11-18-2015

Pelagic Habitat Use by Juvenile Reef Fishes in the Gulf of Mexico

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Fish at Night

AN INTERNATIONAL SYMPOSIUM

17–20 November, 2015
Miami, Florida, USA

SCIENTIFIC PROGRAM AND ABSTRACTS

Bulletin of Marine Science
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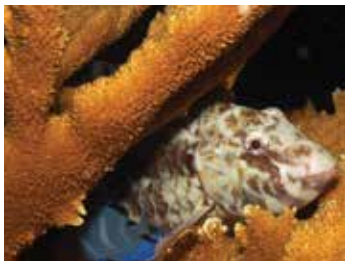
WELCOME TO FISH AT NIGHT!

We are pleased to welcome you to what we hope will be the first in a series of conferences hosted by the *Bulletin of Marine Science.* While the *Bulletin* has published more than 50 conference proceedings over our 65-year history, this symposium is the first that we have organized from the beginning. So, we are particularly excited that the call for abstracts captured the interest of such a large and diverse group of excellent scientists. Clear from the abstracts is that we are in for a stimulating meeting that spans many fields of study from various parts of the world, from the shallows to the deep.



First and foremost, as a scientific publication, our goal is to produce high-quality proceedings that captures the state of the science for all things fish at night. We invite you to you submit your work to be included in the "Proceedings of the 2015 International Fish at Night Symposium," a dedicated, peer-reviewed, open-access special issue of the *Bulletin* that is scheduled for publication in late 2016. This special issue will be guest edited by the symposium science advisory committee. For this issue, the *Bulletin* has decided to waive all publication charges for contributing authors. We encourage you to go to our website and familiarize yourself with author guidelines and submission procedures. The submission deadline for manuscripts is January 31, 2016. However, we encourage you to submit your work as soon as possible.

We hope you enjoy your stay in Miami and that you take away much from this conference. We are excited to produce what will hopefully be the first of many in a BMS symposium series.

Joseph E. Serafy, Ph.D.
Editor
Bulletin of Marine Science

Table of Contents

Study behaviour, migration and positioning of animals in lakes, rivers, oceans and MPAs

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WELCOME TO MIAMI

We are delighted that you will be joining us for the first organized international meeting devoted to understanding fish and fisheries in the dark.

We received 57 high-quality abstracts from several countries around the world. There are some truly diverse and amazing presentations lined up, including talks from industry, government, and academic institutions. We thank all delegates for participating in the symposium and especially would like to thank those who came from afar to contribute.

The Fish at Night scientific program is unique as presentations will be occurring at night. Plenary talks and the scientific program will begin in the early afternoon and run through the evening. Conference attendees will have their mornings free to work or explore Miami prior to the start of the symposium program. We have several social events lined up including a film festival centered on fish at night.

The symposium would not have been possible without the dedicated staff from the *Bulletin of Marine Science,* including Joe Serafy, Geoffrey Shideler, and Rafael Araújo, whose dedication and perseverance made this event possible. Thank you. Many thanks also to Evan D'Alessandro for the beautiful photographs for the program.

Special thanks to our symposium sponsors, several of which are presenting in the scientific program: Wildlife Computers, Desert Star Systems, NOAA Fisheries, Lotek Wireless, Vemco, Forestry Suppliers, Southern Cross Astronomical Society, and the University of Miami's Rosenstiel School of Marine & Atmospheric Science. We are also excited and appreciative to be partnering with Beneath the Waves for the film festival. Finally, we would like to acknowledge the superb work of Lisa Sedelnik and her staff from Spark It Communications and to the staff of the Sonesta Coconut Grove Miami Hotel for their help in coordinating logistics and hospitality for the symposium.

We encourage all attendees to submit their work to be included in the "Proceedings of the **2015 International Fish at Night Symposium**"—a dedicated, peer-reviewed special issue of the *Bulletin of Marine Science.* The presentations, discussions, and proceedings arising from this symposium will advance our understanding of the patterns and processes operating in fish ecology and fisheries during darkness.

Thank you for your attendance. Please enjoy the symposium and Miami!

Neil Hammerschlag, Ph.D. and Steven Cooke, Ph.D.
Scientific Organizers, 2015 Fish at Night Symposium


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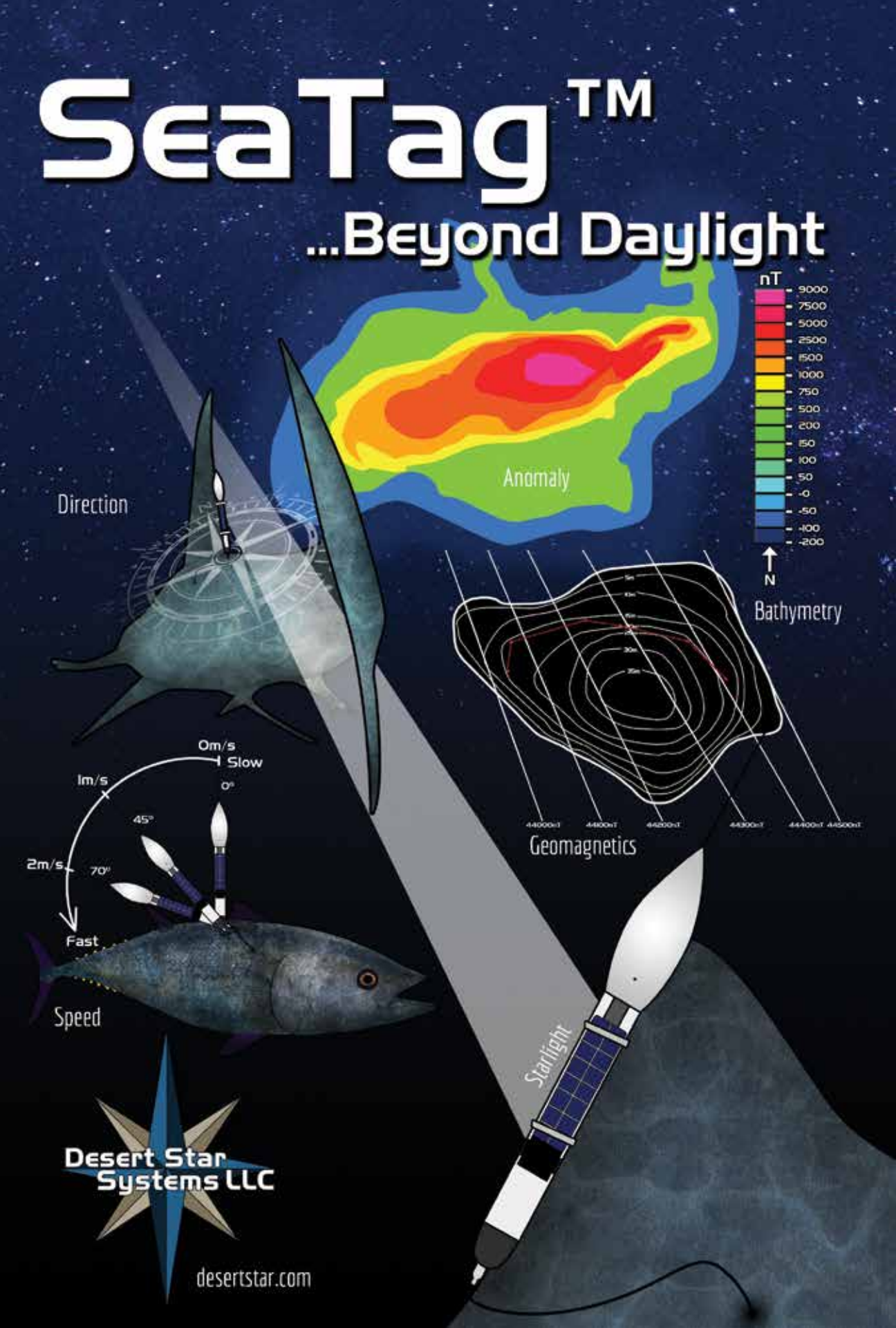
SHINING A LIGHT

As the sun sets, most aquatic researchers pack up their gear and head home. Yet this is precisely the time when many fish are most active. Indeed, some of the planet's greatest migrations occur at night when organisms rise toward the surface, creating massive pulses of biodiversity and biomass. In nearly every aquatic environment, from pelagic waters to coral reefs to headwater streams, what one observes by day can differ markedly from what is happening under the cover of darkness. In polar seas and at great depths, "night" can span, months, years, and beyond. Fish and fishers in these dark systems have adopted tactics and strategies that take advantage of low-light conditions and their study may offer solutions to problems in warmer, shallower habitats.

With this symposium, we hope to provide a forum for improving our understanding of the patterns and processes operating in fish ecology and fisheries during darkness. Neglecting the night has led to an incomplete understanding of marine organism ecology, population/community dynamics, and ecosystem function with consequences for conservation and management of fisheries resources. The ultimate and most important goal of the symposium is to produce a peer-reviewed dedicated volume that will capture the present state-of-knowledge of fish studies in the dark, identifying critical information gaps, and charting a course for future research and collaboration. Ultimately, we want to advance the current understanding of fish at night studies in the systems they occupy. This symposium will catalyze exchange of ideas, data, approaches, and methods pertinent to the symposium's overarching theme. Simply put, we plan to ***shine a light on Fish at Night***.

About the logo

According to Greek lore, while trying to escape from Typhon (the largest and most fearsome of all creatures), Aphrodite and Eros leapt into the sea and transformed themselves into fish. To not lose each other, they tied themselves together with rope. Their mythical transformation gave genesis to the zodiac constellation of Pisces, the archetypal "fish at night." In spite of being a relatively large constellation, Pisces' stars are faint and hard to see with the naked eye. In the Northern Hemisphere, we are able to see Pisces most clearly in autumn, coinciding with the timing of Fish at Night: an international symposium.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TUESDAY, NOVEMBER 17

Rosenstiel School of Marine & Atmospheric Science, University of Miami

16:00
Busses Depart from Sonesta Hotel to RSMAS Campus

17:00–18:00
Dean's Welcome Social: RSMAS Dean Roni Avissar
Food and Beverages on RSMAS Breezeway

18:00–19:00
Tour of RSMAS Seawater Complex and Demonstration of Hurricane Tank
Food and Beverages Continue

19:00
Busses Depart from RSMAS to Sonesta Hotel

WEDNESDAY, NOVEMBER 18

Biscayne Ballroom

13:00–13:20
Welcome to Miami

13:20–14:00
Keynote Speaker: Carl Meyer
Fish at Night: Piercing the Veil with Technology

Session: Larval Fish at Night

Session chair: Andrew Kough

14:00–14:20
Matthew Foretich
Dark Knights: Overnight Pelagic Orientation of Gray Snapper Larvae

14:20–14:40
Erica Staaterman
First Evidence of Fish Larvae Producing Sounds at Night

14:40–15:00
Lacey Malarky
Faunal Composition and Distribution of Pelagic Larval Flatfishes (Teleostei: Pleuronectiformes) in the Northern Gulf of Mexico: Connectivity Between Coastal and Oceanic Epipelagic Ecosystems

15:00–15:20
Rohan Brooker
Chemically Mediated Avoidance of Degraded Habitats: Where is the Tipping Point?

Grove Ballroom

Session: Deep and Polar Sea ("Perpetual Night") Fish and Fisheries

* Session chair

14:00–14:20
Tracey Sutton *
Understanding Deep-Pelagic Ecosystem Dynamics: A New Research Initiative in the Gulf of Mexico (DEEPEND)

14:20–14:40
April Cook
What Have We Learned About the Diversity of Oceanic Fauna of the Gulf of Mexico After Deepwater Horizon? Initial Results of the Offshore Nekton Sampling and Analysis Program

14:40–15:00
Alex Marks
Reproductive Ecology of Dragonfishes (Family: Stomiidae), The Dominant Vertically Migrating Mesopelagic Predators, in the Gulf of Mexico

15:00–15:20
Tiffany Sih
Diving into the Deep-End: Baited Remote Underwater Video Stations (BRUVS) to Study Deep-Reef Fish Communities in the Great Barrier Reef, Australia

15:20–16:00 Sunset Food Break

Biscayne Ballroom

Session: Nocturnal Fish Behavior and Ecology

* Session chair

16:00–16:20
Christopher Koenig *
Beneath a Moonless Sky: Nocturnal, New Moon Spawning in Atlantic Goliath Grouper, *Epinephelus itajara* (Lichtenstein, 1822).

16:20–16:40
Andrew Kough
When is the Witching Hour?: Activity Patterns in Satellite-Tagged Lake Sturgeon (*Acipenser fulvescens*)

16:40–17:00
Kristine Stump
Investigating Nassau Grouper Spawning Aggregations in The Bahamas

17:00–17:20
Michael McCallister
Diel Activity Patterns of the Indo-Pacific Lionfish (*Pterois volitans*) In the Florida Keys through Use of Acoustic Telemetry

17:20–17:40
Chris Taylor
Remotely Sensing the Halo Effect: Mapping Nocturnal Foraging Migrations and Habitat Connectivity in Coral Reefs Using Sonar

Grove Ballroom

Session: Night Fishing, Fisheries, and Enforcement

* Session chair

16:00–16:20
David Kerstetter *
A Historical and Analytical Description of Catches in the South Florida Recreational Tournament Fishery for Broadbill Swordfish, *Xiphias gladius*

16:20–16:40
David Blankinship
Characteristics and Trends in the Nighttime and Daytime U.S. Atlantic Recreational Swordfish Fishery Based on Fishery Dependent Data

16:40–17:00
Steven Cooke
Diel Patterns of Hooking Depth for Active and Passive Angling Methods

17:00–17:20
Farron Wallace
In the Dark: Challenges of Using Electronic Monitoring to Monitor Fisheries at Night

17:20–17:40
Chuanxiang Hua
Comparative Experiment of Aggregation Light for Pacific Saury Fishery in Different Inclinations

17:40–18:20 Starlight Coffee Break

WEDNESDAY, NOVEMBER 18

Biscayne Ballroom

Session: Methods for Studying Fish in Darkness

Session chair: Neil Hammerschlag

18:20–18:40
Kevin Ng
The Portal Advantage

18:40–19:00
M. Holland
Peering into the Dark Using Acoustic Telemetry

19:00–19:20
Marco Flagg
The Practical Use of Geomagnetic Field Strength Measurements to Produce or Enhance Geo-Position Estimates for Tagged Marine Animals in the Euphotic Zone and Beyond the Reach of Daylight

19:20–19:40
Donna Kehoe
Telemetry Tools Illuminate the Darkness

Grove Ballroom

Session: Diel Fish Distribution and Abundance Comparisons

* Session chair

18:20–18:40
Paul Arena *
Characterization of Nocturnal Fish Assemblages on Vessel and Natural Reefs of Broward County, Florida, USA

18:40–19:00
Xavier Chiappa-Carrara
Nychthemeral Differences in Habitat Use of Estuarine Fish in a Tropical Coastal Lagoon of the Yucatán Peninsula

19:00–19:20
Katie Bowen
Pelagic Habitat Use by Juvenile Reef Fishes in the Northern Gulf of Mexico

19:20–19:40
Charles Bangley
Spatial and Diel Habitat Partitioning Among the Elasmobranch Community in a North Carolina Estuary

Peacock Room

20:00–22:00
Trade Show Networking Event

Enjoy complimentary food and beverages while you learn about resources available to you and make professional connections that can assist you with your research interests.

THURSDAY, NOVEMBER 19

Biscayne Ballroom

13:00–13:20
Announcements

Session: Diel Fish Distribution and Abundance Comparisons

* Session chair

13:20–13:40
Eric Orbesen *
Diel Catch Rate Differences of Fish Captured in the Gulf of Mexico Pelagic Longline Fishery

13:40–14:00
Xavier Chiappa-Carrara
Day-Night Variation of Fish Assemblages an a Shallow Tropical Coastal Lagoon

14:00–14:20
R. Eddie Matheson
Diel Differences in Dermersal Ichthyofaunal Assemblages in the Northern Gulf of Mexico

14:20–14:40
Roxanne Juby
The Effect of the Diel Cycle and Depth on a Warm-Temperate Rocky Reef Fish Community, South Africa

14:40–15:00
Patrick Goebel
Diel Distribution and Abundance of Predators Among Seagrass and Mangrove Habitats in Biscayne Bay, Florida

Grove Ballroom

Session: Nocturnal Fish Behavior and Ecology

* Session chair

13:20–13:40
Neil Hammerschlag
Nocturnal and Crepuscular Behavior in Elasmobranchs: A Review of Habitat Use, Foraging, Reproduction, Abundance and Movement in the Dark

13:40–14:00
Jeffrey Milisen
Notes on the Crepuscular Activity of Sandbar Sharks (*Carcharhinus plumbeus*) and Habitat Use by Tiger Sharks (*Galeocerdo cuvier*) at Honokohau Harbor, Hawaii

14:00–14:20
Paul Sikkel *
Gnathiids at Night: Ecology of Interactions Between Mobile Ecto-parasitic Isopods and Coral Reef Fishes

14:20–14:40
Alison Gould
Shedding Light on Bioluminescent Symbioses: The Life History and Ecology of a Coral Reef Fish Host

14:40–15:00
Michael Grace
Species-Specific Development of Retinal Architecture in Elopomorph Fishes: Adaptations for Harvesting Light in the Dark

THURSDAY, NOVEMBER 19

Biscayne Ballroom

Grove Ballroom

Session: Nocturnal Fish Behavior and Ecology

15:00–15:20
N.H. Galvis
Considering Day/Night Location of the Invasive Lionfish Species in the Colombian Caribbean Sea May Improve Fisheries/ Control

15:20–16:00 Sunset Food Break

16:00–16:40
Keynote Speaker: Michael Grace
Fish Biological Rhythms and the Endogenous Clocks that Time Them: Night is Much More than Just Darkness

Session: Human Threats to Fish at Night

* Session chair

16:40–17:00
Steven Cooke *
Fishing in the Dark – The Science and Management of Recreational Fisheries at Night

17:00–17:20
Kristin Kopperud
Circadian Rhythms of Retinomotor Movement in the Atlantic Tarpon, *Megalops atlanticus*

17:20–17:40
Petra Szekeres
Different Forms of Coastal Light Pollution Alter the Nocturnal Behaviour of Juvenile Bonefish (*Albula vulpes*)

17:40–18:20 First Quarter Moon Coffee Break

Biscayne Ballroom

Session: Methods for Studying Fish in Darkness

* Session chair

18:20–18:40
Kevin Boswell *
Distribution and Abundance of Flying Fish in the Northern Gulf of Mexico Using Airborne LIDAR Surveys

18:40–19:00
Bea Sobradillo
Acoustic Estimation of the Nycthemeral Variability, of Pelagic Ichthyofauna and Plankton Abundance in the Bay of Biscay: Application to Fisheries Resources Assessment and Ecosystemic Management

19:00–19:20
Sasha Whitmarsh
Investigating the Effects of Light Colour on Fish Assemblages Observed at Night Via Baited Video

19:20–19:40
Jeffrey Milisen
Diving into Pelagic Diversity

Grove Ballroom

Session: Nocturnal Fish Behavior and Ecology

Session chair: TBD

18:20–18:40
Melissa Soldevilla
Nocturnal Patterns in Fish Chorusing in the South Atlantic Bight

18:40–19:00
Heather Spence
Passive Acoustic Monitoring of Nocturnal Fish Sounds in Quintana Roo, Mexico

19:00–19:20
Shannon Ricci
Use of Underwater Soundscapes to Characterize Nocturnal Fish Behavior and Habitat Use Within a Complex Mosaic of Estuarine Habitats

19:20–19:40
Euan Harvey
Video Observation and Sampling of Fish at Night: A Review of the Use, Challenges, Potential Solutions, and Future Research Requirements

Biscayne Ballroom

20:00–21:00 Film Festival — Beneath the Wave's Fish at Night Film Festival will be showcasing short films about nighttime ocean science and ocean adventures. Complimentary food and beverages will be available.

Peacock Room

21:00–22:00 Networking Event — Move to the Peacock Room after the film festival to continue networking with colleagues and industry representatives while enjoying food and beverages.

FRIDAY, NOVEMBER 20

Biscayne Ballroom

09:00–09:20
Announcements

Session: Larval Fish at Night

* Session chair

09:20–09:40
Donald Kobayashi *
Estimation of Moonlight-Mediated Avoidance Functions for Larval Reef Fishes Captured With a Midwater Trawl

09:40–10:00
Noelle Bowlin
Ontogenetic Vertical Distribution of Mesopelagic Fishes and the Development of Diel Migration

10:20–10:40
Raul Lopez
Fish Eggs at Night in the Colombian Pacific Ocean: First Approach

10:40–11:00
Andrew Kough
An Affordable, Simplistic, and Efficient Light Trap for Capturing Healthy Settlement Stage Marine Larval Fish

Session: Nocturnal Fish Behavior and Ecology

* Session chair

11:00–11:20
Neil Hammerschlag *
Diel Activity Patterns of a Marine Apex Predator (Tiger Shark, *Galeocerdo cuvier*) at a Protected Aggregation Site

11:20–11:40
Alex Dornburg
Descending to the Dark Side: The Role of Nocturnality in the Evolution of Marine Fishes

11:40–12:00
Pedro Luis Diaz-Carballido
Diel Feeding Habits of Three Benthic Stingrays (Batoidea: Urotrygonidae and Narcinidae) in the Gulf of Tehuantepec, Mexico

12:00 Adjourn

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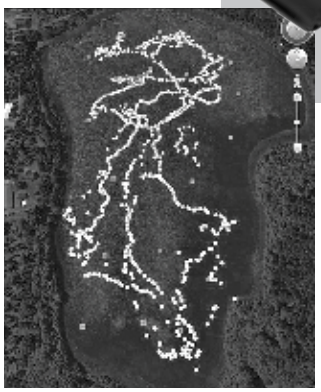

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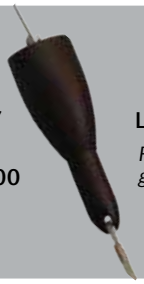

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ABSTRACTS

KEYNOTE

Wednesday, November 18 — 13:20
Biscayne Ballroom

Fish at Night: Piercing the Veil with Technology

MEYER C.
The Hawai'i Institute of Marine Biology
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Email: carlm@hawaii.edu

Our need to understand fish ecology has driven the development of increasingly-sophisticated electronic devices for remotely studying fish behavior in concealing aquatic environments. Among the earliest of these devices were simple acoustic pingers, allowing fish to be followed from a vessel equipped with a receiver and hydrophone. These early tracking studies soon revealed that fishes typically have strong, diel rhythms of behavior, often involving crepuscular migrations and activity level changes between day and night. Our ability to quantify these diel patterns at ever greater levels of resolution, and over longer periods of time, has grown in lockstep with the development of new devices such as pop-up satellite tags and passive acoustic monitoring systems. Most recently, accelerometer-dataloggers have yielded high-resolution insights into fish spatial dynamics, body orientation, and activity levels throughout the diel cycle. Despite increasing sophistication of these tracking devices, in most cases we can still only infer what fish are actually doing in the habitats they visit. To overcome this challenge, we've been using fin-mounted cameras to gain a "sharks-eye view" of habitat use. These video cameras are now small enough for deployment on a wide size-range of fishes, but we currently lack equivalent low-light level and non-visual spectrum cameras suitable for recording in darkness without disturbing natural behavior. This represents a major gap in our technological arsenal because many fishes are nocturnally active, or live in the perpetual darkness of the deep sea. To better understand fish at night, we need to see what they are doing!

Biography

Sharks and fishes live in a concealing environment making them very difficult to study in their natural habitats, yet understanding their behavioral ecology is vital for designing effective conservation strategies for these ubiquitous and important aquatic animals. Carl uses telemetry devices to study shark and fish movement behaviors. These devices range from well-established technologies, such as satellite and acoustic transmitters, to more recent innovations, such as tri-axial accelerometer-magnetometers and miniature cameras. Combining these technologies has provided exciting new insights into shark and fish behavior. Carl is also very interested in developing new technologies to fill important gaps in our understanding of shark and fish ecology. For example, his lab is currently developing a device capable of remotely detecting and recording feeding events in wild sharks and fishes. These prototype "shark pills" survive being eaten and regurgitated, can detect feeding events while inside the stomach, and can be found and recovered from open-ocean. This tool will provide a better understanding of the feeding patterns of wild sharks and fishes, which in turn will increase our understanding of the broader patterns of nutrient and energy flow through marine food webs.

Carl received his Ph.D. from University of Hawai'i and is presently an Assistant Researcher at the Hawai'i Institute of Marine Biology.

KEYNOTE

Thursday, November 19 — 16:00
Biscayne Ballroom

Fish Biological Rhythms and the Endogenous Clocks that Time Them: Night is Much More than Just Darkness

GRACE M.S., Kopperud K.L.

Florida Institute of Technology
Department of Biological Sciences
150 W. University Blvd.
Melbourne, Florida 32901
Email: mgrace@fit.edu

Endogenous biological clocks are ubiquitous among eukaryotic organisms, and although they may sometimes be poorly recognized, they have tremendous adaptive significance. These clocks drive numerous rhythms of physiology and behavior with periods that approximate the periods of natural environmental cycles, allowing organisms to anticipate environmental change without having to first experience such change. Thus, nocturnal animals are not simply active during the dark phase of the daily light-dark cycle. Rather they anticipate the onset of darkness, prepare for it, and change activities even if not exposed to a change in light level. Circadian clocks (clocks with periods approximating 24 hours) and the rhythms they control are reasonably well understood in a few species of fish, particularly freshwater species that serve as laboratory models, but they are very poorly studied in most fish taxa. This presentation will provide an overview of what is known about fish biological clocks, their locations and mechanisms, and the rhythms they control in fish, and will also raise some important unanswered questions. For example, fish living in coastal zones often must time activities based not only upon the daily light-dark cycle, but also upon the tidal cycle. Do multiple clocks with distinct periods operate at the same time in these species? More questions exist than answers, but undoubtedly a good understanding of biological timing mechanisms in fish is important for understanding the temporal organization of fish activities, and for understanding the potential effects of some forms of habitat disturbance, particularly those affecting natural temporal order.

Biography

Michael is a sensory neurobiologist interested in the neural mechanisms that underlie complex animal behavior. While trained in cellular and molecular neuroscience, molecular biology and physiology, his motivation stems from a deep love for the natural world and the ways in which animals collect, process and utilize information from the environment. His work centers primarily on vision and non-visual sensory systems and biological clocks that time daily changes in physiology and behavior. His lab studies vision in tarpon and related marine fish, snakes, turtles, and every now and then a mammal or two, including baleen whales. He also investigates the mechanisms of infrared imaging by pitvipers and pythons. His work is applied to conservation or to the development of novel biomimetic sensor technologies.

Michael earned a BS in Applied Biology from Georgia Tech, followed by MS and PhD degrees from the Emory University School of Medicine. He studied at the University of Kansas Medical Center, and held an NIH post-doctoral fellowship at the University of Virginia where he worked in the NSF Science & Technology Center for Biological Timing. He is currently Interdisciplinary Professor of Biological Sciences and Senior Associate Dean of the College of Science at the Florida Institute of Technology.

ABSTRACTS

*In alphabetical order by presenter's name (in **bold**).*

Session: Diel Fish Distribution and Abundance Comparisons

Wednesday, November 18 — 18:20
Grove Ballroom

Characterization of Nocturnal Fish Assemblages on Vessel and Natural Reefs of Broward County, Florida, USA

ARENA P.T., Anderson R.L.

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The majority of artificial reefs deployed in Broward County, Florida since 1982 are made up of derelict vessels. The goals of these projects were to enhance fish stocks for recreational fisheries and sport divers, as well as reduce pressure on heavily exploited natural reefs (NR's). Several studies have been conducted at both artificial and NR sites in the area; however, none of these have focused on nocturnal fish assemblages. The goal of this study was to characterize nocturnal fish assemblages at these sites Our data, in addition to the existing diurnal data, will provide a more comprehensive understanding of fish assemblage structure on vessel and NR's off south Florida. Comparisons among vessel and natural nocturnal fish assemblages and previous diurnal studies were made. Fish abundance was greater during diurnal periods for both natural and vessel reefs (VR's) when compared to nocturnal periods. Abundance was also greater on nocturnal VR's than nocturnal NR's. The twilight period on VR's was characterized by high abundance of piscivores and a significantly greater abundance of grunts than nocturnal periods, which supports their movement to surrounding sand flats to feed during this time. The high abundance of pelagic and planktivorous fishes on VR's may indicate a preference due to vertical relief effects. Distinctly different fish assemblages were found between reef type and time of day. Economically important fishes were more abundant during the day at both reef types when compared to nocturnal counts and VR's harbored more of these targeted species than NR's.

Session: Diel Fish Distribution and Abundance Comparisons

Wednesday, November 18 — 19:20
Grove Ballroom

Spatial and Diel Habitat Partitioning Among the Elasmobranch Community in a North Carolina Estuary

BANGLEY C.W., Rulifson R.A.

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Spatiotemporal habitat partitioning is widespread among elasmobranchs, particularly within estuaries functioning as multispecies nurseries. However, few studies have incorporated diel patterns of habitat use. We used a combination of fishery-independent shark survey techniques and passive acoustic telemetry to identify patterns in estuarine microhabitat use within Back Sound, North Carolina. Elasmobranchs were captured from March to November using sink gillnet, bottom longline, and drumline gear soaked for 30 minutes at sites chosen using a stratified-random sampling design. Sampling occurred from morning to approximately 1–2 hours after sunset. All elasmobranchs were identified and measured, and depth, temperature, salinity, and dissolved oxygen were recorded at each sampling station. Distances from each station to the nearest mapped seagrass bed and inlet were measured using ArcGIS. Four species were targeted for acoustic tagging based on expected ecological differences: blacknose (*Carcharhinus acronotus*), blacktip (*Carhcarhinus limbatus*), bull (*Carcharhinus leucas*), and bonnethead (*Sphyrna tiburo*) sharks. These tagged sharks were detected on acoustic receivers deployed at sites spatially dominated by seagrass, sand flat, oyster reef, or deep channel microhabitats. The elasmobranch community was numerically dominated by Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) and southern stingrays (*Dasyatis americana*), which also showed the most generalist habitat preferences. Bonnethead and blacktip sharks were more diurnal, while blacknose sharks were more nocturnal. Adult bull sharks and damage to longline gear by large sharks occurred most often during late afternoon and night sets, suggesting predation risk for smaller elasmobranchs increases at night.

Session: Night Fishing, Fisheries, and Enforcement

Wednesday, November 18 — 16:20
Grove Ballroom

Characteristics and Trends in the Nighttime and Daytime U.S. Atlantic Recreational Swordfish Fishery Based on Fishery Dependent Data

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The U.S. Atlantic recreational swordfish fishery occurs along the eastern U.S. coast, Gulf of Mexico, and U.S. Caribbean with the fishery being most active off of South Florida. Swordfish have been domestically managed since 1985 and by the Atlantic Highly Migratory Species Management Division of NOAA Fisheries since 1992. Swordfish have been managed by the International Commission for the Conservation of Atlantic Tunas since the early 1990s and in accordance with the international rebuilding plan developed in 1999. The recreational swordfish fishery has grown in the number of participants and expanded geographically as the North Atlantic swordfish stock has rebuilt over the last decade. Private anglers and charter/headboat self-reported swordfish landings data from 2003-2014 were analyzed to describe characteristics, trends, and shifts in the nighttime and daytime swordfish fishery. In particular, regional and temporal changes in diel fishing patterns and catch are explored that describe the growth in nighttime drift fishing and daytime deep-drop fishing.

Session: Methods for Studying Fish in Darkness

Thursday, November 19 — 18:20
Biscayne Ballroom

Distribution and Abundance of Flying Fish in the Northern Gulf of Mexico Using Airborne LIDAR Surveys

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Acquiring synoptic data on the broad-scale horizontal and vertical distribution of marine organisms over large areas is challenging, but important. To gather such data, we conducted a series of ship-supported aerial LIDAR surveys over large swaths (87°W–90.5°W, 28°N–30°N) of the northern Gulf of Mexico from September 20 to October 6, 2011. The same survey pattern was typically run twice in a 24-hour period covering both daytime and nighttime conditions. Ship-board observations were carried out to collect visual census data, specimens, and water column characteristics. Here, we present information on the distribution of flying fishes (Family Exocoetidae) in the study area. The aerial LIDAR surveys identified groups or schools of fishes with average length scales of about 6.1 km. Ship-board surveys indicated that these were largely groups of flying fishes comprising blackwing flyingfish (*Cheilopogon cyanopterus*), Atlantic flyingfish (*Cypselurus melanurus*), and bluntnose flyingfish (*Prognichthys gibbifrons*). While always near the surface, the LIDAR observations showed that these fishes were slightly deeper at night than during the day. Flying fishes were found most often off of the continental shelf in warm (>27.5 °C) water with low chlorophyll concentrations (<1 mg m^{-3}). This study demonstrated that airborne LIDAR is an effective tool for collecting repeated close-in-time synoptic-scale data. Combining this fast survey tool with ship-board sampling support could result in effective and efficient adaptive survey techniques. Further, repeated surveys on daily time scales allow for the use of more powerful survey analysis mathematics.

ABSTRACTS

Session: Diel Fish Distribution and Abundance Comparisons

Wednesday, November 18 — 19:00
Grove Ballroom

Pelagic Habitat Use by Juvenile Reef Fishes in the Northern Gulf of Mexico

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The assemblage composition, abundance, frequency of occurrence, and vertical distribution of juvenile reef fishes in the offshore pelagic habitat of the northern Gulf of Mexico are described. This study, a component of the NOAA-supported Offshore Nekton Sampling and Analysis Program, is the first to examine juvenile reef fish distributions across the oceanic northern Gulf of Mexico after the Deepwater Horizon oil spill. Results presented here are derived from a 3-month, spring/summer research cruise in 2011 on the M/V Meg Skansi. A 10-m^2 MOCNESS midwater trawl was used to sample 45 stations from the surface to a depth of 1500 m, both day and night. Seven reef fish orders, 30 reef fish families and 119 reef fish species were collected. Initial analysis has revealed the presence of juveniles of some species in locations where adults are not known to occur. Juveniles were found almost exclusively in the uppermost 200m of the water column. A greater number of individuals were collected in nighttime trawls. Surprisingly, some individuals were sampled between 1000–1500 m. During the MS7 sampling program, hydrographic profiles of the water column were recorded. This information provides the hydrographic background setting against which the coastal reef fish distributions in the offshore pelagic habitat of the Gulf of Mexico can be characterized. Results of fish distributions as a function of location (relative to the shelf break) and major mesoscale oceanographic features will be presented.

Session: Larval Fish at Night

Friday, November 20 — 09:40
Biscayne Ballroom

Ontogenetic Vertical Distribution of Mesopelagic Fishes and the Development of Diel Migration

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The mesopelagic zone is one of earth's largest habitats and contains the highest abundance of marine vertebrates in the world. These fishes carry out all of their life stages in the water column. Typical of broadcast spawners, they generally have buoyant eggs that hatch into larvae which inhabit the productive epipelagic zone, but move into deeper habitats as they mature. While a variety of studies have described the vertical distribution and diel migration of juvenile and adult mesopelagic fishes, relatively few have focused on stage-specific vertical distribution of early life history stages. Given the need to choose a habitat that optimizes the balance between foraging and predation, it is plausible that larval fishes, not just juveniles and adults, partition themselves in the water column. Here we analyze depth-specific ontogeny in mesopelagic fishes in the central and southern California current with goals of better defining depth-specific niches and the development of diel vertical migratory patterns.

Session: Larval Fish at Night

Wednesday, November 18 — 15:00
Biscayne Ballroom

Chemically Mediated Avoidance of Degraded Habitats: Where is the Tipping Point?

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On coral reefs, movement of larval fishes from the plankton onto the reef largely occurs during nocturnal periods, with recruitment pulses often correlating with lunar cycles. Many larval fishes have acute sensory systems, using a variety of environmental cues to locate habitat. However, larvae that approach the reef at night are likely to primarily depend on light-independent cues, such as sounds or chemicals, to make critical decisions regarding where to settle. Chemicals in particular appear to play pivotal roles with larvae using a variety of coral reef-based odors to orientate towards, and distinguish between, potential habitats. However, how degradation-induced changes to reef odor will alter larval behavior remains unclear. Coral reefs worldwide are shifting from high-diversity, coral-dominated communities to low diversity systems dominated by seaweeds, potentially impacting essential recovery processes and ecosystem resilience. Recent evidence suggests that chemical cues produced by seaweeds blooming on degraded reefs are avoided by larval fishes, possibly impeding recruitment and creating negative feedbacks that suppress reef recovery and sustain seaweed dominance. Unfortunately, the level of seaweed increase and coral decline that creates a deterrent chemical signature remains unknown, preventing management targets to avoid this tipping-point from positive to negative cuing of recruitment. We conducted flume and field assays suggesting that juvenile fishes sense and respond to cues produced by as little as 11%–25% seaweed cover. However, the herbivore species we tested was more tolerant of degraded reef cues, possibly providing some degree of resilience if these fishes recruit, consume macroalgae, and diminish negative cues.

Session: Diel Fish Distribution and Abundance Comparisons

Thursday, November 19 — 13:40
Biscayne Ballroom

Day-Night Variation of Fish Assemblages in a Shallow Tropical Coastal Lagoon

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Nychthemeral changes in the structure of fish assemblages are related to feed and shelter activities, which are regulated by the light intensity. Differences in diurnal, crepuscular, and nocturnal fish assemblages determine the connectivity between coastal lagoons and marine systems. The aim of this study was to assess the temporal variations (nychthemeral and seasonal) of species composition, abundance, and diversity of fish moving through the inlet connecting a shallow, karstic lagoon with the sea. Biological collections were made every two hours until a 24-hour cycle was completed every two months, from December 2010 to October 2011, using a beach seine covering 800 m^2. A total of 10785 fish, of 77 species, were obtained; the overall mean density was 18.7 ind·100 m^2. Statistical analysis revealed significant differences in species composition at each of the two temporal scales considered. Over the course of the study, 31% of the species were mainly caught during the day, 12% during twilight hours, and 26% at night. The remaining 31% are species whose abundance did not vary significantly between day and night. The largest numbers of organisms and species were recorded during the day, but diversity and equity were significantly greater at night because fish species that are usually found as solitary individuals are more active during the night. This produces a greater equity in the assemblage when compared with daylight hours when fish species that school are present. In this case, few species, as *Anchoa lamprotaenia*, *Chriodorus atherinoides*, *Harengula clupeola* were recorded in high abundances.

ABSTRACTS

Session: Diel Fish Distribution and Abundance Comparisons

Wednesday, November 18 — 18:40
Grove Ballroom

Nychthemeral Differences in Habitat Use of Estuarine Fish in a Tropical Coastal Lagoon of the Yucatán Peninsula

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Coastal lagoons are used differentially throughout the life cycle of many fish species characteristic of the coastal environment. Early life stages of many species are found in these systems that are used as feeding or sheltering sites, and many of these organisms are found in the lagoon environment during the night. The aim of this study was to analyze the occurrence and abundance of nine species estuarine fish at two temporal scales in a tropical lagoon, and to infer the main activities that juvenile individuals perform. Sampling was carried out every two hours until a 24-hour cycle was completed at a two-month interval, from December 2010 to October 2011, using a beach seine swept twice covering an area of 800 m2. Species analyzed were *Cynoscion arenarius*, *C. nothus*, *Elops saurus*, *Mugil cephalus*, *Mugil curema*, *Opisthonema oglinum*, *Orthopristis chrysoptera*, *Symphurus plagiusa*, and *Synodus foetens*. The species-habitat relationships were analyzed using ANOSIM and differences ($P < 0.01$) at the hourly and seasonally scales were found considering both occurrence and abundance data. The fact that over 70% of fish collected had not reached the size at which first maturity occurs is an indicator that these species use the lagoon in the hours of darkness to shelter and feed. Over 40% of the species studied are ichthyophagous, 30% are microcrustacean consumers, 10% feed on shellfish, and 20% on microalgae and detritus. The light and dark cycle regulates the presence and patterns of habitat use of these species within the lagoon.

Session: Deep and Polar Sea ("Perpetual Night") Fish and Fisheries

Wednesday, November 18 — 14:20
Grove Ballroom

What Have We Learned About the Diversity of Oceanic Fauna of the Gulf of Mexico after Deepwater Horizon? Initial Results of the Offshore Nekton Sampling and Analysis Program

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The Deepwater Horizon Oil Spill (DWHOS) necessitated a whole-water-column approach for assessment of disturbance in the epipelagic (0–200 m), mesopelagic (200–1000 m) and bathypelagic (>1000 m) biomes. The deeper regimes collectively form the largest integrated habitat in the Gulf of Mexico (GoM). This habitat received the initial oil/methane discharge, plus millions of liters of dispersant, and contained persistent deep (~1100 m) plumes of oil and dispersant. By some estimates, only half of the discharged oil and none of the methane reached the ocean surface. This demonstrated that DWHOS had an extensive and persistent deep-pelagic component. Before the DWHOS we had only a basic knowledge of the deep-pelagic GoM. Consequently, the large-scale, NOAA-supported Offshore Nekton Sampling and Analysis Program (ONSAP), was implemented as part of the natural Resource Damage Assessment process. Here we provide preliminary results of ONSAP field campaigns in 2011 that sampled the pelagic fauna that inhabit the uppermost 1500 m. During these campaigns a minimum of 717 fish species were represented from the 328,560 specimens collected via midwater trawling. Ongoing analyses are likely to discover and define additional species, as hard-to-identify taxa are resolved. This diversity encompasses one-half of the fish species currently known for the GoM. Also, 60 of the species are new records for the GoM, including numerous undescribed taxa. Fish species richness by functional group and numerical dominance will be presented. These data emphasize that the diversity of the deep-pelagic GoM fauna, like the World Ocean proper, has been historically underestimated.

Session: Night Fishing, Fisheries, and Enforcement

Wednesday, November 18 — 16:40
Grove Ballroom

Diel Patterns of Hooking Depth for Active and Passive Angling Methods

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Interest in the best practices surrounding catch-and-release angling is increasing alongside recognition that many typical angling behaviors impact survivorship post-release. Deep hooking has been associated with hook and bait type, and is known to contribute to post-release mortality in numerous species. Yet, little information is available regarding the role of diel patterns and angling methods in affecting hooking depth. In this study, bluegill and pumpkinseed, two common freshwater fish species, were captured actively (cast and retrieve) and passively (with a bobber) using rod and reel during four time periods spanning the 24-hour cycle. This study represents the first to test whether there is diel variation in hooking depth and if it is mediated by angling method.

Session: Human Threats to Fish at Night

Thursday, November 19 — 16:40
Biscayne Ballroom

Fishing in the Dark – The Science and Management of Recreational Fisheries at Night

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Recreational fishing is a popular activity around the globe, generating billions of dollars in economic benefit. Some fish are harvested by anglers but many are released (i.e., catch-and-release). In most developed countries, recreational fisheries are managed to achieve diverse objectives and ensure that such fisheries are sustainable. Anglers are a keen bunch, with some species targeted during the night. However, night creates a number of challenges for recreational fisheries assessment and management. In some jurisdictions, fishing is prohibited at night or there are specific restrictions placed on night fisheries (e.g., no use of artificial lights). Here we summarize the science and management of recreational fisheries at night covering both inland and marine realms. In doing so, we also provide a review of different angling regulations specific to night fisheries across the globe as well as the basis for those regulations. We discuss the extent to which there is both need and opportunity to actively manage anglers interested in targeting fish at night.

ABSTRACTS

Session: Nocturnal Fish Behavior and Ecology

Friday, November 20 — 11:40
Biscayne Ballroom

Diel Feeding Habits of Tree Benthic Stingrays (Batoidea: Urotrygonidae and Narcinidae) in the Gulf of Tehuantepec, Mexico

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Three benthic rays (*Urotrygon rogersi*, *U. chilensis*, and *Narcine vermiculatus*) are caught simultaneously as bycatch in shrimp trawls in the Gulf of Tehuantepec, Mexico. We tested the hypothesis that differences among diel activity patterns lead to the differential use of trophic resources as the explanatory mechanism that allows the coexistence of these sympatric species. Specimens were caught on two oceanographic campaigns conducted in August and December 2013 on board the *R/V Fipesco*. Stomach contents of 386 rays were analyzed to describe the trophic spectrum of each species by time of day (day and night). The index of relative importance of prey (IRI) and the trophic overlap between species and sexes were calculated. Overall, rays consumed 19 food types and during the night, 80% of the stomachs were full. Rays are specialized consumers and trophic overlap between species is low (<0.5%). Crustaceans were the main contributors to the diet of both *Urotrygon* species, while polychaetes were the main prey types of *N. vermiculatus*. Diel differences in the diet of *U. chilensis* were significant (SIMPROF, 76%) even if no temporal differences of the vacuity index were found. Diel differences in the diet of *N. vermiculatus* were also significant (SIMPROF, 62.3%) but those corresponding to U. rogersi were not even if both species showed a greater feeding activity at night. Distinctive feeding habits resulting in specialized diets and low trophic overlap is a strategy that allows the coexistence of these species.

Session: Nocturnal Fish Behavior and Ecology

Friday, November 20 — 11:20
Biscayne Ballroom

Descending to the Dark Side: The Role of Nocturnality in the Evolution of Marine Fishes

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Nocturnality is a common phenomenon in marine fishes that has independently evolved in lineages such as grunts, squirrelfishes, and cardinal fishes. However, the evolutionary dynamics that underlie such activity changes in diel cycles remain unclear. Here we map diel activity patterns onto a phylogeny of over three thousand marine fish species to assess the effect of latitude, trophic ecology, maximum depth, and encephilization on activity pattern. We further quantify the rate of transition between diurnal and nocturnal behavior and the rates of transition between these diel patterns and deep-sea habitat usage. We find transition rates to be heavily biased, with diurnal lineages far more likely to transition to a nocturnal state. Likewise, we found deep-sea fishes to be far more likely to transition to a nocturnal versus diurnal state. In total, our results provide a fundamental step towards developing an understanding of how transitions between diurnal and nocturnal activity cycles have shaped the evolutionary history of marine fishes.

Session: Methods for Studying Fish in Darkness

Wednesday, November 18 — 19:00
Biscayne Ballroom

The Practical Use of Geomagnetic Field Strength Measurements to Produce or Enhance Geo-Position Estimates for Tagged Marine Animals in the Euphotic Zone and Beyond the Reach of Daylight

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Light observation based geo-position estimation is commonly used by logging and pop-up satellite archival tags for marine animals. The method however suffers from generally poor latitude estimates due to the difficulty of measuring day length underwater, and is limited to the reach of daylight. Klimley proposed measurements of the strength of the earth's magnetic field, which in many parts of the world exhibits a distinct north-south gradient, to improve position estimates. This method has been implemented in the SeaTag line of PSAT tags. This paper presents the fundamental light and magnetic method of position estimation and illuminates its strengths and limitations using tagging results from several animal species. It then discusses methods and presents results of geo-positioning beyond the reach of daylight, where magnetic measurements are employed without light observation augmentation to obtain positions or migratory tracks. While the paper shows that magnetic and light based position estimation is a robust and automated technique that has been validated by comparison to satellite tracks, positioning beyond the reach of light is in its infancy. Building on the results and experience gained to date, the paper thus concludes with the authors estimation of the potential and challenges for the systematic application of magnetic measurements to track animals in the disphotic and aphotic zones.

Session: Larval Fish at Night

Wednesday, November 18 — 14:00
Biscayne Ballroom

Dark Knights: Overnight Pelagic Orientation of Gray Snapper Larvae

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Astonishing swimming and orientation capabilities were recorded for the larval stages of many fish species, yet convincing evidence that they swim towards settlement habitat from the open ocean has been lacking. This is because most behavioral observations have been carried out in the laboratory or in situ during the day. Here we use a Lagrangian behavioral arena deployed at 3 meters in the Florida Straits and equipped with infrared lighting to show that gray snapper (*Lutjanus griseus*) change significantly their swimming behavior after the dusk twilight. They mostly orient against the Florida Current, but inshore (southwest) during the day and offshore (southeast) during the night, thus avoiding the coast in the dark hours. These first in-situ observations of larval fish orientation in the pelagic environment overnight change the established paradigm that fish larvae swim offshore during the day to settle during the night. Our study supports the hypothesis that fish larvae approach the habitat during the day.

ABSTRACTS

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 15:00
Grove Ballroom

Considering Day/Night Location of the Invasive Lionfish Species in the Colombian Caribbean Sea May Improve Fisheries/Control

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Monitoring multiple reports of RENOVOS, the International Network of Fishermen and Divers who are Volunteer Observers of the Colombian Coral Reefs, provide evidence of the lionfish behavior during 2008 till present, reports confirm deeper distribution of adults while juveniles are more frequently found in shallow waters during the day. Divers and fishermen reported larger sizes of lionfishes in shallow waters at night. The CPEU database statistics between 2008-2014 of the PESCAPUR (Association of Fishermen) shows similar catches at night /dawn of native small carnivores with the ones reported from lion fishes which are found normally feeding on the fishing grounds. These findings may serve as advice for some improvements in the controlling efforts of the invasive species, considering that lion fishes behave in the Colombian Caribbean as pasive small groupers during the day, but at night behave similar to the native carnivores of the Caribbean Sea.

Session: Diel Fish Distribution and Abundance Comparisons

Thursday, November 19 — 14:40
Biscayne Ballroom

Diel Distribution and Abundance of Predators Among Seagrass and Mangrove Habitats in Biscayne Bay, Florida

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Mangrove and seagrass habitats are known nursery areas in tropical and subtropical marine ecosystems. Although commonly hypothesized that these habitats harbor lower abundances of predatory fishes, this assumption has been challenged with recent studies reporting abundant predatory fish assemblages and high predation rates. Predator assemblages in inshore tropical habitats likely remain underestimated and the species composition of these assemblages remains unclear. The predatory fish assemblage in subtropical Biscayne Bay, Florida was examined over 24-hr periods along a distance and habitat gradient from the nearshore (0–300 m) mangroves to the farshore (301–700 m) seagrass beds. The research specifically addressed the composition of fish predator assemblages and whether these assemblages changed at a given site over the sampling period. A total of 171 baited remote underwater video deployments (BRUVs) from August 27 to October 1, 2014, were examined to characterize the species composition, abundance, and individual sizes of the predatory fish assemblage. Results indicate that fish predator assemblages differed over both the sampling period and distance. Secondary and tertiary consumer abundances were highest during dawn and day and lowest at night. Tertiary consumer abundance was highest in the nearshore zone while secondary consumer abundance was highest in the farshore zone. Our results also indicate that the fish predator assemblage is not uniformly distributed over the seagrass bed. Thus, the degradation or loss of seagrass habitat along a distant gradient could differentially impact individual species abundances.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 14:20
Grove Ballroom

Shedding Light on Bioluminescent Symbioses: The Life History and Ecology of a Coral Reef Fish Host

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The highly cryptic cardinalfish *Siphamia tubifer* inhabits shallow coral reefs throughout the Indo-Pacific, making it an excellent model luminous fish to examine the host's ecology and life history in relation to its bioluminescent symbiosis. Using bacterially-emitted light, *S. tubifer* actively forages at night, and remains sheltered among the long spines of sea urchins during daylight hours. Aspects of the host's behavioral ecology, including homing, site fidelity, and olfactory preferences were described relative to the fish's symbiosis with luminous bacteria, as were the fish's diet, growth, and reproductive rates in Okinawa, Japan. Results indicate that *S. tubifer* can return to a home reef from at least 2 km, exhibits daily fidelity to a host urchin, and is attracted to the chemical cues of conspecifics and its luminous symbiont in seawater. The life history characteristics examined included growth, reproduction, and diet, and indicated that once settled, *S. tubifer* grows quickly, reproduces early, and typically survives much less than a year in Okinawa. These characteristics are similar to other small reef fishes, but they indicate that *S. tubifer* experiences unusually high mortality, probably due to predation, and they support the hypothesis that high predation rates have shaped the cryptic existence of *S. tubifer* as a nocturnally active, bioluminescent reef fish. This study provides the first detailed account of the life history and ecology of a bacterially luminous fish relative to its symbiosis.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 14:40
Grove Ballroom

Species-Specific Development of Retinal Architecture in Elopomorph Fishes: Adaptations for Harvesting Light in the Dark

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Elopomorph fishes are distinguished in part by a shared leptocephalus larval form. These glass-clear ribbon-like larvae are remarkably similar across the elopomorpha, yet they mature to radically different forms as adults. Along the timecourse of development, they transition through a variety of spectrally-distinct habitats, occupying very different niches as adults – some diurnal predators in high-light environments, others crepuscular, and others benthic and nocturnal. In concert with these changes, we found that the retinas of a variety of elopomorph fish change in similarly dramatic ways over the course of development. While the mature bonefish (*Albula vulpes*) retina is specialized for visual tasks in a high-light environment, the Atlantic tarpon (*Megalops atlanticus*) and ladyfish (*Elops saurus*) exhibit specializations for function at night or otherwise in very dim light conditions. These include stacked rod photoreceptors that are gathered into massive bundles, retinomotor movement of photoreceptor outer segments, and a highly reflective tapetum. The speckled worm eel maintains an all-rod retina in the adult form. The dramatic divergence among taxa over the course of development produces species with distinctly specialized visual capabilities. Moreover, the ability to change over the course of development may underlie the capacity for resilience in the face of anthropogenic insults including light pollution in increasingly developed coastal zones. On the other hand, if light can drive retinal change, exposure to artificial light at night may be detrimental to the survival of individuals that move between light-polluted and naturally dark locations.

ABSTRACTS

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 13:20
Grove Ballroom

Nocturnal and Crepuscular Behavior in Elasmobranchs: A Review of Habitat Use, Foraging, Reproduction, Abundance, and Movement in the Dark

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It is commonly believed that elasmobranchs (sharks, skates and rays) are most active during low-light periods (dawn, dusk, night). While many species of elasmobranchs possess sensory adaptations that could be advantageous for hunting prey during dark conditions, this assertion has not been critically evaluated, and it remains unknown how widespread nocturnal behaviors and activity may be in elasmobranchs. It is also unclear whether these times are utilized for the performance of important life-history events such as mating or pupping, which, if were the case, this time period would then be of crucial importance to the conservation of many imperiled elasmobranch species. Here we review and summarize previous studies on elasmobranch behavior during nocturnal and crepuscular periods focusing specifically on patterns of habitat use, movement, reproduction, abundance, feeding and predator-prey interactions. Where possible, we compare these activity patterns with daytime behaviors to assess whether activity is heightened during nocturnal or crepuscular periods. Taken together, we used these data to examine the scale and scope of studies that have been carried out on elasmobranch behavior during low-light periods and what this research has revealed. Finally, we identify gaps in our knowledge and present a set of research questions to assist the development of future studies.

Session: Nocturnal Fish Behavior and Ecology

Friday, November 20 — 11:00
Biscayne Ballroom

Diel Activity Patterns of a Marine Apex Predator (Tiger Shark, *Galeocerdo cuvier*) at a Protected Aggregation Site

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Predators can impact community structure and function through both consumptive and non-consumptive effects on their prey. Thus understanding the patterns and drivers of habitat use by predators are important in light of widespread population declines for many species. Such knowledge is particularly important in the case of aggregation sites where individuals may be vulnerable to exploitation or which can serve as critical protected areas. Sharks are commonly cited and generally considered to be more active during dawn and dusk periods, but few studies have empirically tested for diel patterns in shark habitat use and how this may differ based on various intrinsic biological and extrinsic environmental factors. Tiger sharks (*Galeocerdo cuvier*) are apex predators in temperate and tropical seas. In the western central Atlantic Ocean, there is a shallow-water aggregation site for females of this species on the little Bahama Bank, The Bahamas, nicknamed Tiger Beach. The area is a Shark Sanctuary, making it illegal to fish for sharks. Here, tiger sharks are provisioned year round by dive-tourists at spatially explicit sites; however, the potential influences of these activities on the daily behavior of the tiger sharks is not fully understood. In the present study, we used acoustic telemetry to examine diel patterns in habitat use of tiger sharks at Tiger Beach and relate them to biological factors such as size and life-stage and environmental factors such as tide, temperature and lunar phase. Further, we evaluated whether these patterns differed in areas used by dive tourists.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 19:20
Grove Ballroom

Video Observation and Sampling of Fish at Night: A Review of the Use, Challenges, Potential Solutions, and Future Research Requirements

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Diel activity patterns of fishes result in some commercial and recreational fishers actively targeting fishes at night. Whereas fisheries and biodiversity management are often spatially explicit it is equally important to understand diurnal and nocturnal habitat usage and to include temporal information for effective habitat management. Passive and active acoustics have been successfully used to track the movements of fish both during the daytime and at night and have given us valuable insights into fish movements at night. Because of the cost and invasive approach of active and passive acoustic monitoring, however, the numbers of fish and range of species tracked is limited. Baited remote underwater stereo video systems (stereo BRUVS), offer an alternative complementary approach. The addition of artificial lighting to such systems allows fish to be monitored at night, across a range of benthic habitats that may be inaccessible to sampling by fishing. Moreover, artificial lighting extends the use of stereo BRUVS to depths where natural light is inadequate for video recording of either diurnally or nocturnally active fishes. Many nocturnal and/or deep water fishes, however, have highly sensitive eyes and will both sense and respond to artificial lights. In this talk we review the visual sensitivities of fish at low light levels, and the implications for sampling and observing fish at night with cameras using artificial lighting. We will discuss the spectral range of light to which fish are most sensitive, and review the lighting systems that people are using with underwater cameras, and the behavioral reactions to lights that have been recorded. Where researchers are using baited cameras we question whether the use of bait will overcome the effect of artificial light. We suggest technical solutions to the problem of artificial lighting.

Session: Methods for Studying Fish in Darkness

Wednesday, November 18 — 18:40
Biscayne Ballroom

Peering Into the Dark Using Acoustic Telemetry

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The use of Acoustic Telemetry for studying fish behavior and movement has been growing at exponential rates for the past two decades. There now exist multiple organized telemetry networks worldwide with over 25,000 VEMCO acoustic telemetry receivers deployed. The tools and techniques used in acoustic telemetry are ideal for studying fish at night over long periods of time as they can operate autonomously. During this presentation, a VEMCO representative will provide an overview of how the technology has evolved from early beginnings with small scale active tracking to today's large scale multinational arrays. Additionally, we'll discuss the variety of applications for telemetry studies from survival studies to development of MPAs. Finally we'll take a look at latest technology developments including fine scale positioning, detecting predation events, expanding detections beyond fixed coastal arrays and miniaturization of transmitters.

ABSTRACTS

Session: Night Fishing, Fisheries, and Enforcement

Wednesday, November 18 — 17:20
Grove Ballroom

Comparative Experiment of Aggregation Light for Pacific Saury Fishery in Different Inclinations

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Pacific saury *Cololabis saira* is one of main fishing targets in the temperate waters of the northern Northwest Pacific Ocean, and fishing lamp lighting configuration is an important content of efficient fishing technology for saury fishery. Through the imitating experiment of the optical properties of lamp boxes, the paper structure the illuminate distribution models of saury aggregation lights using Matlab software and analyze the light illumination effects of fish aggregation lamp boxes under different inclination scenarios. The results show that, when the angle of fish aggregation lamp boxes was 45°, 60°, and 75°, the ground illumination of saury aggregation lamp boxes decreases as the increasing of ground distance, and there were significant differences between ground illumination distribution in different inclinations, the attenuation degree of illumination distribution also decreased with the increasing of light box angle. Significant difference on fluctuation of light field can be found between the illuminations under different inclinations. The fluctuation of light field for the illumination under 45° inclination was remarkable than those under 60° and 75° inclinations. The density of illumination isoline decreases as the increasing of inclination angles. When the angle of fish aggregation lamp box was 60°, the distribution of illumination and the fluctuation of light fields were relatively stable, and the larger area conducive to aggregating saury can be found.

Session: Diel Fish Distribution and Abundance Comparisons

Thursday, November 19 — 14:20
Biscayne Ballroom

The Effect of the Diel Cycle and Depth on a Warm-Temperate Rocky Reef Fish Community, South Africa

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Diel variation in fish assemblages has been documented at multiple marine habitats, however, possible fish movement patterns that drive these observed differences have received less attention. To investigate whether fish movement is a result of photic preferences alone, this study compared fish assemblages between day and night at multiple shallow photic (10–30 m) and deep aphotic (60–100 m) sites along two continuous and homogenous rocky reef habitats employing baited remote underwater stereo-video systems. Depth was found to have a significant effect on the observed assemblage with catfish (*Galeichthys* spp.) and small shoaling sparids (Sparidae) dominating the deep and shallow reefs, respectively. Diurnal and nocturnal assemblages were significantly different at the shallow photic zone, with richer assemblages, higher abundances and dominated by sparids, an important family in the commercial and recreational local line fisheries. In contrast, there was no significant difference between the diurnal and nocturnal assemblages in the deep aphotic zone. Many of the large top predatory sparids including *Chrysoblephus cristiceps*, *Polysteganus praeorbitalis* and an apex predator, *Petrus rupestris*, indicated a preference for light as these species were recorded only in the shallow depth zone during the day. In contrast, top predatory shark species, including *Mustelus mustelus*, *Triakis megalopterus* and *Squalus acanthias*, showed an opposite pattern which suggests their preference for low light conditions. The latter shark species were recorded in the deep aphotic zone at day and night, and at shallow reefs only at night, thus suggesting diel movement into the shallow depth zone in response to reduced ambient light.

Session: Methods for Studying Fish in Darkness

Wednesday, November 18 — 19:20
Biscayne Ballroom

Telemetry Tools Illuminate the Darkness

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Telemetry equipment collects data continuously making it possible to differentiate between nocturnal and diurnal behavior, collected data shedding light on movement patterns, inter-species and multi-species interactions, distribution and rates of motion, which, in turn, may be correlated to natural or anthropogenic influences. The equipment selection is broad; radio, acoustic, satellite and archival, with advantages and limitations associated with each equipment type. Ultimately, the research question, fish size, fish weight, environmental conditions and size of the study area will dictate the type of equipment most suited. Combined radio acoustic transmitters (CART) link fresh water and marine environments, ideal for diadromous species. Dual-mode acoustic transmitters link acoustic receiver brands with temperature, depth and motion sensors options and transmission rates as fast as 2 seconds. Acoustic systems are limited by the ability to monitor over large areas but are excellent in focused areas, such as reefs, near shore environments and near fishing vessels. Satellite and archival tags are more appropriate for collecting data over large geographical areas with tag retention and or tag retrieval being a limitation.

Session: Night Fishing, Fisheries, and Enforcement

Wednesday, November 18 — 16:00
Grove Ballroom

A Historical and Analytical Description of Catches in the South Florida Recreational Tournament Fishery for Broadbill Swordfish, *Xiphias gladius*

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Swordfish (*Xiphias gladius*) are increasingly sought worldwide by recreational anglers. The Florida Straits in particular are an important breeding and nursery area for North Atlantic swordfish, as well as historical fishing grounds for both recreational and commercial swordfish fisheries. In this analysis, the recreational fishery for swordfish in South Florida is categorized into two periods. The first (historic) period started in 1977 and includes the first tournaments to specifically target swordfish. Despite high initial catches, low catch numbers resulted in the demise of the tournament fishery by 1983. The second (modern) period, when recreational swordfish tournaments reemerged, began in 2000 and continues to the present day. Data from a total of 104 swordfish tournaments (17 historic, 81 modern) were contrasted and compared with information from 72 istiophorid billfish tournaments (all modern) in South Florida. These data were gathered from tournament directors, websites, and personal communication with participants, with supplementary data from the NOAA's Atlantic Highly Migratory Species (HMS) tournament registration and reporting program. The tournaments occurred in Florida from Stuart south to Key West, with most between Pompano Beach and Islamorada. Although participation correlated to catches, catch per hour (CPH) showed a slow decline over time. Despite the changes in CPH throughout the two periods, landed swordfish weights remained roughly the same, which may be due to the minimum length restrictions implemented in the modern period tournaments. The future of the nighttime recreational swordfish fishery is discussed within the context of newer, daytime targeting techniques.

ABSTRACTS

Session: Larval Fish at Night

Friday, November 20 — 09:20
Biscayne Ballroom

Estimation of Moonlight-Mediated Avoidance Functions for Larval Reef Fishes Captured with a Midwater Trawl

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Avoidance functions for larval reef fishes captured with a cobb-stauffer mid-water trawl in Hawaii were modeled using catch data compared to larval abundances generated from a computer simulation of a dynamic larval pool. The virtual larval pool was sampled at the same time/space strata as the trawl surveys. A generalized additive model (GAM) was used to mimic the capture process using a suite of environmental covariates. GAM functions based on moon-phase and moon-angle were found to be statistically significant and of the expected form to characterize patterns of visual avoidance of the towed gear. This approach will be useful to quantify larval fish catches from this gear as well as help better understand larval transport and settlement dynamics in Hawaiian waters.

Session: Nocturnal Fish Behavior and Ecology

Wednesday, November 18 — 16:00
Biscayne Ballroom

Beneath a Moonless Sky: Nocturnal, New Moon Spawning in Atlantic Goliath Grouper, *Epinephelus itajara* (Lichtenstein, 1822)

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The timing, diel and lunar, of reef fish spawning is often highly specific. All evidence indicates that Atlantic Goliath Grouper, *Epinephelus itajara*, spawn at night, predominantly during the new moon period. Evidence for night spawning comes from: (1) documentation of night-time calls combined with night-time vertical ascents by acoustically tagged Goliath Grouper on spawning sites, (2) one observation of an early-evening spawning ascent—a presumptive female, followed by two presumptive males, rapidly ascended about 25 m, and a presumptive sperm cloud was observed at the apex of the ascent, and (3) collection of Goliath Grouper eggs (genetically verified) at night downstream from spawning sites. Conversely, we did not observe a single daytime spawning event after thousands of hours of daytime observation of Goliath Grouper on spawning sites on over twenty spawning seasons (1994–2014). New moon spawning was inferred from: (1) maximal night-time calling on new moon nights, minimal calling on full moon nights—these calls occurred only on spawning sites and only during the spawning season, and (2) ovarian biopsies of Goliath Grouper captured on spawning sites had significantly higher frequencies of both postovulatory follicles (POFs) and hydrated oocytes on new moon relative to full moon periods. We suggest that dark-night spawning is an adaptation to minimizing egg predation by scad and herring which are abundant on Goliath Grouper spawning sites. The significance of the late summer-early fall spawning season is also discussed.

Session: Human Threats to Fish at Night

Thursday, November 19 — 17:00
Biscayne Ballroom

Circadian Rhythms of Retinomotor Movement in the Atlantic Tarpon, *Megalops atlanticus*

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Light is a critically important environmental variable in the lives of marine organisms. It affects physiology and behavior acutely, and can also have long-term effects on immune function, daily biological rhythms, seasonal reproduction and longevity. In unpolluted natural environments, the daily light-dark cycle is a reliable environmental cue, but with today's rapid coastal development, light pollution is an increasingly serious threat to living things. This research aims to shed insight on these issues by examining clock operation in the Atlantic tarpon (*Megalops atlanticus*), one of the most sought-after game fish. We have determined that tarpon begin life with rod-dominated retinas, and then add cone photoreceptors at key life transitions. Furthermore, photoreceptors undergo daily changes in position within the retina according to time of day. The development of these retinomotor movements is part of a suite of changes that occur over the course of the day and over the course of the lifetime. These dramatic changes in retinal form and function support transition among habitats, and may enhance survival in the face of anthropogenic disturbance that alters light quality. Abnormally-timed light exposure (such as artificial light at night) may disrupt these rhythms and affect behaviors essential to survival, such as prey capture, predator avoidance, and spawning. Therefore, determining how the tarpon's retina and internal clock(s) respond to alterations to the natural daily light-dark cycle is an essential step in linking what we already know about mechanisms of retinal change with the reasons why change is important in the natural world.

Session: Larval Fish at Night

Friday, November 20 — 10:40
Biscayne Ballroom

An Affordable, Simplistic, and Efficient Light Trap for Capturing Healthy Settlement Stage Marine Larval Fish

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Light trapping is a proven method for sampling marine fish postlarvae in tropical regions around the world. The concept is simple: create a gradient of light that directs phototactic larvae into a trap from which they have difficulty escaping. As such there are a myriad of different plans and styles that have been published but very few are cost effective and still fewer are easy to transport. As many field sites are in remote areas, space and weight are often at a premium, and custom supplies are hard to come by so using standard materials such as PVC and cable ties is an advantage. Here we describe how to construct a portable, economic, and efficient light trap using any long-lasting dive light, schedule 40 PVC, insect netting, cable ties, and clear plastic solo cups. We caught >1000 larvae from >10 different species over 5 nights of sampling in the northern Exuma islands of The Bahamas. Almost all fish were retrieved alive, and in adequate health for ecological experimentation. Teen learners were engaged as part of the construction design process, which demonstrated the viability of such exciting and thought provoking work within the classroom.

ABSTRACTS

Session: Nocturnal Fish Behavior and Ecology

Wednesday, November 18 — 16:20
Biscayne Ballroom

When is the Witching Hour?: Activity Patterns in Satellite-Tagged Lake Sturgeon (*Acipenser fulvescens*)

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Lake sturgeons are large, charismatic, slow-growing and long-lived members of the Great Lakes Basin. Unfortunately, they are also threatened or endangered across 95% of their range. Surprisingly little is known about the basic ecology of lake sturgeon, including their diel activity patterns and how far they migrate to spawn, which hinders recovery efforts. During the late spring of 2014, 45 lake sturgeons were captured and fitted with Argos satellite tags near spawning grounds in the Lower Niagra River. The topological characteristics of the area proved challenging for accurately georeferencing the fish, but the built in accelerometer data let us describe activity patterns during the night and day. Using a subset of 12 recovered tags, we built up a baseline of sturgeon swimming behavior that we used to classify when fish were actively swimming or foraging. We then applied this baseline to describe when the population was most active, and correlations between the physical environment and activity. Lake sturgeon were most active in the evening with a significant peak at 8PM (Rayleigh's test; $Z = 39$; $P < 0.001$). In addition, we present on a few case studies including fish that displayed regular mid-afternoon porpoising behavior, and sustained swimming during long-distance migration between spawning and feeding grounds. These data are an important first step towards potentially describing sturgeon connectivity in the Great Lakes Basin.

Session: Nocturnal Fish Behavior and Ecology

Friday, November 20 — 10:20
Biscayne Ballroom

Fish Eggs at Night in the Colombian Pacific Ocean: First Approach

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Evaluations of ichthyoplankton (fish eggs and larvae) are important in ecological studies and fisheries prospections, since help to define periods and breeding areas, and because such early stages are a key link within the trophic web of zooplankton and upper levels. For assessing the distribution and abundance of fish eggs in September 2007 along the Colombian Pacific Ocean (CPO), zooplankton was collected by oblique tows to 184 m mean depth with a 60-cm bongo sampler (294- and 520-Qm mesh). The abundances reached 53382/100 m^3 in the first net and 631/100 m^3 in the second one. The largest aggregations in the neritic south area of the CPO can be associated with spawning of fish stocks, high productivity, and the proximity of mangrove swamps, which are spawning and nursery grounds. The highest abundances in ocean waters could be partially explained by transport and retention processes, as an effect of the complex system of currents in the CPO. Considering both nets, diel variation was not wide (day 2476/100 m^3 vs night 2200/100 m^3), suggesting continuous spawning, although many fish have higher spawning at night to avoid predators. Surface water temperature and salinity did not appear to play a significant role on distribution and abundance of eggs. This scenario can change, depending on the sampling month, fish species and the reproductive mode and location and extent of spawning grounds, and because fish spawning behavior is dictated by photoperiod (length of daylight).

Session: Larval Fish at Night

Wednesday, November 18 — 14:40
Biscayne Ballroom

Faunal Composition and Distribution of Pelagic Larval Flatfishes (Teleostei: Pleuronectiformes) in the Northern Gulf of Mexico: Connectivity between Coastal and Oceanic Epipelagic Ecosystems

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Pleuronectiformes (flatfishes) occur throughout the global oceans, and have high ecological and commercial importance in some areas. Though much is known regarding life history, abundance, and distribution for the benthic adult stages of flatfish species, much less is known about the pelagic larval phases of flatfishes in the open ocean. Taxonomic uncertainty and limited sampling in the oceanic Gulf of Mexico have led to data gaps with respect to the distribution of early life history stage flatfishes in this region. Pleuronectiform specimens collected during seven cruises in the northern Gulf of Mexico from 2010 to 2011, as part of the Offshore Nekton Sampling and Analysis Program, were quantified and identified to lowest taxonomic category. Results of the first large-scale distributional analysis of larval Pleuronectiformes in this region will be presented, demonstrating how larval flatfishes are a consistent component of the oceanic ichthyofaunal composition. During the M/V Meg Skansi 7 survey, 467 flatfish specimens were collected, representing four families and ten genera. Species composition was dominated by Bothus spp., which increased in abundance more than two-fold from day to night, and had a high percent frequency in the epipelagic zone, occurring in 78% of all night and 61% of all day trawls. Trichopsetta ventralis and Citharichthys spp. were the second- and third-most abundant taxa, respectively. In regards to vertical distribution, discrete-depth sampling revealed that 87% of individuals collected occurred between 0 and 200 m, 7% between 200 and 1000 m, and 6% between 1000 and 1500 m.

Session: Deep and Polar Sea ("Perpetual Night") Fish and Fisheries

Wednesday, November 18 — 14:40
Grove Ballroom

Reproductive Ecology of Dragonfishes (Family: Stomiidae), the Dominant Vertically Migrating Mesopelagic Predators, in the Gulf of Mexico

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Diel vertical migration is one of the prevailing fish behaviors in oceanic waters. Of the vertically migrating species, the dragonfishes (Stomiidae) are the dominant mesopelagic predators, preying primarily upon lanternfishes, which are the major zooplanktivorous migrators. While aspects of dragonfish feeding ecology have been quantified, little is known regarding their reproductive characteristics and production rate. In 2010–2011, a large-scale sampling program was initiated in the northern Gulf of Mexico over all four seasons using a discrete-depth sampling system and a large, commercial-sized midwater trawl. Of the dragonfishes collected on these cruises, gonads were dissected from 710 individuals belonging to 45 species. A gross examination of the gonads was performed using a visual, macroscopic assessment, as well as a microscopic, histological approach using hematoxylin and eosin stains. Using these methods, we will present data on size at first reproduction, sex ratios, hermaphroditism, and seasonality of production of the 13 dominant species collected. These data are essential for ecosystem-based modeling of global deep-pelagic ecosystems, which contain the overwhelming majority of earth's fish biomass.

ABSTRACTS

Session: Diel Fish Distribution and Abundance Comparisons

Thursday, November 19 — 14:00
Biscayne Ballroom

Diel Differences in Dermersal Ichthyofaunal Assemblages in the Northern Gulf of Mexico

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Although diel turnover of reef-fish assemblages has been generally well documented, much less is known regarding diel dynamics of demersal fish communities along the U.S. Gulf of Mexico continental shelf. We analyzed trawl data collected as part of the Gulf of Mexico Southeast Area Monitoring and Assessment Program (SEAMAP) to document diel changes in fish abundance. Trawling operations were conducted day and night in neritic waters from Florida to Texas. All types of sampling gear have limitations and biases, and trawl gear typically collects smaller individuals and species that are found near the bottom and are unable to avoid the net. Numerous schooling species (e.g., engraulids, clupeids, carangids) were much more abundant during daylight hours, suggesting school dispersal or upward movement in the water column at night. Many species which burrow into the substrate or move into structural habitats during the day (e.g., ophidiids, eels, haemulids, flatfish) were more abundant at night, although these patterns may also be partially attributable to gear avoidance during daylight hours. Interestingly, there are several examples of contrasting diel trends among closely related species, which may indicate temporal resource partitioning among otherwise ecologically similar fishes. In this presentation, we will document strong diel trends in the SEAMAP trawl data and interpret these trends based on current understanding of the behavior of species and species groups.

Session: Nocturnal Fish Behavior and Ecology

Wednesday, November 18 — 17:00
Biscayne Ballroom

Diel Activity Patterns of the Indo-Pacific Lionfish (*Pterios volitans*) in the Florida Keys through Use of Acoustic Telemetry

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The use of passive acoustic telemetry has become increasingly prevalent in the study of temporal movement patterns of marine fishes. This allows researchers to collect information on fish activity at times of day when researchers may be unable to effectively study them, namely twilight and night. The invasion of the Indo Pacific lionfish (*Pterois volitans*) throughout the Caribbean and southeast Atlantic represents a significant threat to local ecosystems, yet few studies have examined the daily movement patterns of lionfish. We used acoustic telemetry to track lionfish movements across various habitats within the Florida Keys. Seventeen lionfish were tagged between five habitats. The total detection period for tagged fish ranged from 1 to 136 days, and tagged fish had a mean residency index of 0.83 3 0.07. A significant difference in residence index was observed between the sampled habitats. Hourly detection data revealed diel activity patterns with peaks at dawn and dusk. Analysis of detection data showed highly significant effects of time of day (TOD) and the interaction of TOD*Habitat. Mean detections per hour were greatest at twilight, however, this effect was not consistent across habitats. These results support observations that lionfish are most active at dawn and dusk when they are foraging. These findings will prove useful to fishery managers developing lionfish control strategies, especially the use of localized lionfish removals.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 13:40
Grove Ballroom

Notes on the Crepuscular Activity of Sandbar Sharks (*Carcharhinus plumbeus*) and Habitat Use by Tiger Sharks (*Galeocerdo cuvier*) at Honokohau Harbor, Hawaii

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A series of dives were performed in a popular foraging area for both sandbar and tiger sharks. Metadata from the resulting photographs showed the time of encounter for each of the species of interest. Images of tiger sharks were used in a photo-id study to identify 22 animals that used this habitat for foraging purposes. Many of the sharks returned to this area many times throughout the study with one animal being observed 3 times throughout the summer of 2015. These data show that tiger sharks actively forage in the area throughout the day while the foraging behavior of sandbar sharks is restricted to the late evening hours.

Session: Methods for Studying Fish in Darkness

Thursday, November 19 — 19:20
Biscayne Ballroom

Diving in to Pelagic Diversity

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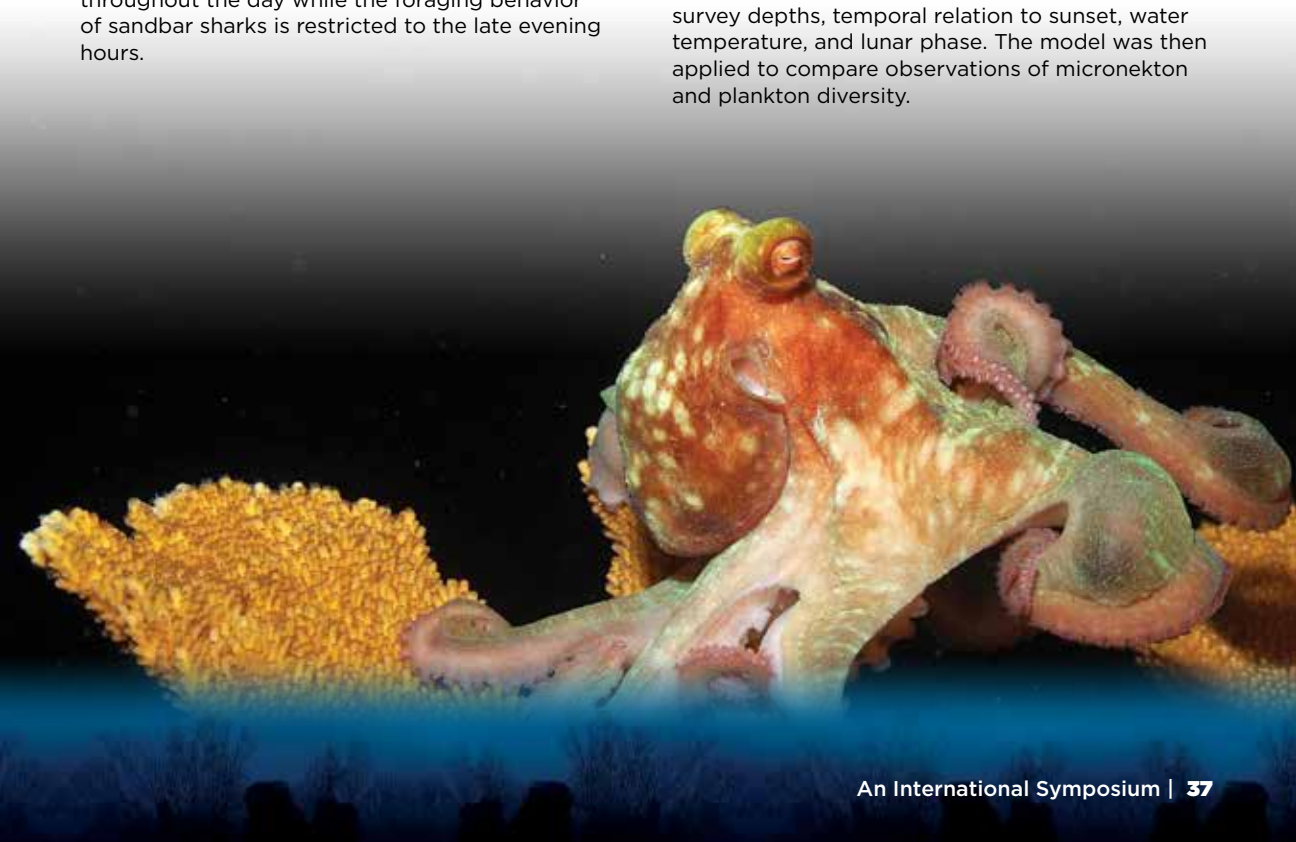
The epipelagic ocean is the largest environment in the world and yet researchers have yet to accurately estimate the true biodiversity. Salps, ctenophores, siphonophores, and larval fish, four of the most common groups of pelagic animals, are usually missed by traditional study methods. This study used novel, in-situ, observational methodology to develop a baseline for pelagic diversity offshore from Kona, Hawaii. Fifty-three drifting pelagic night dives (termed “blackwater”) were each divided into four 15-minute quadrants and surveyed for 5 of those 15 minutes. Biological community data were compared against environmental data to produce a series of regressions that were combined into a generalized additive model. This model predicted pelagic diversity deviations in response to bathymetry, survey depths, temporal relation to sunset, water temperature, and lunar phase. The model was then applied to compare observations of micronekton and plankton diversity.



ABSTRACTS

Session: Methods for Studying Fish in Darkness

Wednesday, November 18 — 18:20
Biscayne Ballroom

The Portal Advantage

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Researchers today have ever increasing requirements to preserve their data and to make re-sults accessible to collaborators and the general public. Knowing the growing importance of data security and data sharing, Wildlife Computers has made available a cloud-based Data Portal. Through an in-depth look at a recent study on Southern Bluefin Tuna, we will demonstrate the features of the Data Portal and its benefit to the research team.

Session: Diel Fish Distribution and Abundance Comparisons

Thursday, November 19 — 13:20
Biscayne Ballroom

Diel Catch Rate Differences of Fish Captured in the Gulf of Mexico Pelagic Longline Fishery

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Bycatch has been and continues to be a pressing problem in fisheries around the globe. The time (of day) that a fishery operates can have substantial effects on the types and quantities of species encountered, whether they are targeted or caught unintentionally. We compared diel catch rates in the U.S. Atlantic pelagic longline fishery to gain insight into the catch-bycatch trade-offs associated with day or night commercial fishing. Specifically, we compared catch rates between sets which had soak times primarily during daylight or nighttime in the Gulf of Mexico. To test for diel catch rate differences, we examined 30 species/species groups using a generalized linear mixed model with a negative binomial distribution, which accounted for operational and environmental covariates including: year, water temperature, season, hook type, bait, and maximum hook depth. Yellowfin and skipjack tuna, lancetfish, wahoo, dolphin, rays, white marlin, blue marlin, and sailfish all exhibited significantly higher catch rates for sets with a daytime soak, while thresher shark, bigeye tuna, bigeye thresher shark, tiger shark, oilfish, pomfret, silky shark, escolar, and swordfish had a significantly higher catch rate at night. In addition, we tested the nighttime sets for a moon effect on catch rates. No significant diel differences were found for key conservation priorities such as sea turtles and marine mammals. However, for other conservation priorities such as billfishes it might be possible to reduce bycatch by shifting fishing to nighttime sets though this could come at a cost to targeted yellowfin tuna.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 19:00
Grove Ballroom

Use of Underwater Soundscapes to Characterize Nocturnal Fish Behavior and Habitat Use Within a Complex Mosaic of Estuarine Habitats

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Structurally complex estuarine habitats such as seagrass beds, salt marshes, and oyster reefs are used by fish for foraging, avoiding predators, and spawning. These habitats often occur as a complex mosaic of all three habitat types, and sampling fish within them, and particularly at night, is difficult with traditional sampling gear such as trawls and throw traps. Underwater acoustic recordings may provide a cost-effective and non-invasive approach to monitor fish habitat use. This study characterized spatiotemporal dynamics of the soundscape in a mosaic of estuarine habitat types within a coastal reserve in North Carolina, USA, and the potential processes underlying those patterns. Passive acoustic recorders were deployed at eight sites in the reserve, and sampled over three months during summer 2014. This study revealed that spawning activity was variable within the reserve and identified the interacting roles of nighttime and tidal phase on fish behavior and habitat use. Species-specific fish chorusing was present at sites adjacent to deeper channels and the outer edge of the reserve during nighttime high tides. Silver perch produced spawning sounds primarily during slack high tide through the first hours of ebb tide, only at night. Oyster toadfish chorusing was most active at night and during a 2-hour period bracketing high tide. Chorusing by other sciaenids, including spotted seatrout, peaked at dusk, throughout most of the tidal cycle, excluding low tides. This study highlights the value of using soundscape characterization, especially at night, to better capture patterns of fish activity in estuarine habitats.

Session: Deep and Polar Sea ("Perpetual Night") Fish and Fisheries

Wednesday, November 18 — 15:00
Grove Ballroom

Diving Into the Deep-End: Baited Remote Underwater Video Stations (BRUVS) to Study Deep-Reef Fish Communities in the Great Barrier Reef, Australia

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Underwater video has great utility to study harder to sample areas such as deeper reefs. Baited Remote Underwater Video Stations (BRUVS) and multi-beam bathymetry were used to investigate deep-reef fish communities off the continental slope in the Great Barrier Reef, Australia. BRUVS were deployed between 50–300 m in three depth categories (Deep-Shallow, Deep-Mid and Deep-Deep), and fish species richness and diversity were recorded using Australian Institute of Marine Science (AIMS) software. There were significant differences in fish assemblages across depths, with different dominant families and groups of species characterizing each category. For the particular reefs studied, multi-beam habitat derivatives such as depth, rugosity and slope were correlated with higher species diversity and greater abundance. Longer deployments than typical shallow-water BRUVS deployments were required to maximize fish sampled below 200 m. This study resulted in novel records for fish species recorded elsewhere in the Indo-Pacific at similar depths, new depth records of known species in the GBR, and also identified potential new species. BRUVS have proved useful as a fishery-independent method to survey fish communities, to identify potential "hot-spots" of biological diversity and new species, and to explore surprisingly diverse deep reefs.

ABSTRACTS

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 14:00
Grove Ballroom

Gnathids at Night: Ecology of Interactions Between Mobile Ectoparasitic Isopods and Coral Reef Fishes

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Although parasites dominate biodiversity in coral reef environments, they are typically ignored in studies of reef ecology. Parasites can influence reef community structure and function through direct effects on host behavior and physiology, or indirectly through their role as vectors of disease, contribution to trophic connectivity, and mediators of other symbiotic interactions. They can also play a major role in the success of invasive species. Gnathiid isopods are highly mobile ectoparasites and micropredators that infest a wide range of fishes in reef and associated habitats. Because they are active primarily at night and during crepuscular periods, they can have a strong influence and can be strongly influenced by the activities of fishes during these periods. Over the past 20 years, our research team has investigated multiple aspects of parasite-host ecology in coral reef and associated ecosystems with a focus on nocturnally-active gnathiid isopods and their reef-fish hosts. A summary of our key findings to date will be presented, including documentation of predation on gnathiids by nocturnal fishes, nocturnal predation of gnathiids on settlement stage fishes, the potential impact of gnathiids on nocturnal migratory behavior in reef fishes, and the role of gnathiids in trophic connectivity via nocturnal-migratory fish species.

Session: Methods for Studying Fish in Darkness

Thursday, November 19 — 18:40
Biscayne Ballroom

Acoustic Estimation of the Nycthermal Variability, of Pelagic Ichthofauna and Plankton Abundance in the Bay of Biscay: Application to Fisheries Resources Assessment and Ecosystemic Management

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Anchovy (*Engraulis encrasicolus*) is one of the main commercial species in the Bay of Biscay. Anchovy biomass estimation is calculated annually from two different surveys, an acoustic survey and a survey based on the Daily Egg Production Method (DEPM). The objective of this project was the development of a methodology for acoustic estimation of abundance of Bay of Biscay anchovy and sardine using the acoustic data collected in the DEPM survey. These data differ from the typical acoustic data for abundance estimation in several aspects, being the most important one that they were collected 24 hours a day. Therefore, about half of the acoustic data were collected during the night, when schooling aggregations disappear and fishes disperse increasing the difficulty of discriminating them from the plankton. Therefore, for the species discrimination, in addition to the typical pelagic trawls, a mask based on the different frequency response of different organisms was configured and applied to separate acoustic echoes in three coarse taxonomic groups: fish (with and without swimbladder), “fluid-like” plankton (euphausiids, copepods, salps, siphonophores without gas inclusion and other large crustacean zooplankton) and others (mainly fish larvae and gelatinous and gas-bearing siphonophores). The work was based on the data of year 2012. Although this is a work in progress and the methodology is far from being completed and validated, the results obtained were promising and consistent with the Bay of Biscay anchovy biomass assessment in 2012.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 18:20
Grove Ballroom

Nocturnal Patterns in Fish Chorusing in the South Atlantic Bight

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Fish chorusing is a major component of the marine acoustic environment, and much of this chorusing activity happens at night. These nocturnal sounds are commonly associated with reproductive behavior. For these nocturnal species, there is a limited time window for critical behaviors, and competition to be heard by conspecifics likely increases. Using passive acoustic recording units distributed in the nearshore waters of the South Atlantic Bight, we evaluated the frequency space and temporal activity of nocturnal fish chorusing, and how these sounds contribute to the overall soundscape. We identified spatial and temporal patterns of calling for several species of sonic fish through spectrographic analysis. The nocturnal acoustic scene was dominated by black drum and toadfish, but the calls of many other species (primarily sciaenids) also occur. We examined the acoustic indices of acoustic richness and acoustic diversity to compare nocturnal and diurnal fish calling activity. When sustained fish chorusing activity increases, acoustic diversity decreases but acoustic richness increases. With the differences in composition of nocturnally- and diurnally-active species groups, the acoustic environment at night is different than during the day. Passive acoustic surveys represent an exciting approach to understand the nocturnal behavior and reproductive activity of coastal fishes.

Session: Nocturnal Fish Behavior and Ecology

Thursday, November 19 — 18:40
Grove Ballroom

Passive Acoustic Monitoring of Nocturnal Fish Sounds in Quintana Roo, Mexico

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Passive Acoustic Monitoring provides a long-term stream of continuous data, including throughout the night, because it does not require light to operate, can be autonomous, and is relatively low cost. In the present study, Passive Acoustic Monitoring using an Ecological Acoustic Recorder was conducted for one year off the coast of Quintana Roo, Mexico just north of Isla Mujeres, collecting the first data on fish sound production at night in this region. Pulsed fish sounds were a major contributor to the soundscape and were persistent (present in 88% of recording samples) and low frequency (100–1000 Hz). Many of the sounds were attributed to Bluestriped grunts (*Haemulon sciurus*). Some recording periods were dominated by anthropogenic noise. Boat motor noise contributed to higher SPL during the day than in the night and contributed to noise between 500 Hz – 25 kHz, which is consistent with small vessels. While boat motor noise was not as frequent as fish sounds, when present it potentially overwhelms the natural soundscape. The diel patterns of boats may be impacting the patterns of fish activity. Anthropogenic characteristics of this soundscape have implications for regulations in the nearby marine protected areas.

ABSTRACTS

Session: Larval Fish at Night

Wednesday, November 18 — 14:20
Biscayne Ballroom

First Evidence of Fish Larvae Producing Sounds at Night

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The acoustic ecology of marine fishes has traditionally focused on adult fishes, which produce sounds to find mates, defend territories, or startle predators. While larval fish may listen to acoustic signals to navigate, the possibility that fishes in the early life history stages could also produce sounds has been overlooked. Here we document the first acoustic recordings of pre-settlement stage gray snapper larvae (*Lutjanus griseus*). Through a combination of in situ and unprovoked laboratory recordings, we found that *L. griseus* larvae produce "knock" and "growl" sounds that are spectrally and temporally similar to sounds produced by adults. The fish larvae only produced sounds at night. While the exact function and physiological mechanisms of sound production in fish larvae are unknown, we suggest that these sounds may enable snapper larvae to maintain group cohesion at night when visual cues are reduced. We show for the first time that fish larvae are not just listeners, which opens the door for further research into the acoustic ecology of small pelagic organisms.

Session: Nocturnal Fish Behavior and Ecology

Wednesday, November 18 — 16:40
Biscayne Ballroom

Investigating Nassau Grouper Spawning Aggregations in the Bahamas

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The Nassau Grouper, *Epinephelus striatus*, was once one of the most important fishery species in the wider Caribbean, but due to heavy overexploitation is now endangered and in decline throughout most of its native range. Over winter full moons, the formation of annual transient fish spawning aggregations at known locations makes this iconic species particularly vulnerable to overfishing. Recent telemetry research in The Bahamas has shown that Nassau Grouper can migrate up to hundreds of miles along shelf edges to the same aggregation sites year after year. Up to 30 historical aggregation sites have been reported in The Bahamas, though mostly through anecdotal information and local knowledge. Very few have been described in the scientific literature, and whether or not many of these locations still support active aggregations has only been minimally investigated. Based on previous work, we have designed a new study that uses advanced acoustic telemetry, combined with diver surveys, molecular analyses, and bathymetric mapping to investigate the (1) the spatial and temporal dynamics of migrations to, from and within Nassau grouper spawning aggregations; (2) spawning stock size estimates; (3) population structure and connectivity; and (4) reproductive output among aggregation sites within The Bahamas. Results will be used to inform science-based adaptive management of this ecologically and economically important species. Here, we report on initial telemetry and diver survey data from the 2014/2015 winter spawning season.

Session: Deep and Polar Sea ("Perpetual Night") Fish and Fisheries

Wednesday, November 18 — 14:00
Grove Ballroom

Understanding Deep-Pelagic Ecosystem Dynamics: A New Research Initiative in the Gulf of Mexico (DEEPEND)

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The Deepwater Horizon oil spill has demonstrated a worst-case scenario oil disaster at great depths, while also highlighting the paucity of baseline data for deep-ocean ecosystems in general. Without such data, and information on the drivers of natural variability in these systems, impacts from these activities are difficult or impossible to assess. Here we introduce a new research initiative, DEEPEND (Deep-Pelagic Nekton Dynamics of the Gulf of Mexico), whose mission will be to characterize the oceanic ecosystems of the Gulf of Mexico to infer baseline biophysical conditions in the water column. This information will establish a time-series with which natural and anthropogenic changes can be detected. The DEEPEND Consortium will conduct a 3-year (2015–2017) sampling and analysis program that will focus on short-term (sub-generational) and long-term (evolutionary) timescales to appraise the dynamic nature of communities using a suite of integrated approaches. These investigations include: (1) a direct assessment (taxonomic and genetic) of GoM deep-pelagic community structure, from microbes to nekton, with simultaneous investigation of the physical and biological drivers of this structure; (2) examination of the patterns of deep-scattering layer distributions in response to time (day vs. night) and oceanographic conditions; (3) a time-series analysis/modeling of biophysical data from 2010–2017; (4) a time-series examination of differences in genetic diversity among key species; (5) biogeochemical assays of the effect of DWHOS on shallow- and deep-pelagic biota (otolith microchemistry and whole-body PAH analyses); and (6) traditional and isotope-based trophic analyses to examine the primary vectors in a food web context.

ABSTRACTS

Session: Human Threats to Fish at Night

Thursday, November 19 — 17:20
Biscayne Ballroom

Different Forms of Coastal Light Pollution Alter the Nocturnal Behaviour of Juvenile Bonefish (*Albula vulpes*)

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Light pollution is a prevalent but often overlooked ecological concern in a variety of ecosystems. Although most research to date has focused on the effects of ecological light pollution on terrestrial animals, and to some extent freshwater animals, very little research has focused on coastal marine animals. Marine environments are subjected to lighting from coastal development, as well as lighting from offshore sources such as fishing vessels, oil platforms and cruise ships. Species that rely on nearshore habitats get very little respite from coastal development and inefficient lighting; juvenile life stages are particularly susceptible as they are often limited to nearshore habitats due to predation risk. Juvenile bonefish are one such species which rely on nearshore habitats, and are therefore directly subjected to coastal lighting and development. In Florida, the adult bonefish population is designated as 'near-threatened' by the IUCN, with their population in decline. Additionally, exhaustive efforts to locate juvenile bonefish along the Florida coastline have been met with little success over the past two decades, although they are still found along the far-less developed shorelines of Eleuthera, The Bahamas. This research attempts to determine whether there are changes to juvenile bonefish activity in the presence of two common light sources; constant street lighting (high pressure sodium) and intermittent car headlights (H4 halogen). The results from this research could shed some light on the disparities in juvenile bonefish populations between the Florida coastline and Eleuthera and offer suggestions for more efficient lighting techniques.

Session: Nocturnal Fish Behavior and Ecology

Wednesday, November 18 — 17:20
Biscayne Ballroom

Remotely Sensing the Halo Effect: Mapping Nocturnal Foraging Migrations and Habitat Connectivity in Coral Reefs Using Sonar

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Coral reef fishes rely on a mosaic of habitat types for survival, feeding and growth. Several species use reefs as resting refugia during the day and migrate off reef at dusk or dawn onto adjacent habitats for foraging. Direct visual observations of these behavioral patterns is challenging, especially under low light conditions. Remote sensing using underwater acoustics provides one of the few tools that can document movements of fishes between habitats. We conducted repeated surveys over coral reef systems in the US Caribbean using split-beam fishery echosounders to map the changes in distribution and biomass of fish over diurnal and crepuscular periods. While species identification is not possible using fishery echosounders alone, changes in biomass distribution is interpreted as a line of evidence for migration from reefs to adjacent habitat types by a large guild of reef fishes. When benthic vegetation was present, the vast majority of fish biomass was observed extending over vegetated habitats and much less so over nonvegetated sediments. The extent of spreading in biomass away from reefs exceeded several hundred meters over adjacent habitats and corroborates patterns of daily migrations of individual fish from tag telemetry studies. These data contribute to models of habitat connectivity and energy transfer in coral reef ecosystems as well as emphasizing the importance of considering arrangement of habitats in marine reserve design and ecosystem management plans.

Session: Night Fishing, Fisheries, and Enforcement

Wednesday, November 18 — 17:00
Grove Ballroom

In the Dark: Challenges of Using Electronic Monitoring to Monitor Fisheries at Night

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The National Marine Fisheries Service (NMFS) and the North Pacific Fishery Management Council are on a path to integrate electronic monitoring (EM) technology into the North Pacific fisheries monitoring program in-lieu of observers onboard small catcher vessels where placing an observer is logistically difficult. The Council's objective is to implement EM systems to collect images of catch to provide scientific data that can be used to estimate discard. In an effort to evaluate the efficacy and inform implementation EM systems have been deployed in 2014 and 2015 among volunteer vessels. Research and development of new technologies is also in progress to help address challenges for using EM to collect scientific data. One of the challenges identified in testing is that image quality can be greatly compromised during night fishing due to light glare and weather. This is especially concerning for many fisheries in the North Pacific operating during times of the year when daylight is very short. Problems encountered with EM during daylight fishing such as species identification and length estimation, two current goals of the North Pacific EM research, tend to be exacerbated by the night time environment. By leveraging the latest development in camera technology and computer vision may offer potential solutions. The Observer program at Alaska Fisheries Science Center are developing an EM system that incorporates an infrared (IR) camera paired with color camera with high dynamic range. Initial testing indicate that these systems could greatly improve our ability to monitor fisheries operating at night.

Session: Methods for Studying Fish in Darkness

Thursday, November 19 — 19:00
Biscayne Ballroom

Investigating the Effects of Light Colour on Fish Assemblages Observed at Night Via Baited Video

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Video systems such as BRUVS (Baited Remote Underwater Video Stations) are potentially useful for assessing fish assemblages at night. They can be used to assess fish behavior as well as provide estimates of abundance and diversity. One of the challenges of using a visual medium at night is having adequate illumination and minimizing the potential biases each light source may have. Our study compared two light colors, red and blue, within a range of habitats to further quantify the effects of light color on fish assemblages recorded at night. Red was selected as it is theorized to be below the threshold of visibility for many fish species due to its fast retention in the water column, whereas blue was chosen because previous studies have suggested that it provides a bigger area of illumination without reflection issues caused by white light, thus making identification easier. The study was conducted in seagrass, bare substrate, shipwrecks, and in a range of protection levels, providing insights into how the effects of light color are influenced by these factors. The results from this study will allow for more informed decision-making in regards to light color and the effect it has on fish assemblages observed. Our study found some differences in the assemblages observed between light colors along with differences in how the light interacted with the water turbidity. Overall, it was found that BRUVS was a suitable method for assessing fish assemblages at night with multiple species seen from both light colors.

Fish at Night Film Festival

The *Bulletin of Marine Science* is proud to partner with Beneath the Waves, Inc., a global platform for ocean conservation, education, and discovery. Their mission is to raise awareness regarding critical marine issues, foster the advancement of science, and promote the protection of our oceans.

For the first time, Beneath the Waves is hosting a special film festival showcasing films about night-time ocean science and ocean adventures. Have you been in the ocean at night and seen something remarkable? Have you attempted to study the behavior of a marine creature in the darkness? We want to hear your stories! To learn more, go to http://beneaththewaves.org.

Film Festival Program

Thursday, November 19th, 2015, 20:00
Biscayne Ballroom

Chisembe: Shadow Hunters of the Malawi
Filmmaker: Matt Arnegard

Squidilicious 2
Filmmaker: Gary Hawkins

Discovering the Abyss
Filmmaker: Gritta Veit-Köhler

Night of the Mobulas
Filmmaker: Julie Ouimet

Ripple
Filmmaker: Jennifer Berglund

Xibalba: The Mayan Underworld
Filmmaker: Elke Specker

Antarctica: The Hunt for the Killer Crab
Filmmaker: Honey Whitney

Whale Fall: After Life of a Whale
Filmmaker: Sharon Shattuck

Special thanks to Helena Bernardi (HBO Latin America), Lara Talamas (DLA, Inc.), and Felipe Tewes (HBO Latin America) for volunteering as film festival jury members. We are also grateful to Austin Gallagher and Erica Staaterman for bringing Beneath the Waves to Fish at Night.

BENEATHTHEWAVES

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