and adults of numerous fish species in the Caribbean. Fish using these habitats include those of importance to marine resource managers due to their economic value, ecological function or their threatened status. Thus, understanding factors that influence mangrove fish communities and populations of key species residing in mangroves is essential for effective management of mangrove systems and species that depend on them. Here we combine GIS analyses of human threats to mangrove systems, in situ measurements of environmental parameters, and surveys of fish from mangrove creek systems from the Bahamas and Virgin Islands. Using these datasets, we examine the relationship that human threats and environmental factors have with mangrove creek fish population and community structure. Preliminary analyses show that environmental variables such as water depth have the greatest influence on fish community structure, but several human threats also contribute to fish community structure and populations of fishery species.

[👤] CATCH-AND-RELEASE ANGLING IN MANGROVE CREEKS: SURVIVAL AND BEHAVIOR OF BONEFISH (*ALBULA* SPP.) IN ELEUTHERA, BAHAMAS

Sascha A. Danylchuk^{§1,3,4}, *Andy J. Danylchuk*^{1,3}, *Steve J. Cooke*^{1,2,3}, *Tony L. Goldberg*^{1,4}, *Jeff Koppelman*^{1,5}, & *David P. Philipp*^{1,3,4}

¹ Cape Eleuthera Institute, Eleuthera, The Bahamas. ² Institute of Environmental Science and Department of Biology, Carleton University, Ottawa, Canada. ³ Illinois Natural History Survey, Center for Aquatic Ecology and Conservation, Champaign, IL, U.S.A. ⁴ Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL, U.S.A. ⁵ Missouri Department of Conservation, Columbia, MO, U.S.A.

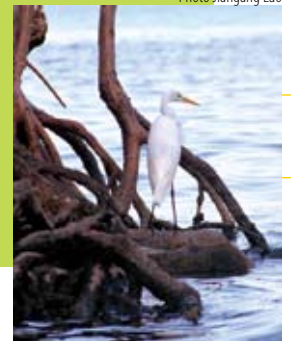
Bonefish (*Albula* spp.) inhabit shallow tropical and subtropical mangrove environments worldwide and are economically important due to their popularity among recreational anglers. Despite their importance, little is known about the biology and ecology of bonefish. The purpose of this study was to examine how different

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Dahlgren

Danylchuk

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angling, handling, and release techniques affect the short-term post-release survival of bonefish inhabiting mangrove creeks in Eleuthera, Bahamas. A total of 87 fish were angled, released, and visually tracked using small surface floats. A total of 15 (17%) bonefish were preyed upon. Fish released near protective mangrove cover did not experience decreased predation risk. However, all but one of the predation events occurred over 10 m distance from mangrove cover. These results indicate that handling practices and release strategies can significantly affect the short-term survival of bonefish in mangrove creeks. Angler education and management plans that encourage conservative handling can help to sustain this important fishery.

[📄] DIFFERENT FISH COMPOSITION IN SEAGRASS BEDS ADJACENT TO EXTENSIVE MANGROVE AREAS AS OPPOSED TO CORAL REEFS

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Radboud University, Department of Animal Ecology and Ecophysiology, Nijmegen, The Netherlands.

Little is known about fish assemblages on seagrass beds located adjacent to different habitats. Visual census surveys were used to study the fish composition of two types of seagrass habitats in Zanzibar (Tanzania): seagrass beds adjacent to extensive mangrove areas in an embayment (bay seagrasses) and seagrass beds situated on the continental shelf adjacent to coral reefs (reef seagrasses). At species level, 39 fish species were common in the seagrass habitats, of which 9 showed significantly higher densities in bay seagrasses, and 4 species were exclusively observed in bay seagrasses. Seine net data supported these data and showed that 5 species occurring only or in higher densities in bay seagrasses were species typically associated with the mangroves as juveniles (*Lethrinus harak*, *Lutjanus argentimaculatus*, *L. ehrenbergii*, *L. fulviflamma* and *Scarus ghobban*). This suggests that for some species, the occurrence of fishes on seagrass beds is related to the connectivity with mangroves.

[📍] LOCAL JUVENILE FISH DENSITIES IN FLORIDA KEYS MANGROVES CORRELATE WITH REGIONAL LANDSCAPE CHARACTERISTICS

C. Ashton Drew[§] & David B. Eggleston

¹ North Carolina State University, Department of Marine, Earth, and Atmospheric Sciences, Raleigh, NC, U.S. A.

Juvenile fish density and diversity vary greatly among mangrove prop root habitat in the Great White Heron National Wildlife Refuge, Florida Keys, USA. We tested relationships between juvenile fish density and diversity and patch- (100s m) and landscape-scale (1 km) habitat characteristics by using backwards elimination, multiple regression models, and Akaike's Information Criterion and adjusted R^2 values to evaluate model fit. We observed that: (1) variability in juvenile fish density was better explained by landscape- than patch-scale habitat characteristics; (2) each species' density responded uniquely to patch and landscape characteristics; and (3) juvenile fish diversity was not strongly related to either patch- or landscape-scale habitat characteristics. Contour maps of predicted relative juvenile species density and diversity in mangrove habitat (based on landscape-scale regression models) provided a good fit to field data. Our conclusions urge caution where experimental design or conservation strategies generalize the importance of mangrove habitat to juvenile fish.

Photo Evan D'Alessandro



[📍] INTEGRATED APPROACHES FOR MANGROVE CONSERVATION AND FISHERIES RESOURCES DEVELOPMENT

P. Eganathan[§], *H.M.S.R Subramanian*, & *M.S. Swaminathan*

M. S. Swaminathan Research Foundation, Chennai, India.

The past few years have been marked by the exploitation of the mangrove ecosystem for coastal development. Indiscriminate felling of mangrove trees has been going on for timber, charcoal, etc. Aquatic faunas are depleted for commercial gains without any awareness toward ecological harm that it might lead to. Of late there is an increasing awareness at various levels of governments as well as the society in general with regards to the crucial ecological functions that the mangrove ecosystem plays. One good example is the strategy of Joint Mangrove Management (JMM) that involves coastal community along with government bodies in the conservation of mangrove ecosystem. This method has received some success in Tamilnadu wherein the JMM involved people who live along the coasts near the mangroves and linked them to the Forest Department. The presentation will explain in detail the methods of implementing JMM and thereby achieving sustainable management of mangrove and fishery resources.

[📍] SPINY LOBSTER AND FISH IN MULTIPLE BACKREEF HABITATS IN THE LOWER FLORIDA KEYS, USA

David B. Eggleston^{§1}, *Geoff W. Bell*, *Eric G. Johnson*, & *G. Todd Kellison*²

¹ North Carolina State University, Raleigh, NC, U.S.A. ² National Oceanic and Atmospheric Administration, Southeast Fisheries Science Center, Miami, FL, U.S.A.

Aerial photographs and ground-truthing were used to map putative backreef nursery habitats in the lower Florida Keys, followed by diver-surveys of spiny lobster and juvenile fish. Back reef habitats appear to serve as an integrated mosaic of nursery habitats for reef fish and spiny lobster. Channels connecting the Atlantic Ocean and Gulf of Mexico provide conduits for larval ingress into back reef nursery habitats, as well as for ontogenetic migrations of animals from back reef to offshore reef habitats. Expansive seagrass meadows contained the smallest stages of fish and spiny lobster, whereas mangroves contained the highest densities of fish. Isolated patch coral heads contained the highest diversity of fish and density of spiny lobster. The relatively high densities of fish observed in the lower Keys compared to other Florida and Caribbean backreef systems highlight the important nursery role of this tropical system, and the need for strict conservation.

[📍] A META-ANALYSIS OF SNAPPER AND GRUNT DATA FROM MANGROVE SHORELINE HABITATS IN THE GREATER CARIBBEAN

Craig H. Faunce

Florida Fish and Wildlife Research Institute, Tequesta Field laboratory, Tequesta, FL, U.S.A.

Worldwide field studies (109) were examined for size (mean, range, and maturation) and utilization (standardized abundance, density, or biomass) of mangrove habitats by snappers and grunts. The majority of comparable data are derived from visual surveys conducted in the Netherland Antilles (NA) and Florida (FL). The average size of each species examined was roughly half its respective size-at-maturity, though adult-sized fish were recorded for most species. Average sizes of six species were comparatively larger in FL, though differences were significant in only two cases. The mean density of snappers and grunts were significantly greater than either seagrass or reef habitats in three of four comparisons. Agglomerative cluster-analysis and Indicator Species Analysis of data from 21 studies identified three distinct groupings; *Lutjanus apodus* and *Haemulon flavolineatum* indicated most island countries, *Lutjanus griseus* indicated continental western margins, and *Lutjanus jocu*, *Haemulon aurolineatum*, and *Haemulon bonairi* indicated Guadeloupe.



Eganathan

Eggleston

Faunce



ABSTRACTS

Photo Evan D'Alessandro



[🔍] ONTOGENETIC USE OF COASTAL VEGETATED SEASCAPES BY TWO REEF FISHES

Craig H. Faunce ^{§1} & Joseph E. Serafy ²

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In the western Atlantic it is widely believed that seagrass beds (SG) and mangrove forests (MF) support exploited fish stocks because they contain relatively high densities of juveniles. Studies conducted in southeastern Florida (USA) provided the basis to examine how *Lutjanus griseus* and *Haemulon sciurus* utilize these habitats during their ontogeny. Both species exhibited a three stage ontogenetic pattern: (1) settlement and grow-out (8–10 months) within SG, (2) expansion to MF at 10–12 cm total length, and (3) increased utilization of inland MF (a) during the dry season and (b) with larger body size. The factors “distance from oceanic inlet” and “water depth” were stronger predictors of reef fish utilization of MF than the factors “latitude,” “water temperature,” and “width of root-habitat”. Thus we conclude that the juvenile contribution function of MF is not homogeneous, but is a greater function of season and geographic isolation than of local physiochemical conditions.

[🔍] UTILIZATION OF MANGROVES BY JUVENILE LEMON SHARKS (*NEGAPRION BREVIROSTRIS*) IN THEIR PRIMARY NURSERY AREAS

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Lemon sharks and other coastal shark species utilize shallow, protected waters during their early stages of life. Many of these highly productive, shallow nurseries in tropical and subtropical areas tend to be mangrove-fringed coastlines and estuaries. Sharks are thought to use these areas to reduce predation risk and maximize prey availability. An ongoing, multi-year telemetry study of juvenile lemon sharks in two primary nursery areas demonstrated that these sharks are disproportionately found near the mangrove roots. During the first two years of this study, we found that 55% of all tracking locations from 26 individuals in two separate nurseries were within 50 m of the mangroves and over 88% within 200 m of the mangroves. Prey sampling showed that prey density significantly decreases beyond 100 m from the mangroves suggesting that more prey are available close to shore. Additionally, predator presence increases proportionately with increasing distance from the mangroves suggesting that it is safer close to shore. These results stress the importance of mangroves for a properly functioning coastal shark nursery.

[🔍] SPECIAL MANAGEMENT NEEDS OF THE GOLIATH GROUPER, *EPINEPHELUS ITAJARA*, IN THE WESTERN ATLANTIC OCEAN

Sarah Frias-Torres

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Groupers are extremely vulnerable to commercial extinction, due to their late maturity, longevity, site fidelity, and formation of spawning aggregations. The Goliath grouper, *Epinephelus itajara*, is the largest reef fish in the Atlantic Ocean. It is found in tropical and subtropical waters. The species has been protected in U.S. waters since 1992. *Epinephelus itajara* is mangrove-dependent, with juveniles restricted to mangrove habitats and adults found in coral reefs and artificial structures. The status of *E. itajara* populations in the western Atlantic Ocean is evaluated. Lack of no-take mangrove reserves in the region might affect juvenile survival if

Photo Jiangang Luo





fishing bans are lifted. Since existing marine protected areas (MPAs) rarely link nursery and adult habitats, I propose that, for *E. itajara* conservation, future MPA design should aim to link coral reefs with adjacent nursery habitats. Such strategy will also be useful to protect other coral reef fish species.

[] BIOLOGICAL, FISHING, AND SOCIO-ECONOMIC STUDIES WITHIN THE CAYAPAS-MATAJE MANGROVE ECOLOGICAL RESERVE IN THE PROVINCE OF ESMERALDAS, ECUADOR

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The Cayapas-Mataje Mangrove Ecological Reserve (REMACAM) is one of the most important ecological areas of the Ecuadorian coastal zone. It is located on the northwestern part of Ecuador. The reserve has extensive mangroves forests, which are very important for its high productivity, and where hundreds of aquatic species inhabit. The REMACAM has ecological and economic value, which serve as food for the local communities. The main objective was to obtain biological, fishing, and social information, such as the structure of phytoplankton and zooplankton within the reserve, the current biodiversity, and to have a baseline of biological and socioeconomic information, to help the knowledge and sustainable management of the reserve. Fourteen classes, with a wide variety of species, represent the zooplankton in which *Acartia lilljeborg* and *A. tonsa* predominated during the rainy and dry season, respectively. The northern area of the reserve is very productive and it showed the highest plankton biomass, with a diversity that varied between 3 and 5 bits, which means clean waters and low presence of human activities. In the central area of the reserve, the zooplankton increased and the phytoplankton decreased in relation to the northern area. It means that in this central area there are more human activities. The diversity oscillated between 3 and 4.3 bits, which is still an indication of clean water. In the southern area, the diversity decreases (1.4 and 2.8 bits). This means that these waters might be lightly polluted due to the physical and chemical conditions, especially due to the increase organic matter that is good for those species from inner waters, such as *Pseudodiaptomus cf. marshi* and *Pseudodiaptomus* sp., and also due to the anthropogenic activities within the REMACAM. There was more abundance of zoea and megalopa of brachyuran (70%), especially along the central zone. In addition, we have identified *Macrobrachium* larvae and larvae of *Litopenaeus* shrimp, which are of commercial importance, and local consumption (18%), but also species of ecological value such as mysidaceae, caridea, anomura, fish larvae, chaetognata, among others (12%). Concerning cockles' landings, the highest were registered in the Tambillo community with an annual average of 392,109 cockles in 2000 and 497,591 cockles in 2001. The capture per unit of effort was 151 cockles of *A. tuberculosa* and 45 of *A. similis* in 2000, while the CPUE in the 2001 was 169 cockles of *A. tuberculosa* and 51 of *A. similis*. The average income was of US\$1757 for the community of Santa Rosa, US\$7787.5 for Tambillo, and US\$3127 for the community of El Viento.

[] DO FOUR INTERTIDAL MANGROVE CREEKS IN A HOMOGENOUS SALINITY ZONE HAVE THE SAME HABITAT VALUE FOR JUVENILE FISH ASSEMBLAGES?

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Fyke net samples taken from September 2003 to July 2004 in the Curuçá estuary, south of the mouth of the Amazon, north Brazil, caught a total of 65 fish species, mostly juveniles (90%). Temporal patterns in fish fauna composition occurred cyclically according to seasonal changes in salinity. Biomass and density of juvenile fishes were significantly higher in the two middle estuarine creeks than in the two inner estuarine creeks throughout the year suggesting that they are per se important juvenile fish habitats. Since neither salinity (excluded factor) nor creek size (no relationship with biomass and density) explained this pattern, factors such as relative estuarine location and landscape features may play a role. Given the spatial heterogeneity encountered between the fish assemblages, a classification of mangrove habitat landscape features seems to be necessary for characterization e.g., different types of creeks that can be reasonably related to spatial differences in fish habitat use.

Gaibor

Giarrizzo

ABSTRACTS

Photo Jiangang Luo



[🔍] LARVAL AND ZOOPLANKTON COMMUNITIES: COMPARING INTACT AND CLEARED MANGROVE AREAS IN BOCAS DEL TORO, PANAMA

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The zooplankton and larval species in a habitat are important indicators of food availability, propagule arrival and settlement for future community structure. Determining how larval and zooplankton communities differ between intact mangrove and cleared mangrove habitat will clarify the role mangroves play in entraining zooplankton and larvae and the importance of mangrove habitat as a settlement site. Light traps and plankton tows were used to quantify and compare larval communities between intact and cleared mangrove areas in Bocas del Toro, Panama. Communities within intact mangrove areas had greater species richness. Amphipods, ostracods as well as larval, postlarval and reproductive mysids were more common in intact mangrove areas. These differences indicate important changes in larval and zooplankton communities following mangrove removal and have implications for food availability and propagule sources within mangroves and adjacent seagrass bed and coral reef habitat.

[🔍] FISH ASSEMBLAGES ASSOCIATED WITH DAMAGED AND UNDA- MAGED MANGROVE SHORELINES FOLLOWING A MAJOR HURRICANE IN SOUTHWEST FLORIDA

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Mangroves apparently form important habitats for many fishes because they include areas for foraging, refuge, and nurseries. Hurricanes occasionally devastate mangrove forests through wind damage and storm surge. It is unclear how quickly pre-hurricane forest structure can be recovered following such damage. A significant proportion of mangroves—principally red mangrove, *Rhizophora mangle*—in Charlotte Harbor (southwest Florida) were damaged by Hurricane Charley, a category 4 storm with sustained winds of over 230 km h⁻¹ which struck in August 2004. Using fishery-independent data collected with 21.3-m and 183-m seines, we address two main questions: Do fish assemblages collected along mangrove shorelines in Charlotte Harbor differ according to the degree of mangrove damage? Are post-hurricane mangrove-associated fish assemblages in Charlotte Harbor different from pre-hurricane assemblages?

[🔍] ADULT SURVIVAL, PROBABILITY OF CAPTURE, AND ABUN- DANCE ESTIMATES FOR MANGROVE DIAMONDBACK TERRAPINS (*MALACLEMYS TERRAPIN*) IN EVERGLADES NATIONAL PARK, FLOR- IDA

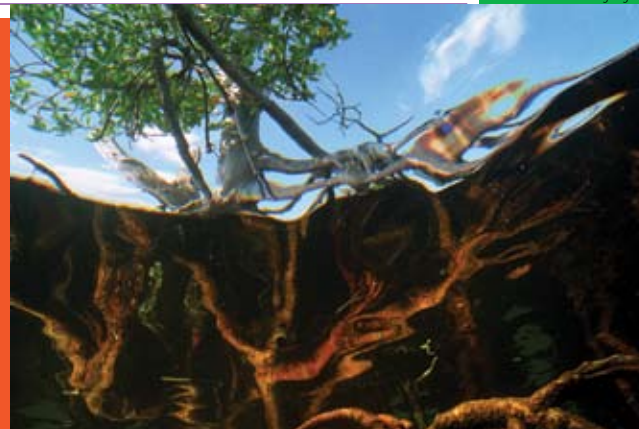
Kristen M. Hart^{§1}, Catherine A. Langtimm², & Carole C. McIvor¹

¹ U.S. Geological Survey, Center for Coastal and Watershed Studies, St. Petersburg, FL, U.S.A. ² U.S. Geological Survey, Florida Integrated Science Center, Gainesville, FL, U.S.A.

Diamondback terrapins are distributed along the US east coast from Massachusetts to Texas in brackish water, but little is known about terrapins living in mangrove habitats. To estimate adult survival rate, capture probability, and abundance for mangrove terrapins, we conducted a capture-recapture study in the Big Sable Creek (BSC) complex of the Florida Everglades (November 2001–December 2003), and analyzed individual

Photo Evan D'Alessandro





turtle encounter histories over five sampling occasions. We determined the first adult survival rate ($\phi = 0.79$) and population estimate (mean $N = 1545$ individuals) for mangrove terrapins. We also determined that terrapin distribution within BSC lies largely in small headwater creeks. Moreover, terrapins in BSC showed a higher than expected injury rate (16%) compared to other populations surveyed in more northern salt marsh habitats. This high rate of injury may be due to a high proportion of unfished predators in the protected waters of BSC.

[] FISH ASSEMBLAGES IN THE CAUSEWAY MARGINS[†]

Joán Irán Hernández-Albernas

Centro de Estudios y Servicios Ambientales de Villa Clara, Santa Clara, Villa Clara, Cuba. [†] Poster presented by Alejandro Farinas on behalf of the author.

In 2003, 80 visual censuses were performed along the Caibarién-Santa María causeway to know the environmental impact on fish communities. The families better represented were Haemulidae, Lutjanidae, and Scaridae. The abundance and biomass showed significant differences ($P < 0.05$) for the interaction of factors strata and margins. The sizes most seen varied between 10-20 cm fork length. The dominant trophic guild was the benthivore. The composition per species showed high similarities to the ones registered at the mangroves of the region, even though the community structure based on the density, differed to those reported in the nearest biotopes. The biomass estimates in some areas were similar to those obtained in the productive reef patches at the Sabana-Camagüey archipelago. The results suggest that the spatial heterogeneity (increase of refuges) contributed by the rocky margins of the causeway has created favorable conditions for the development of fish assemblages exported from the adjacent mangroves areas.

[] ECOLOGICAL EFFECTS OF THE EXTENSIVE BIMINI BAY RESORT DEVELOPMENT ON THE JUVENILE LEMON SHARK (*NEGAPRION BREVIROSTRIS*) POPULATIONS OF BIMINI, BAHAMAS: A BACI ANALYSIS

D. E. Jennings, S. H. Gruber¹, S. T. Kessel, B. R. Franks^{2,3}, & A. L. Robertson

¹ University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL, U.S.A. ² Drexel University, Philadelphia, PA, U.S.A. ³ Bimini Biological Field Station, Bimini, Bahamas.

The shallow waters around Bimini (25°43.70'N, 79°18.00'W) provide an ideal nurseries for lemon sharks (*Negaprion brevirostris*), but this habitat is under threat from an extensive resort development. Using BACI analysis, effects of the development were investigated by studying three aspects; comparing growth rates of juvenile lemon sharks in the North Sound, Sharkland, and South Bimini nurseries; comparing first-year survival rates of neonate lemon sharks in the North Sound and Sharkland between 1995–2005; and a comparing of habitat structures in the North Sound and South Bimini between 2003 and 2005. BACI analysis did not identify statistically significant differences between growth rates of sharks before and after March 2001. However there was a highly significant statistical difference between first-year survival rates of both North Sound and Sharkland neonates before and after March 2001. Significant changes were also identified between 2003 and 2005 in the North Sound nursery.

[] VARIATION OF OTOLITH ELEMENTAL SIGNATURES AMONG THREE SPECIES OF JUVENILE SNAPPERS INHABITING NURSERY REGIONS WITHIN SOUTH FLORIDA

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The snappers inhabiting south Florida's marine ecosystems are a commercially, recreationally, and ecologically important group of fishes that use mangrove and seagrass nursery habitats before migrating to the reef tract as young adults. Trace elements permanently incorporated into the otoliths of a fish during growth will

Hernández-Albernas

Jennings

Jones

ABSTRACTS

Photo Evan D'Alessandro



vary in composition and proportion depending on the environmental conditions to which the fish was previously exposed. ICP-MS was used to determine the microchemical constituents of fish otoliths defining a distinct “elemental signature”. These signatures can differ among fishes exposed to different water masses and environmental conditions allowing them to serve as natural tags for tracking fishes. The trace elemental composition of otoliths extracted from 227 individuals of four species of snapper (*Lutjanus apodus*, *L. chrysurus*, *L. griseus*, and *L. synagris*) collected from 14 sites within and around Florida Bay were examined in order to assess the extent of spatial, temporal, and taxonomic variability.

[🔊] AN EVALUATION AND COMPARISON OF DUAL-FREQUENCY SONAR AND STEREOSCOPIC VIDEO FOR ESTIMATING FISH ABUNDANCE AND SIZE STRUCTURE IN MANGROVE HABITATS

G. Todd Kellison ^{§1}, Jiangan Luo ², Jack Javech ¹, Peter S. Rand ³, Peter Johnson ⁴, & Joseph E. Serafy ¹

¹ National Oceanic and Atmospheric Administration, Southeast Fisheries Science Center, Miami, FL, U.S.A. ² University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL, U.S.A. ³ Wild Salmon Center, Jean Vollum Natural Capital Center, Portland, OR, U.S.A. ⁴ LGL Northwest, North Bonneville, WA, U.S.A.

Underwater visual fish surveys have become the most commonly used method for estimating fish abundance and diversity in coral reef environments, and more recently in adjacent environments such as mangroves, which provide habitat for a wide range of ecologically and economically important species. Limitations associated with visual surveys (e.g., restricted to daylight hours and relatively clear-water conditions) have resulted in a potentially incomplete assessment and understanding of fish community composition, structure and dynamics. In the present study, we examine the utility of three techniques for underwater fish community assessment. In mangrove and coral reef habitats, under varying conditions of light and water clarity, we compare and contrast: (1) a newly-developed, dual-frequency sonar system (DIDSON); (2) a stereo-video system; and (3) a standard visual survey. We discuss the benefits and limitations of each method for assessing fish community structure, and recommend combined survey approaches to maximize our knowledge of fish utilization of reef and mangrove habitats.

[🔊] SPATIAL VARIATIONS IN MANGROVE NURSERY BOUND JUVENILE LEMON SHARK (*NEGAPRION BREVIROSTRIS*) PREY ITEMS, BIMINI, BAHAMAS

S. T. Kessel, S. H. Gruber ¹, & S. P. Newman

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The North Sound and South Bimini study sites, Bimini Bahamas, are important nurseries for lemon sharks *Negaprion brevirostris* and a variety of finfish and invertebrates. Both sites are fringed by *Rhizophora mangle*, but *Laguncularia racemosa* and *Avicennia germinans* also occur. Following ground truthing of a false-color Landsat image, 17 habitats were recognized and overlain in GIS software with teleost catches comprising 574 daytime seine and block nets hauls. Positive relationships were identified between prey communities and specific habitats. The mangrove prop-roots showed highest prey densities, which decreased steadily with increasing distance from shore. These relationships suggest mangroves and near-shore habitats are essential for the survival of juvenile lemon sharks at Bimini. Uncontrolled development has already resulted in extirpation of approximately 30% of the North Sound fringing mangroves and sedimentation of much of the near-shore fringing habitat. Site plans which call for complete destruction of the fringing habitat have been approved. This would likely result in complete sterilization of this irreplaceable nursery ground.

Photo Jiangan Luo





☛ MANGROVES AS ESSENTIAL NURSERY HABITAT FOR GOLIATH GROUPER (*EPINEPHELUS ITAJARA*)

Christopher C. Koenig¹, Felicia C. Coleman^{§1}, Anne-Marie Eklund², Jennifer Schull², & Jeffrey Ueland³

¹ Florida State University Coastal and Marine Laboratory, St. Teresa, FL, U.S.A. ² NOAA-Fisheries, Southeast Fisheries Science Center, Division of Protected Resources and Biodiversity, Miami, FL, U.S.A. ³ Department of Geography, Ohio University, Athens, OH, U.S.A.

We evaluated goliath grouper, *Epinephelus itajara* (Lichtenstein, 1822), use of mangroves as essential nursery habitat by estimating absolute abundance, density, survival, age structure, home range, mangrove habitat association, habitat quality, and recruitment to the adult population. Densities were calculated for mangrove-lined rivers and mangrove islands of the Ten Thousand Islands (TTI) and Everglades National Park (ENP), which includes Florida Bay (FB), Florida, USA. Juveniles showed high site fidelity in mangrove habitat for 5 to 6 years, then emigrated from mangroves at about 1.0 m total length, TL. In the TTI, juvenile densities around mangrove islands were generally higher and less variable than those in rivers. Density was negatively correlated with the frequency of dissolved oxygen and salinity minima. Very low densities in FB were probably related to other water-quality variables in this human-altered system. Juvenile absolute abundance estimates extrapolated to all mangrove habitat of TTI and ENP rivers was 15,740; to all TTI mangrove island habitat, 54,553; and to all mangrove-island habitat of FB, 1,115. The offshore abundance of adults was largely explained by abundance of mangrove, but not seagrass, habitat. High-quality mangrove habitat, which appears essential to the recovery and sustainability of goliath-grouper populations, should be protected and/or restored.

☛ ALTERED MANGROVE WETLANDS AS HABITAT FOR ESTUARINE NEKTON: ARE DREDGED CHANNELS AND TIDAL CREEKS EQUIVALENT?

J.M. Krebs^{§1,2}, A.B. Brame^{1,2} & C.C. McIvor¹

¹ U.S. Geological Service, Florida Integrated Science Center, Center for Coastal & Watershed Studies, St. Petersburg, FL, U.S.A. ² ETI Professionals, Tampa, FL, U.S.A.

Ofentimes, hasty decisions are made regarding the restoration of “altered” habitats, when in fact the value of these habitats may be equivalent to a natural site. To assess the value of altered mangrove-lined habitats for nekton, we initiated a multi-year study at three Tampa Bay wetlands. Species composition and spatial distribution of nekton assemblages in permanent subtidal portions of natural tidal creeks, mosquito-control ditches, and stormwater-conveyance ditches were estimated through seasonal seine sampling. Differences in species composition and density were observed between natural and altered habitats, though not consistently among the three wetlands. Results indicate that environmental conditions (e.g., dissolved oxygen, current velocity, physical structure) may provide a more useful indication of potential habitat “value” for nekton than whether the habitat has been altered. With this in mind, a calculated effort needs to be made during the planning process to consider environmental conditions rather than simply restoring for restoration sake.

☛ PATTERNS IN TIDAL MIGRATION OF MANGROVE FISH: A HYDROACOUSTIC APPROACH

Uwe Krumme[§] & Ulrich Saint-Paul

Center for Tropical Marine Ecology (ZMT), Bremen, Germany.

A 200-kHz split-beam echosounder with a 6° circular-beam transducer was applied in a macrotidal mangrove channel in north Brazil to study the migratory patterns of intertidal fish. Each tidal cycle, the first flood rise caused a clear response in the upstream movements of the entire fish population. Riding the first flood rise likely enables fish to early access the productive intertidal zone and to avoid significant expenditure of energy for movement, thereby gaining capacity for faster growth. Together with a net upstream longitudinal current in the study area, it is likely sufficient for the fish to achieve retention in the tidal tributaries from one tidal cycle to the next, emphasizing the importance of these habitats in providing a significant nursery function. When sampling the spatiotemporal distribution of fish in intertidal environments, the 3D spatial heterogeneity versus time should be considered. Hydroacoustics provides a valuable non-intrusive, high-resolution method, even in a turbid mangrove environment.

Koenig

Krebs

Krumme

ABSTRACTS

Photo Jiangang Luo



ECOLOGICAL CHARACTERIZATION OF MANGROVE ECOSYSTEM AS A FISH HABITAT IN TERMINOS LAGOON, IN THE SOUTHERN GULF OF MEXICO

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During seasonal sampling in 1991 and 1992, 909 individuals of 25 different fish species were collected with a trap net along the fringe red mangrove in Estero Pargo. Juvenile and pre-adults stages predominated in the community. With more than 70% of the catch species having commercial importance; we conclude that the mangrove ecosystem is an important critical habitat.

ENHANCEMENT OF FISHERIES FOR MUD CRABS *SCYLLA* SPP. IN THE MANGROVES OF NAISUD AND BUGTONG BATO, IBAJAY, AKLAN, PHILIPPINES

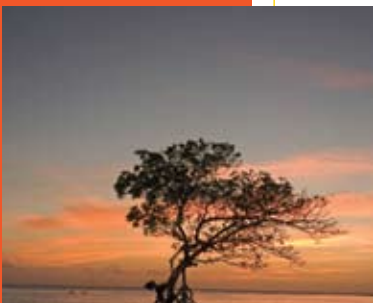
M.J.H.L. Lebata ^{§1}, J.H. Primavera ², M. Walton ¹, J.B. Biñas ², & L. Le Vay ¹

¹ School of Ocean Sciences, University of Wales, Anglesey, Wales, U.K. ² Southeast Asian Fisheries Development Center, Aquaculture Department, Tigbauan, The Philippines.

Marine fisheries are one of the most important sources of livelihood in the Philippines, an archipelago of 7100 islands. The loss of mangrove habitat and demand from the rapidly increasing human population has caused related fisheries, including mud crabs, to be overexploited. Over the last century, more than 70% of mangroves in the Philippines have been lost to timber, charcoal, aquaculture, agriculture, and settlement. The decline in mud crab populations can be addressed through regulation of fishing effort, rehabilitation of mangrove habitats, mangrove friendly-aquaculture, and enhancement of wild stocks. In this study, the effectiveness of stock enhancement through release of hatchery-reared juvenile crabs was evaluated. A 70-ha basin mangrove forest in the villages of Naisud and Bugtong Bato in Iabajay, Aklan, Panay Island, Philippines was chosen as a pilot site to conduct stock enhancement trials of *Scylla* spp. Prior to conducting the trials, baseline data were collected on the population dynamics and fisheries of mud crabs in the study area over a period of two years. Then, a total of 5601 crabs were released in 21 batches from May 2004 to September 2005. These included 14 batches of wild-collected *Scylla olivacea* (n = 1789). Hatchery-reared crabs were either released directly from the hatchery (unconditioned) or reared for 1–2 months in ponds (conditioned) prior to release. Seven batches of unconditioned *S. serrata* (n = 1832) and 1 of *S. tranquebarica* (n = 94), 2 batches of conditioned *S. olivacea* (n = 441), 5 of *S. serrata* (n = 1206) and 1 of *S. tranquebarica* (n = 239) have been released. Recapture of released *S. olivacea* was higher in wild-source (53.93% ± 5.91%) than in hatchery-reared (29.20% ± 0.40%) crabs. In both *S. serrata* and *S. tranquebarica* recapture rates were higher for conditioned (38.92% ± 2.90% and 46.86%) than unconditioned crabs (11.93% ± 3.71% and 1.06%). These recapture rates are

very high and reflect high survival rates, low levels of post-release dispersal and ecological capacity for higher population densities of crabs in these mangroves. Factors affecting the success of such release programmes and applicability to other sites will be discussed.

Photo Evan D'Alessandro





[📌] WHAT CAN STABLE ISOTOPE RATIOS REVEAL ABOUT FISH UTILIZATION OF BAHAMIAN MANGROVE-LINED TIDAL CREEKS?

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Fish use of mangrove habitats is extensive, but reasons underlying this phenomenon remain ambiguous. The paradigm of the mid- to late-20th century was that detrital material, derived from salt marsh grasses or mangrove leaves, directly supported productive estuarine fisheries. Stable isotope ratios, however, suggest other basal resources, such as microalgae, phytoplankton, or seagrass, are the most important basal resources. We draw on our database of more than 2500 individual stable isotope ratio analyses from mangrove-lined Bahamian tidal creeks to discuss opportunities and drawbacks for applying stable isotope ratios to assess potential direct and indirect contributions of mangroves to food webs. We propose novel uses of stable isotope ratios in mangrove ecosystems, e.g., as measure of assemblage-wide trophic diversity, and discuss how these approaches reveal novel aspects of food web structure and provide insight into the link between mangroves and fisheries.

Layman

Lewis

Ley

[📌] IMPORTANT CONSIDERATIONS TO ACHIEVE SUCCESSFUL MANGROVE FOREST RESTORATION WITH OPTIMUM FISH HABITAT

Roy R. "Robin" Lewis III^{§1} & R. Grant Gilmore²

¹Lewis Environmental Services, Inc., Salt Springs, FL, U.S.A. ²Estuarine, Coastal and Ocean Sciences, Inc., Vero Beach, FL, U.S.A.

Recent reviews of historical attempts to restore mangrove forests around the world have reported that routine failure to achieve significant cover by mangrove species is common. It appears that most failures are associated with a misunderstanding of mangrove forest hydrology, and the false assumption that simply planting mangroves is all that is necessary to establish a mangrove forest. Beyond establishing mangrove plant cover, tidal hydrology for optimum fish and invertebrate use of a site needs to be carefully designed. Published studies indicate that most mangrove forests are flooded by tidal waters 30% or less of the time. Fish and invertebrate use of the forest is obviously linked to the depth, duration, and frequency of flooding of various portions of the forest. Restoration design needs to attempt to mimic tidal stream morphology and hydrology to maximize access to the restored forest over time.

[📌] DIEL PATTERNS IN MANGROVE FISH ASSEMBLAGES IN NORTHEASTERN AUSTRALIA ESTUARIES

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Australian Maritime College, Beauty Point, Tasmania, Australia.

Diel activity patterns of tropical estuarine fishes in near-pristine mangrove-dominated waterways remain largely undocumented, as remoteness, turbidity, and nocturnal crocodiles limit the choices of practical sampling methods. To capture mobile mangrove fishes, gill nets (12 nets, 19-152 mm mesh) were set perpendicular to steep mangrove-covered mudbanks and anchored midstream, passing through the fringe into adjacent open waters. During 13 bimonthly sampling trips, nets were set for 6 hours (15:00–21:00) and checked hourly (1407 daytime and 1870 nighttime checks). Of the 161 species netted, 47 were exclusively nocturnal and 23 were only present in the daytime. Each net-set averaged 4.2 fish per hour by day vs 7.1 fish per hour by night. Significantly different diel fish assemblages were detected in 75% of the 24 net-estuary combinations (ANOSIM $P < 0.05$). By day, finer mesh nets were dominated by detritivores (*Liza* spp., *Valamugil* spp.); by night, planktivores (*Thryssa hamiltonii*, *Ambassis* spp.) prevailed. For the larger mesh nets, the species that were dominant during the day (*Drepane punctata*, *Scomberoides commersonianus*) were caught in similar numbers at night; however, by night, assemblages were distinctive and, in fact, the predators *Lates calcarifer* and *Nibea soldado* dominated at night in all six estuaries. Thus, although changeovers were apparent in prey fish communities as night-time planktivores replaced daytime detritivores, larger predators were only prevalent at night. Diel shifts in activity by predatory and prey fishes may be key processes in the trophodynamics of these tropical mangrove estuaries.



ABSTRACTS

Photo Evan D'Alessandro



[📍] THE CHRONIC ABSENCE OF CUMULATIVE IMPACT ANALYSES IN COASTAL CONSTRUCTION PERMITTING

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Sustainable fishery management is contradicted when juvenile growth and mortality rates are compromised by long-term degradation of key habitats. However, construction projects that modify habitats continue at high rates in many areas. Primary permitting agencies have been consistently reluctant to say no or to seek significant reductions in project impacts. Many problems, well known in permitting, yet absent from most workshops, require attention. Cumulative impacts and associated habitat and trophic cascades are still rarely considered, even in massive documents regarding areas that have already undergone many anthropogenic disturbance events. Too often, environmental impact assessments only represent large project justification exercises. Expensive monitoring projects often do not meet minimum standards of peer-review (e.g., no replication, an absence of BACI designs). Euphemistic assumptions about project impacts gain administrative momentum and are continuously repeated in subsequent assessments. Tractable, but underutilized, analytic and administrative alternatives exist and are summarized using examples from coastal areas of the northern Caribbean.

[📖] PUBLICATION OF A 2ND EDITION OF THE WORLD MANGROVE ATLAS

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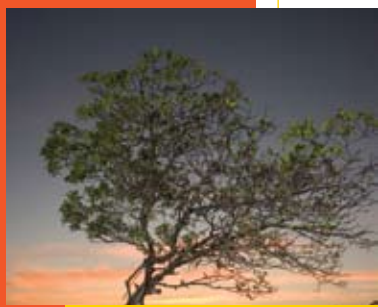
Mangrove ecosystems are unique and highly productive. They support the livelihoods of millions living along tropical and subtropical coasts, providing diverse services including supporting fisheries. Drastic losses of mangrove forest are being experienced. Accurate information on the status of mangroves is essential to achieve conservation and sustainable use of these services. The publication of a 2nd edition of the *World Mangrove Atlas*, first produced in 1997, is intended to inform not only scientists but also managers and conservation experts, and provide a reliable and consistent baseline. The *World Mangrove Atlas* will include national and local-level case studies and thematic case studies that cut across national boundaries. Also country data will include profile, map, threat data where available and updated information on the current extent and changes in mangrove areas. This publication is being prepared as a joint initiative of FAO, ISME, ITTO, UNESCO-MAB, the UNEP-WCMC and UNU-INWEH.

[📍] SPATIAL AND TEMPORAL VARIATION IN FISH COMMUNITY STRUCTURE OF A MARINE EMBAYMENT IN ZANZIBAR, TANZANIA

Blandina R. Lugendo^{1,2}, *Arjan de Groene*¹, *Ilse Cornelissen*¹, *Annelies Pronker*¹, *Ivan Nagelkerken*¹, *Gerard van der Velde*^{1,3} & *Yunus D. Mgaya*²

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Photo Evan D'Alessandro





Spatial-temporal variations in the fish community structure were studied from a tropical non-estuarine embayment in Chwaka Bay, Zanzibar. Fish samples were collected bimonthly for one year from mangroves, mud/sand flats and seagrass beds. Environmental variables were examined to determine their relationship with fish community structure. The fish community structure together with the environmental variables in mangroves and mud/sand flats remained constant for most part of the year; however, a marked decline in fish densities, biomass, and species richness and in environmental variables was observed during the rainy period. A significant relationship was found between density and species richness of fish, and temperature, salinity, and water clarity. Salinity was the most conspicuously changing environmental variable with seasons; we therefore propose that, salinity alone or in combination with the other environmental variables, was probably the most important environmental factor structuring the fish assemblage in the mangroves and mud/sand flats habitats.

☛ THE RELATIVE IMPORTANCE OF MANGROVES AS FEEDING HABITAT FOR JUVENILE FISH

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The importance of mangroves as a source of carbon and as feeding grounds for fish has been a subject of debate in the Indo-Pacific. By using stable isotope analysis of carbon and nitrogen, we investigated four different settings of mangroves along the Tanzanian coast, to establish if mangrove setting influences the use of this habitat as a potential feeding ground by fish. The four settings were: non-estuarine bay mangroves, non-estuarine mangrove channel, non-estuarine fringing, and estuarine fringing mangroves. The $\delta^{13}\text{C}$ signatures of fish from bay mangroves and mangrove channel indicated significant incorporation of $\delta^{13}\text{C}$ signatures of food items that originated from the mangroves. However, little or no significant assimilation of $\delta^{13}\text{C}$ signatures of food items from mangroves could be deduced for fish species from both types of fringing mangroves. The results suggest that, fringing mangroves are less important as potential feeding grounds for fish compared to submerged mangroves.

☐ CONNECTIONS BETWEEN ROOT EPIBIONTS AND FISH COMMUNITIES IN MANGROVE HABITATS

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Many fish and epibiont species utilize red mangrove (*Rhizophora mangle*) prop roots as habitat. There is often great variation between mangrove areas; fish communities and populations may vary significantly between nearby, similar mangrove areas. This study examined the relationship between fish and prop-root epibiont communities. Fish communities at 15 sites in Bocas del Toro, Panama, were examined by visual census and trapping. Artificial mangroves consisting of stakes driven into seagrass, adorned with artificial epifauna (combinations of blocks and dowels) were also established. Prop-root organisms were censused using a random sample of roots per site. There was significant correlation between epibiont diversity and fish diversity, and a correlation between percent coverage of epibionts and fish diversity. The artificial mangroves with the most artificial epifauna attracted the most diverse fish community. Data will also be presented on community composition between sites, and on results of epibiont manipulation experiments.

☛ THE IMPACTS OF NATURAL DISTURBANCE ON THE NEKTON COMMUNITY STRUCTURE IN MICRONESIAN MANGROVE FORESTS

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Lugendo

MacDonald

MacKenzie

ABSTRACTS

Photo Evan D'Alessandro



Six and 18 months after a category 3–4 typhoon devastated the island of Yap, we surveyed nekton communities from mangroves hypothesized to be more impacted and less impacted from the typhoon using lift and float nets. Fish densities were not significantly different among any sites in either year. Densities were generally higher in disturbed sites compared to undisturbed sites in 2004, and were dominated by Gobiidae. In 2005, fish densities were higher in undisturbed sites compared to disturbed sites, and were dominated by Apogonidae. Shrimp densities were higher in disturbed sites compared to undisturbed sites in 2004, but were similar between all sites in 2005. Results suggest that demersal fish may be better adapted at recovering from typhoons compared to other species. Elevated shrimp densities may have resulted from increased deposition of mangrove leaves after the typhoon, which may provide an important mechanism to help fish species recover after typhoons.

[🌱] ECONOMIC VALUE AND SOCIAL DIMENSIONS OF MANGROVE FISHERIES IN VILLAGES AFFECTED BY THE 2004 TSUNAMI

Rusyan Jill E. Mamiit

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On December 26, 2004, mangrove fisheries in coastal villages in Sri Lanka were subject to severe damage caused by the tsunami. The impacts of the disaster on the mangrove ecosystem magnified the significance of the resource as important source of fish, which supports the livelihood of the village residents. A socio-economic assessment of the value of mangrove fisheries in Kapuhenwala and Waduruppa, villages characterized by functioning and degraded mangrove ecosystems, respectively, was carried out following the tsunami. Results indicate that intact mangroves generate an average annual fishing economic value of approximately SLR641,148 (US\$6411) per fishing household; whereas, a degraded mangrove ecosystem has a value of SLR243,662 (US\$2437). The economic values suggest that areas with degraded mangroves generate lower fishing benefits to the community. The findings further provide a sound basis for the inclusion of mangrove rehabilitation efforts in the post-tsunami reconstruction and rebuilding programs.

[🌱] EVALUATING TROPHIC LINKAGES IN MANGROVE-BASED FOOD WEBS USING STABLE ISOTOPES OF CARBON AND NITROGEN

Debashish Mazumder^{§1}, *Ron Szymczak*¹, *Neil Saintilan*² & *Robert J. Williams*³

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An understanding of the energy flow pathways and trophic linkages in estuarine food webs is essential for managing estuaries and their ecosystems sustainably. These pathways are complex, given the dynamics in physico-chemical processes, variety and area of habitats. Carbon and nitrogen stable isotope ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) were measured for a variety of fish, invertebrate, and crustacean species collected from saltmarsh and mangrove habitats in Botany Bay and Homebush Bay, NSW, Australia. The work is on-going, however, initial observations indicate specific prey-predator linkages evident within a complex trophic structure. Results also advocate the role of certain non-commercial estuarine species as important conduits of energy and nutrition to higher trophic-order commercially valuable species, linking these with specific estuarine habitats. This work seeks to model the source of energy and nutrition in mangrove and saltmarsh-based food webs and to determine the chemical linkages between high trophic order species and different habitat resources.

Photo Rafael J. Araújo





[] VARIABILITY OF STABLE ISOTOPE RATIOS OF MANGROVE GLASSFISH (*AMBASSIS JACKSONIENSIS*) FROM SOUTHEAST AUSTRALIA AND THE IMPLICATIONS FOR ECOSYSTEM STUDIES

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Scientists concerned with organic matter flow and food web structures in aquatic ecosystems are increasingly realizing the potential of stable isotope ratios as natural tracers. Stable isotopes offer an accurate and cost effective way to understanding critical pathways of energy and pollutant transfer. Further, many aquatic habitats have been degraded and isotope ratios offer insights into appropriate conservation and rehabilitation techniques to manage these valuable resources. So far, the literature shows little attention has been paid to spatial and temporal variations in isotope signatures of samples taken from saltmarsh and mangrove environments. This study reports on investigations into the differences in isotopic signatures within a single species, *Ambassis jacksoniensis*, surveyed from two locations at two different times. The results suggest significant variation in $\delta^{13}\text{C}$ between different season and location for glassfish, but not for $\delta^{15}\text{N}$. The results also suggest that care is needed in interpreting previously published results.

[] EPSCOR PHASE II: FUTURE DIRECTIONS — LAND-SEA INTERACTIONS

Amber McCammon [§], Richard Nemeth, Meri Whitaker, & Nasseer Idrisi

University of the Virgin Islands, U.S.V.I.

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a program of NSF to strengthen research, development and competitiveness in participating states and territories. The Virgin Islands EPSCoR is a partnership between NSF and the higher education, government, and business communities of the Virgin Islands to promote the development of the territory's science and technology resources through targeted research, education, and outreach activities. The current VI-EPSCoR research thrust is the study of the Bio-complexity of Caribbean Coral Reefs (BCCR). BCCR research covers areas of oceanography, biodiversity, and ecology of Caribbean coral reef ecosystems. In accordance with the environmental mission of VI-EPSCoR, phase II will cover the land-sea interface, including mangroves, an important component to the island ecosystem. Mangroves act as nursery grounds for many coral reef fishes. Mangroves also act as a buffer to filter nutrient and sediment run-off that would potentially upset the fragile balance of coral reef ecosystems.

[] USE OF CARBON AND NITROGEN STABLE ISOTOPIC TO INFER FOOD SOURCES IN BELIZE OFFSHORE MANGROVES

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As part of an ichthyological survey of Twin Cays, Belize, we sampled fish and crustaceans for carbon and nitrogen stable isotopes from multiple habitats (fringe forests, dwarf *Rhizophora mangle* forests, ponds, internal channels, sinkholes). Of 12 species with at least three individuals in a given habitat (individuals analyzed separately), eight species differed significantly in their C isotopic values and five species differed in N isotopic values in different habitats. Species using multiple habitats, therefore, are likely to derive both carbon and nitrogen from different within-habitat sources. Animals from hydrologically isolated sinkholes had carbon isotopic values significantly more negative than in other habitats, indicating either greater dependence on a carbon source from mangroves or from highly-respired, microbial carbon. Comparison of frequency histograms of carbon isotopic values from Twin Cays' consumers with those from other mangrove studies indicates a greater incorporation of a variety of carbon sources than previously reported.

Mazumder

McCammon

McIvor

ABSTRACTS

Photo Rafael J. Araújo



☛ CONNECTIVITY CONTROLS MANGROVE-FISH ASSEMBLAGE STRUCTURE: EVIDENCE FROM 12 MANGROVE-LINED WETLAND PONDS IN TAMPA BAY, FLORIDA

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We collected seasonal nekton samples (fish and decapod crustaceans) from 12, mangrove-lined tidal ponds as part of a larger study to characterize the coastal wetlands of Tampa Bay. We captured 43,493 individuals of 63 species using a center-bag seine. Pond assemblages differed between regions of the bay and were distinct from tidal-creek assemblages from which they are likely derived (PRIMER, ANOSIM, Global $r = 0.619$, $p = 0.004$). The differences between pond and creek assemblages indicate predictable macrohabitat associations for some species. When averaged over the 2004 sampling year, mean nekton density in ponds ranged from 79 to 1160 per 100 m². Species composition of ponds can be explained by degree of connectivity with nearby estuarine waters (PRIMER, $p = 0.001$). Three ponds with only intermittent connection to bay waters were depauperate, whereas ponds with moderate or good connectivity supported estuarine transient as well as estuarine resident species.

☛ THE INSULAR ECOLOGY OF THE DIAMONDBACK TERRAPIN, *MALACLEMYS TERRAPIN*, ON THE MANGROVE KEYS OF SOUTH FLORIDA

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The insular ecology and population dynamics of *Malaclemys terrapin macrospilota* and *M. t. rhizophorarum* on mangrove keys permeating Florida Bay and the Florida Keys are under investigation by collaborative investigators from many management, research, and educational institutions in south Florida. Results indicate extreme site fidelity over this time period for terrapins. Survival of individual terrapins over a 20-year span has been documented using data from previous researchers in the region. Many are currently residing in the same highly localized black mangrove system, *Avicennia germinans*, in which they were first captured in the early 1980s. *Malaclemys* have a varied diet consisting of fish, crustaceans, and molluscs. The analyses of mitochondrial DNA (mtDNA) and nuclear DNA (nDNA) microsatellite markers support the physical evidence of limited dispersal. Florida terrapin populations represent localized assemblies with strong tendencies for long-term site fidelity. This has significant implications for management of these populations.

☛ RELATIONSHIP BETWEEN ESTUARINE HABITATS AND COASTAL FISHERIES IN QUEENSLAND, AUSTRALIA

Jan-Olaf Meynecke^{§1}, Shing Yip Lee¹, Norman Duke², & Jan Warnken¹

¹ Griffith University, Bundall, QLD, Australia. ² Centre for Marine Studies, University of Queensland, St. Lucia, QLD, Australia.

Photo Jiangang Luo





Worldwide, estuaries have been recognized as a driver of near-shore fish productivity. The purpose of this study is to demonstrate the importance of the habitat characteristics of estuaries to Australian commercial fish catch, with particular focus on the role of mangroves, salt marsh and seagrass, and their connectivity. Combination of these habitats and their accessibility may explain the importance of estuaries to nekton. A literature review identifies the role of estuaries as integrated systems for fisheries and the knowledge gaps in the debate on estuarine outwelling. Outcomes from preliminary analyses in Queensland, Australia, suggest that collective spatial characteristic of estuarine habitats such as size and combination significantly relate to fishery catchment data. An exploration of currently available information on habitat distribution and fisheries catch shows the need to rigorously scrutinise their spatial and temporal convergence and accuracy, and how best to use them to understand estuarine-fisheries links. Finally, conclusions are drawn on how to optimize habitat and fisheries management.

Milano

Mirera

[📍] RESTORING ESSENTIAL FISH HABITAT IN SOUTHEAST FLORIDA: MANGROVE AND SEAGRASS HABITAT DESIGN COMPONENTS AND SUCCESS MONITORING

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Rapid urbanization of the south Florida area has resulted in a loss of vital fisheries habitat for many commercially and recreationally important fish and invertebrate species. Large-scale wetlands restoration efforts are being designed and implemented regionally to maximize habitat heterogeneity, and provide critical fish habitat. To provide diverse seagrass and mangrove habitats for larval and juvenile fish development, the designs include a network of tidal flushing channels inter-connecting low energy tidal pools, and shallow open-water areas with specific hydrological criteria. To document the efficacy of the restored habitat, fish assemblages are being monitored at a 30-ha mangrove wetlands restoration site on Key Biscayne, Florida. To date, a total of 29 fish taxa have been identified in the restored tidal pools, and the diversity of fish species has increased from five to ten species per tidal pool over the five year monitoring effort. Fish species richness has increased by four species since the baseline was established in 2000/2001, and the fisheries inventory has documented the restored areas functioning to support important fisheries species.

[📍] SEASONAL VARIATION IN FISH ABUNDANCE IN MANGROVE ECOSYSTEMS: COMPARING FORESTED AND UN-FORESTED HABITATS

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The research investigated fish abundance in forested and unforested sites at Ungwana Bay, Kenya. Four forested sites having paired unforested sites were studied for comparison. Samples were collected with nets for eight months over two years (2003 and 2004). Mean fish abundance ranged from 6.11 fish/36 m² to 80.08 fish/36 m² in forested sites and 3.08 fish/36 m² to 125.89 fish/36 m² in unforested sites while biomass varied from 37.87 to 326.75 in forested sites and 7.88 to 303.92 in unforested ones. The results indicate a high abundance of fish in forested sites compared to unforested ones a part from site 4 where the unforested area had more fish abundance due to one big sample of *Pellona ditchella* that accounted for 73.1% of the fish in the site. A total of 35 fish species were sampled from both forested and unforested sites with 11 being exclusively forested and five unforested. There were significant differences in fish abundance and biomass with respect to substratum type indicating that the fish community preferred muddy bottom forested sites to sandy bottom forested sites. Fish abundance was significantly higher in all sites (forested and unforested) during northeastern monsoon compared to southeastern monsoon, however, the gap between the seasons was more pronounced in muddy substratum sites compared to sandy ones. The unforested sites showed significantly lower density of meiofauna in the sediments compared to forested sites, while muddy substratum sites also had significantly higher meiofauna density. The results support the hypothesis that fish visit mangrove habitats to feed and to avoid predators. They also raise the idea of substrate type as an influencing factor in fish habitat preference.

ABSTRACTS



[] NUTRIENT DYNAMICS IN A CLOSED SYSTEM WITH MANGROVE SEEDLINGS AND POECILID FISHES

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Six closed recirculation systems (1000 L each) with poecilid fishes and mangrove seedlings were designed to estimate the nutrient uptake by mangroves and the survival and growth rate of poecilid fishes. Each system has a biological filter of gravel and sand, 34 mangrove seedlings (*Rhizophora mangle* and *Laguncularia racemosa*) and 200 poecilid fishes. The results show that mangroves removed 71% to 94% of the dissolved inorganic nitrogen (DIN) and 36% to 47% of the orto-PO₄. The systems without mangroves removed 35% to 52% of DIN and 21% to 25% during a cycle of 10 days. The poecilid fish survival was 100% with a good growth rate in all the systems (1 cm/month). Even though growth rate and survival of the poecillid fishes were similar in all the systems, we consider that in a long term, the mangroves play an important role in keeping good water quality conditions for fish communities.

KEYNOTE PRESENTATION:

ARE NON-ESTUARINE MANGROVES AND CORAL REEFS CONNECTED THROUGH FISH MIGRATION? A MINI-REVIEW

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Worldwide, mangroves are used by fish species as a life-time or temporal habitat. It is assumed that mangroves provide a high abundance of food and a high degree of structure which reduces predation, resulting in higher survival and growth rates of fishes than in other shallow-water coastal habitats. When mangroves are located near coral reefs, juvenile reef fish species are found in high densities between the mangrove roots. This has led to the assumption that mangroves function as nursery habitats for coral reef fishes. However, critics argue that mangroves are only a nursery when its contribution per unit area to the production of individuals that recruit to the adult reef population is greater, on average, than the production from other coastal habitats in which the juveniles occur. This should be supported by a higher density, growth and survival of animals in the mangroves, and ontogenetic migration between the juvenile habitat and the adult habitat (e.g. coral reefs). Otherwise, mangroves may merely function as sinks for juvenile fish. Due to a lack of (experimental) studies testing the above variables, hardly any direct proof has been provided that mangroves can serve as nursery grounds for juvenile reef fish species, and the degree to which mangroves and coral reefs are connected. In this mini-review, the status of recent research on this topic is reviewed for the Caribbean and Indo-Pacific, with the focus on the connectivity between non-estuarine mangroves and coral reefs by fishes. During the last 5 years increasingly more indirect evidence has been obtained for such connectivity in the Caribbean and Indo-Pacific. New or advanced techniques such as laser-ablation ICPMS, stable isotope analysis, DNA analysis, and use of internal micro-tags/transponders have recently become more readily available at lower costs, providing new opportunities for investigating the connectivity between tropical coastal habitats by fishes.

Photo Jiangang Luo





[📍] SPATIO-TEMPORAL VARIATION IN MANGROVE AND SEAGRASS COMMUNITIES, AND THEIR DIETARY IMPORTANCE TO LEMON SHARKS

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Mangrove and nearshore seagrass faunal communities were concurrently sampled in two areas of contrasting primary productivity (North Sound: low; South Bimini: high) at Bimini, Bahamas. Over 200,000 individuals, comprising 175 species, were identified from catches between March 2000 and March 2003. Cluster-analysis revealed distinct mangrove and seagrass communities, with Morisita's index indicating a greater degree of spatial and temporal homogeneity in North Sound. Catch abundance, diversity and biomass were significantly greater in the mangroves than over seagrass in both locations (Kruskal-Wallis tests, $P < 0.05$), and highest off South Bimini. Low productivity, faunal diversity and abundance in the North Sound were probably due to extreme abiotic variables. Dietary composition and prey size of juvenile lemon sharks were compared with faunal communities, revealing greatest similarity with mangrove communities. This study suggests mangroves are essential to lemon shark prey, and reinforces their need for protection in the Bahamas.

[📍] ADOPTION RATES OF SILVOFISHERIES INNOVATIONS AS AN OPTION FOR MANGROVE CONSERVATION; CHALLENGES AND RESEARCH OPPORTUNITIES ALONG THE EAST AFRICA COASTLINE

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Mangrove wetlands offer refuge and nursery ground for juvenile fish, crabs, shrimps, and molluscs. Apart from being nutrient rich ecosystems they also act as buffers protecting the coastline from erosion, storm damage, wave action inclusive the recent traumatic tsunamis. This vital ecosystem has been jeopardised along the East African coast due to poor realisation of its diversified importance. Though efforts have been made by mangrove experts and conservationists, the big problem has been convincing the people on the immediate use of this resource to attain their daily food requirement while maintaining sustainability. Getting a new idea adopted, even when it has obvious advantages is difficult; hence a common problem for many individuals and organisations is how to speed up the rate of diffusion of an innovation. In trying to empower the local people to own and conserve their resource, intense awareness campaigns on silvofisheries and mangrove eco-tourism are prioritized along the East African coastline. Presently, ten communities along the Kenyan coast and five along Tanzania's Tanga regions are covered in silvofisheries on farm trials to assess technology adoption rate. Social changes and social problems facing the East African coastal communities affect the diffusion of the innovations. The main challenge lies in the extreme poverty of the people and lack of dedication in culturing crabs and fish to market size coupled with mangrove conservation. The diffusion of innovations and consequent adoption is essentially important in silvofisheries technology in East Africa so as to ascertain meaningful mangrove conservation. Despite the success of a few communities, the researchers are challenged on how their day to day findings can reach the custodians and beneficiaries of our vital mangrove wetland. In due respect, the question still remains of whether there is enough silvofisheries research along East Africa coastline.

[📍] FOOD HABITS OF FISH ASSOCIATED TO COASTAL HABITATS IN SAN ANDRÉS ISLAND, COLOMBIAN CARIBBEAN

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Feeding habits of fish captured at Hooker-Honda and Sea Horse Bays in San Andrés Island (Colombian Caribbean) were characterized. Four hundred and twenty-one individuals distributed in 18 families and 37 species were caught and purchased from local fishermen in the area. Three species of some commercial importance,

Newman

Obura

Ochoa

ABSTRACTS

Photo Jiangang Luo



formed 60% of the abundance; *Opisthonema oglinum* (32%), *Gerres cinereus* (15%) and *Harengula humeralis* (13%). Other species, for instance *Oligoplites palometa* and *Caranx hippos* demonstrated very low numerical abundances, with only one individual caught each. In stomach content analysis, 91 nutritional categories of different taxa, including seaweeds, seagrass, mollusks, annelids, crustaceans, fish, among others, were identified. In addition, each species was trophically categorized yielding the following proportion: 76% carnivores, 19% omnivores, 5% herbivores; planktivores were absent. This proportion has been widely observed in a variety of tropical systems. The dominant group was the carnivores, which exercise a strong predatory activity over crustaceans, mollusks, and fishes.

EXPLAINING PATTERNS OF ABUNDANCE FOR FISH USING MANGROVES: A MULTI-SCALE SEASCAPE APPROACH

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Mangroves are often considered an important resource for many species of fish, supporting high densities of juveniles including many commercially important species. Typically, these species use mangroves as part of a chain of interlinked resources through daily home ranges and to support developmental shifts (“ontogenetic stepping stones”). Considerable spatial variability is found in the patterns of abundance from one area to another. This study applies a landscape ecology approach to explore the influence of seascape composition on the abundance of fish using mangroves in southwestern Puerto Rico. We quantified within-patch structure (1 m² quadrat) and seascape structure (50, 100, 300, 500 m) using landscape metrics applied to NOAA’s benthic habitat map. Results indicate that the amount of seagrass surrounding mangroves explains more of the variability in fish abundance than fine-scale mangrove structure. Fish community composition is significantly different in mangroves with high adjacent seagrass cover than mangroves with little or no seagrass cover. This has important implications for resource protection, restoration efforts, and water quality management.

KEYNOTE PRESENTATION:

INTEGRATION OF AQUACULTURE AND MANGROVES

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Southeast Asia has the highest concentration of mangroves and brackish water aquaculture ponds. This paper describes studies that integrate mangroves as biofilters, and as pen culture sites for mud crab farming. In one study, passing shrimp pond effluents through a natural mangrove stand reduced levels of TSS, sulfide, NH₃-N and NO₃-N by 18.7–64.2%. Estimates show that 1.4–6.5 ha of mangroves are needed to assimilate nitrogen wastes from one hectare of shrimp pond. Mangrove biomass increase was 2.5 times greater with effluents compared to a control mangrove, although plant numbers remained similar. Present mud crab *Scylla* spp. farming still depends on raw (“trash”) fish and wild seed. To lessen such dependence, another study compared the stocking of hatchery vs wild juveniles, and feeding of pellet + raw fish (“trash fish”) vs fish alone. Preliminary results show that low-cost pellets can reduce raw fish requirement, and that hatchery crab juveniles need immediate feeding whereas wild crabs can subsist on natural mangrove productivity for one month. Mud crab pen culture is commercially viable but technological refinements and land tenure issues remain.

Photo Jiangang Luo





[📍] THE MANGROVE ACTION PROJECT: ITS GENESIS, MISSION AND CHALLENGES

Alfredo Quarto

Mangrove Action Project, Port Angeles, WA, U.S.A.

Founded in 1992, the Mangrove Action Project (MAP) is an environmental, non-governmental organization dedicated to reversing the degradation and destruction of mangrove forest ecosystems worldwide. Early work focusing on mangrove conservation and restoration in Latin America and Asia has expanded to include science, education and outreach projects around the globe. Its mission is to promote the rights of local coastal peoples, including fishers and farmers, in the sustainable management of their coastal environment. MAP provides five essential functions for grassroots associations and other proponents of mangrove conservation: (1) serving as an information clearinghouse on the status of, and future threats to, mangrove systems around the world; (2) coordinating an international network of over 450 NGOs on issues relevant to mangrove protection; (3) promoting public education and awareness of mangrove forest issues; (4) developing of technical and financial support for relevant NGO projects; and (5) communicating, both within and outside impoverished coastal fishing and farming communities, how consumer demand affects coastal livelihoods and environments. MAP is addressing the challenges of conserving diverse and productive mangrove systems in the face of poverty, shrimp aquaculture and development for tourism through participatory resource management, promoting responsible consumer choices and implementing sound environmental and socio-economic impact studies.

Quarto

Rehage

Restrepo

[📍] SEASONAL FISH-COMMUNITY PATTERNS IN UPSTREAM REACHES OF MANGROVE CREEKS IN EVERGLADES NATIONAL PARK, FLORIDA

Jennifer S. Rehage[§] & William F. Loftus

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The role abiotic factors play in structuring communities is one of the fundamental questions in ecology. At small spatial and temporal scales, abiotic conditions influence patterns of species movement and habitat use. At larger scales, abiotic factors affect patterns of species abundance and distribution. The structuring effect of abiotic conditions may be particularly important along ecotones. In the Everglades, mangrove-lined creeks link freshwater marshes to estuarine habitats. This study examined seasonal dynamics in the fish community of the upstream reaches of creeks in the southwest region of Everglades National Park, specifically Rookery Branch and the North and Watson Rivers. Six creeks were sampled in each drainage via electrofishing, gill nets, and minnow traps in the wet, early dry, and mid-dry season. Catches and numbers of species were greater in Rookery Branch than in the North and Watson Rivers reflecting an influx of freshwater fishes into Rookery Branch as marshes dried.

[📍] MANGROVE COVER, FISHERIES, AND ENVIRONMENTAL PERTURBATIONS IN THE CIÉNAGA GRANDE DE SANTA MARTA (CGSM), COLOMBIAN CARIBBEAN

Jorge Restrepo, Jacobo Blanco, Carlos Villamil[§], Efraín Vilorio, Juan Carlos Narváez, & Mario Rueda

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Hydrological manipulations in the Ciénaga Grande de Santa Marta (CGSM) since 1956, mostly due to road and channel building, as well as historically-low precipitation in the 1990s, caused high rise in salinity in soil and water. In 1995, 56% of the mangrove cover disappeared, and fish catch declined by 49%. Channel dredging supplying freshwater from the Magdalena River in 1996 and 1998, and high rainfall in 1999 (2509 mm) caused the reduction of salinity in soil and water, which fostered a 10% increment in mangrove cover and 40% in fish catches. Nile tilapia (*Oreochromis niloticus*), an exotic freshwater species favored by environmental changes, represented 62% of the catch in 1999–2000. After 2000, draught and channel sedimentation affected mangrove cover, fish catches, and species composition. Climatic variation associated with ENSO seemed to account for these changes, involving hydrological and community perturbations, which in turn affected vegetation and fish resource availability in the CGSM system.

ABSTRACTS

Photo Evan D'Alessandro



[📄] ICHTHYOLOGIC DYNAMICS IN THE MANGROVE OF TÉRRABA, SOUTH PACIFIC, COSTA RICA: TOOLS FOR MANGROVE MANAGEMENT

José Rodrigo Rojas Morales

Instituto Costarricense de Electricidad, San José, Costa Rica.

Abundance and diversity of the estuarine fish of the mangroves in the south of the Pacific Coast of Costa Rica were determined between June 2001 and June 2004. Eighty five species distributed in 34 families and 48 genera were found. The total number of individuals captured was 4200 and the total biomass was 547.6 kg. Thirty one families belong to osteichthyes and three to chondrichthyes (*C. limbatus*, *Dasyatis longus* and *Urotrygon nana*). The families with more species are Carangidae (10), Haemulidae (7), Centropomidae (6), Lutjanidae (6), Scianenidae (6), Ariidae (5), Gerridae (5). Seventeen families are represented only with one species. The main community component in the site was an occasional visitor, comprised 43% of species. *Anchoa spinifer* (876), *Centropomus armatus* (610) and *Bairdiella ensifera* (479) accounted 46.7% of the total number of individuals. Based on these results, it is proposed the establishment of an integral management plan.

[🐟] PREDATION RATES VARY WITH WATER DEPTH AND OTHER BIOLOGICAL FACTORS IN MANGROVE-LINED TIDAL CREEKS

Andrew L. Rypel ^{§1}, Craig A. Layman ², D. Albrey Arrington ³, & Lori M. Valentine ¹

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Changing water depths are thought to drive many ecological processes in estuarine intertidal zones. We examined how predation rates varied as a function of water depth in mangrove-lined tidal creeks of the Bahamas by tethering an abundant prey fish, mojarra (*Eucinostomus* spp.). Results revealed a significant exponential relationship between predation rate and water depth. Tethered mojarra in shallow water mangroves had significantly longer survival times than did fish tethered in deeper water, and we were able to identify a “critical depth” of predation, i.e. a water depth threshold at which predation rates increased abruptly. Subsequently, we explored three additional factors (local predator density, prey fish size, and creek flooding regime) which contributed to variation in time until predation along the water depth gradient. Predation rates are influenced by all of the above mentioned variables, and we suggest that water depth especially should be incorporated into studies linking mangroves and fisheries ecology.

[🐟] CHANGES TO FISH ASSEMBLAGES VISITING ESTUARINE WETLANDS FOLLOWING THE CLOSURE OF COMMERCIAL FISHING IN BOTANY BAY, AUSTRALIA

Neil Saintilan ¹, Debashish Mazumder ², and Karen Cranney ^{§1}

¹ Centre for Environmental Restoration and Stewardship, ACU National, North Sydney, NSW, Australia. ² Australian Nuclear Science and Technology Organisation, Menai, NSW, Australia.

Photo Rafael J. Araujo



Data on commercial landings of fish and crustaceans are available for 52 estuaries in New South Wales. These same estuaries have been mapped with regards to the distribution of fish habitat, including mangrove, saltmarsh, and seagrass, along with a suite of geomorphic units. A multiple regression analysis demonstrated strong relationships between the area of mangrove and the catch of a number of commercially important species, including long-finned eel, and the mud crab *Scylla serrata*.



[📍] INTERRELATIONS BETWEEN MANGROVES, LOCAL ECONOMY, AND SOCIAL SUSTAINABILITY: AN EXAMPLE FROM A CASE STUDY IN NORTH BRAZIL

Ulrich Saint-Paul

Center for Tropical Marine Ecology, Bremen, Germany.

The littoral region of coastal Pará in NE Brazil is part of the world's second-largest continuous mangrove region. The Bragança peninsula is the specific study area of the interdisciplinary still ongoing joint German Brazilian project on "Mangrove Dynamics and Management" (MADAM), which started in 1995. Human use in this mangrove ecosystem is characterized by about 15 products, which have either subsistence value or generate monetary income for the local rural population. The importance of these functions for the rural households increases with the distance from the urban center. In the primary production sector, agriculture and artisanal fisheries are the main source of income in the wider Bragantian region. Both industries are characterized by many small operators. The industrial sector is very underrepresented throughout the region. Presently the control of the allocation of resources within this region rests predominantly in the hands of local individuals. This paper examines the conditions for the successful co-management of diverse species, resource use patterns and household income portfolios in a mangrove environment. Therefore stakeholders have been incorporated directly e.g. by participation in workshops. This is part of the support of the formation of the local RESEX (reserves extrativistas) movement, a Brazilian model of natural resources co-management.

[📍] DISTRIBUTION AND ABUNDANCE OF GREAT BARRACUDA (*SPHYRAENA BARRACUDA*) AND GRAY SNAPPER (*LUTJANUS GRISEUS*) ALONG A SUBTROPICAL MANGROVE SHORELINE

Joseph E. Serafy¹, Monica Valle², Craig H. Faunce², & Jiangan Luo²

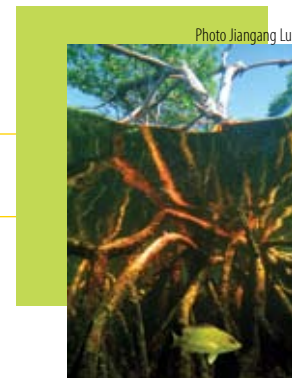
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Research on fish utilization of mangrove habitats is relatively new, with few multi-year studies spanning large spatial or environmental gradients. From 1998 to 2005, 537 visual fish surveys have been conducted along a 60-km stretch of mangrove-lined shoreline in the vicinity of Biscayne Bay (southeastern Florida, USA). This mangrove shoreline lies directly downstream of a major wetlands restoration project that aims to return more natural salinity regimes to the western margin of the region's coastal bays. In this paper, we examined spatial and temporal patterns of mangrove habitat use by two ecologically and economically important fish species: *Sphyraena barracuda* and *Lutjanus griseus*. Along a north-south gradient, seasonal variation in their size-composition, occurrence, concentration and density was quantified and correlated with measures of mangrove coverage, salinity and depth. These results provide a "baseline" for evaluating restoration impacts on this shoreline fish habitat and may also have relevance in regional coral reef fish stock assessments.

Saint-Paul

Serafy

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☛ HURRICANE-INDUCED CONVERSION OF MANGROVE FOREST TO MUDFLAT: IMPACTS ON NEKTON, BIG SABLE CREEK, FLORIDA

Noah L. Silverman ^{§1,2}, Carole C. McIvor ¹, Justin M. Krebs ^{1,2} & Victor A. Levesque ¹

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The passage of two Category 4-5 hurricanes across SW Florida (Labor Day Hurricane of 1935, Hurricane Donna 1960) resulted in patchy conversion of mangrove forest to mudflat habitat within Big Sable Creek, Everglades National Park, Florida. Our goal was to determine the consequence of this habitat conversion on nekton (i.e., fish and decapod crustaceans) inhabiting the intertidal zone. We used block nets across intertidal rivulets to compare nekton leaving replicate forest and mudflat sites. Overall nekton density (individuals per m³) was significantly greater for forested habitats than non-vegetated mudflats (RM ANOVA, $p < 0.001$). Species composition also differed between habitat types (PRIMER, ANOSIM). Benthic forage species dominated forested sites, whereas schooling species dominated mudflats. Results are consistent with previous studies regarding the influence of vegetation structure on density of fish. These results can assist managers in assessing the long-term impact that strong hurricanes can have on mangrove-associated nekton.

☐ THE IMPORTANCE OF MANGROVES AS NURSERY HABITAT FOR SMALLTOOTH SAWFISH (*PRISTIS PECTINATA*) IN SOUTH FLORIDA

Colin A. Simpfendorfer

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The use of mangrove habitats by smalltooth sawfish (*Pristis pectinata*) was investigated using surveys, acoustic telemetry, a public encounter database and habitat suitability models. Neonates (70–99 cm) occur on shallow mud banks, normally associated with mangrove coves or shorelines. Movements of these animals are strongly affected by the tide, with individuals electing to use very shallow parts of the bank (< 30 cm), presumably to avoid predation by sharks that occur in adjacent deeper water. When depths on banks become too deep to avoid predators, sawfish refuge within mangrove prop root habitats, either on the edges of banks or in drainage channels running out of mangrove stands. Acoustic tracks of juveniles 100–199 cm in length show that they inhabit slightly deeper water (< 100 cm) and their movements are strongly associated with mangrove shorelines. Analysis of sawfish encounter data indicated that juvenile sawfish < 200 cm are positively associated with mangroves, and that there is a positive relationship between size and distance from mangroves. To identify priority conservation areas for the endangered smalltooth sawfish habitat suitability models including mangrove distribution were constructed.

☛ SPATIAL-TEMPORAL PATTERNS OF ISLAND MANGROVE CREEK HABITATS: A CHARACTERIZATION AS RELATED TO SIZE, ENERGETICS, AND FEEDING MODE OF FISHES

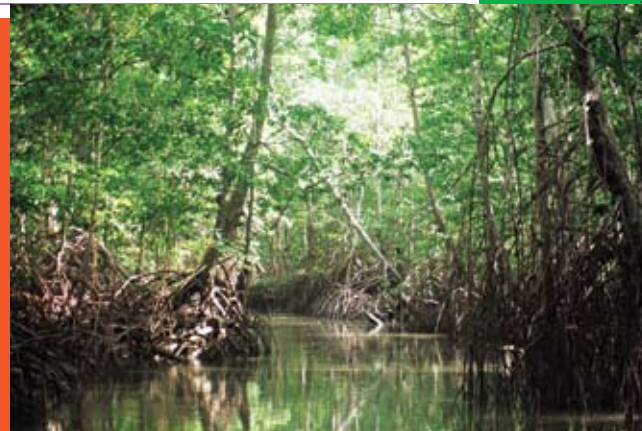
Kathleen Sullivan Sealey [§], Vanessa L. Nero, & Sherry Constantine

¹ University of Miami, Department of Biology, Miami, FL, U.S.A.

We examine the benthic and oceanographic characteristics of small mangrove creek systems with adjacent soft-bottom embayments in the northern and central Bahamas to understand differences in the diversity and biomass of fishes. Fish assemblages were evaluated by standard beach seines, visual surveys and traps. Key species such as bonefish (*Albula vulpes*), snappers (Lutjanidae) and mojarras (Gerridae) vary in their abundance,

Photo Rafael J. Araújo





size-frequency distribution and abundance based on season, tidal state and habitat (site). Benthic characteristics focused on floral (e.g., algae and seagrass) species composition, density and canopy height. Habitat maps of three different islands are used to first characterize mangrove systems by size, variability in temperature and salinity, geomorphology as well as proximity to platform margin reefs. Associations of fishes with particular habitat and oceanographic features can be crucial to monitoring population dynamics of commercially important species. The use of more detailed mangrove creek habitat-complex characterization can improve Marine Protected Area (MPA) planning.

📍 MANGROVE REMOVAL IN THE BELIZE CAYS: EFFECTS ON FISH ASSEMBLAGES IN THE INTERTIDAL AND SUBTIDAL

*D.S. Taylor*¹, *E.R. Reyier*², *W.P. Davis*³, & *C.C. McIvor*⁴

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We investigated the effects of mangrove cutting on fish assemblages in Twin Cays, Belize using two very different methods. We conducted extensive trapping with wire minnow traps within the intertidal zone in both disturbed and undisturbed fringing and transition (landward) mangrove forests. Catch rates were low: 638 individuals from 24 species in 523 trap nights. Cutting appeared to have no effect on species composition in either forest type (PRIMER, MDS followed by ANOSIM). Visual censuses from the permanent subtidal area adjacent to fringing forests in two disturbed and two undisturbed sites gave different results. Here, observers recorded significantly more species and individuals in undisturbed sites (MDS, ANOSIM). Different results from the two methods (and habitat types) may be explained by two factors: a larger species pool in the subtidal habitat and more extensive mangrove clearing adjacent to the census sites.

📍 AN ASSESSMENT OF ICHTHYOFAUNAL ASSEMBLAGES WITHIN THE MANGAL OF THE BELIZEAN OFFSHORE CAYS

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We assessed ichthyofaunal diversity within Belizean offshore cay mangroves during three sampling events (2003–2005). A variety of sampling gears ($n = 10$ types nets/traps) were deployed in pre-defined habitats: red fringe, transition, dwarf red, internal creek, pond, sinkhole, and deep creek. A total of 2586 gear sets were completed and 8131 individuals collected, comprising 75 species. The most abundant species was *Poecilia orri*, followed by *Gerres cinereus* and *Gambusia yucatanana*. However, 38.2% of gear sets (primarily small traps) had no catch. Data analysis for the different sub-habitats is continuing, but our data reinforce the difficulty of collecting in the mangal. In addition, we conducted extensive visual (snorkel) surveys around the fringe at a number of cays, tallying an additional 67 species. An overall total of 142 species from 55 families have therefore been documented from mangroves of the cays, a figure among the highest reported for oceanic mangroves in this biogeographic realm.

📍 A HYBRID MAXIMUM-LIKELIHOOD METHOD FOR DERIVING LARGE-SCALE MANGROVE DISTRIBUTIONS IN FLORIDA FROM THEMATIC MAPPER DATA

Jeff Ueland

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The mangrove habitats of Florida have experienced significant change in recent years due to both anthropogenic and natural forces. Understanding regional-scale changes of mangroves, so as to be utilized in conjunction with large-scale datasets on marine fisheries, requires a systematically derived and comparable spatial inventory of these important habitats. This paper offers a method for this purpose by examining the

Taylor

Ueland

ABSTRACTS



spatial extent and change of mangrove habitat in a 14 county area of south Florida between 1987 and 2000. To this end, remotely sensed, Thematic Mapper satellite data were classified by coupling posterior probabilities from a maximum-likelihood, supervised classification process with spatially explicit ancillary data sources. The results showed a decline in mangrove habitat over the 13 year period, but the changes were uneven and varied across space.

[📍] RESPONSE OF FISH SECONDARY PRODUCTION TO TIDAL CREEK FRAGMENTATION AND RESTORATION

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¹ University of Alabama, Tuscaloosa, AL, U.S.A. ² Loxahatchee River District, Jupiter, FL, U.S.A. ³ Yale University, New Haven, CT, U.S.A.

We quantified fish secondary production, a measure of ecosystem function, in Andros Island (Bahamas) tidal creeks to assess effects of habitat fragmentation (i.e., roads blocking tidal flow), and to characterize the ecological response following restoration of tidal flow. Unfragmented tidal creeks had up to 17 times higher secondary production values for individual fish species than fragmented creeks. Restoration of hydrologic connectivity increased biodiversity and biomass in upstream (i.e., restored) areas, primarily through a daily influx of transient individuals which utilize restored habitat at high tide, though these same individuals exited creeks or moved to deeper areas during ebb tides. By integrating secondary production with economic values for commercially important species (e.g., snappers) we show that fragmentation significantly affects the realized value of tidal creek ecosystems through loss of ecosystem function (i.e., fish production). Restoration of tidal flow can increase the economic value of tidal creeks in as few as 5 months.

[📍] MANGROVES AND SEAGRASS BEDS AS DIURNAL FEEDING HABITATS FOR JUVENILE *HAEMULON FLAVOLINEATUM*

Marieke C. Verweij ^{§1}, Ivan Nagelkerken ¹, Susanne L.J. Wartenbergh ¹, Ido R. Pen ², & Gerard van der Velde ¹

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Caribbean seagrass beds supposedly are important feeding habitats for so-called nocturnally active zoobenthivorous fish, but the extent to which these fishes use mangroves and seagrass beds as feeding habitats during daytime remains unclear. Therefore, we studied daytime behavior of large juvenile (5–10 cm) and sub-adult (10–15 cm) *Haemulon flavolineatum* in mangroves and seagrass beds in Curaçao. Sub-adults occurred in mangroves only, spent most time on resting, and showed rare opportunistic feeding events, regardless of their social mode (solitary or schooling). They probably feed predominantly during the night in seagrass beds. Large juveniles were present in both habitat types and solitary fishes mainly foraged, while schooling fishes mainly rested. Large juveniles showed more feeding activity in seagrass beds than in mangroves. The study shows that both mangroves and seagrass beds provide daytime feeding habitats for some life-stages of *H. flavolineatum*, which is generally considered a nocturnal feeder.

Photo Evan D'Alessandro





[] DEVELOPING SHALLOW-WATER ACOUSTIC TELEMETRY METHODS FOR JUVENILE SNAPPER HABITAT STUDIES IN THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Samantha R. Whitcraft^{§1}, *Bill Richards*², *John Lamkin*², *Trika Gerard*², *Tom Carlson*³, *Geoff McMichael*⁴, *Jessica Vucelick*⁴, *Greg Williams*⁵, & *Lisa Pytko*⁶

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The recent availability of customized coded micro-transmitters for juvenile fish tagging may provide useful tools in determining the early life history habitat requirements of commercially valuable snapper species within and outside marine protected areas. This pilot study utilizes micro-acoustic tags (dry wt = 0.65 g; excess mass = 0.39 g; 417 kHz) and standard acoustic telemetry methodologies developed by Battelle and NOAA Fisheries to investigate questions of habitat-use patterns of juvenile snappers in Florida Keys National Marine Sanctuary's reserve areas. We apply these methodologies to examine specific physical, environmental, and biological factors with the goal of optimizing telemetry instrumentation and field techniques for this application. Optimization requires trade-offs between limitations imposed by biological constraints and factors influencing the propagation/detection of signals in estuarine/marine environments. Important physical factors are operating frequency, encoded pulse length, and vegetation density in mangrove and seagrass habitats in 1.5–6 m depths. Environmental factors include determining baseline configuration within the geometry of distinct habitat patches and effects of dense mangrove prop roots on acoustic signal propagation and reception. Biological factors include tag-effects on survivorship of juvenile snappers. We present initial data from shallow-water testing of acoustic reception in obstruction-rich environments, compare juvenile salmon and snapper survivorship, and range-testing strategies.

[] RECRUITMENT OF JUVENILE BLUE CRABS TO NATURAL TIDAL CREEKS AND ALTERED DITCHES IN MANGROVE WETLANDS

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Our knowledge of mangrove wetlands as habitat for juvenile blue crabs, *Callinectes sapidus*, is limited. We sampled seasonally for one year in natural mangrove-lined creeks and in mangrove habitats altered by man-made ditches at three wetlands along a north-south gradient in Tampa Bay. Differential habitat use was observed for juvenile blue crabs between natural and altered mangrove habitats. Densities were highest in mosquito ditches, followed by natural creeks, and lowest in stormwater ditches. Differences among habitats are possibly related to variations in substrate type, current regime, or proximity to the open bay. Greatest abundances of juvenile blue crabs were recorded in winter and spring when young-of-the-year blue crabs recruited. Results indicate that the environmental conditions in stormwater ditches provide less suitable habitat for juvenile blue crabs than other mangrove habitats, whereas mosquito ditches may function more effectively than creeks. This finding presents important implications for habitat restoration and management.



Whitcraft

Yeager



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CES appreciates being involved in this symposium addressing the importance of mangrove ecosystems. We recently carried out a scientific assessment of trends in these sensitive ecosystems in north-central Brazil. CES is also negotiating the terms of reference for similar studies on mangrove systems in south Brazil. For more information about programs and symposia support, visit our web site at:

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