2016

Fish Behavior, Ecology, & Conservation in the 21st Century

Program for the 20th Biennial

Ecological and Evolutionary Ethology of Fishes

Photo credit - Valdivia A, Bruno JF, Cox CE, Hackerott S, Green SJ. (2014) Re-examining the relationship between invasive lionfish and native grouper in the Caribbean. PeerJ 2:e348 https://doi.org/10.7717/peerj.348

History of EEEF

The *Ecological and Evolutionary Ethology of Fishes* (EEEF) meetings originated with discussions at a *Midwestern Regional Meeting of the Animal Behavior Society* among several scientists interested in fish behavior, including the late Jack Ward (Illinois State University) and David Noakes. Illinois State University in Normal, Illinois, hosted the first few meetings starting from 1977 through 1983. Hosts thereafter changed with the meeting, moving from university to university, crisscrossing geographic locations to attract different researchers, create opportunities for them to highlight their research, and have all attendees see the places where they live and carry out their science.

Several things distinguish the EEEF meetings: (1) fostering the development of students, and (2) bringing together the full range of people with interests in behavior, ecology, and evolution of fishes. Conservation biology gained importance through the efforts of Gene Helfman (University of Georgia, Athens); and (3) including research that spans marine and freshwater fishes, practical and applied research, academic scientists and those from a wide range of private industry, consulting, and government agencies. The record of EEEF meetings, particularly in the publications from special symposia or entire sessions of previous meetings, speaks to EEEF's success (usually in special issues of the journal, Environmental Biology of Fishes). EEEF always fosters personal contacts, collaboration, and creative approaches to science. The emphasis continues to be on students, and we continue to learn from and through them. Young people and new ideas always dominate the EEEF meetings.

While a number of the original conveners have died, EEEF continues to gain new colleagues and so continues to grow and develop. EEEF is firmly rooted in the past but dedicated to the future. We have no formal organization, no elected officers, and no continuing budget. We meet because we are interested in each other and what we are doing. We organize special sessions on topics of current interest, to recognize lifetime contributions of some of us, but mostly to foster the development of students and young colleagues. We welcome EEEF 2016 to Tallahassee and to Florida State University with enthusiasm for our new participants, the special sessions, the opportunity to learn about fishes of the Gulf of Mexico, and the chance to experience the local environment and culture.

Year	Site	Year	Site
1977	Illinois State University	1998	University of Washington
1979	Illinois State University	2000	University of Georgia
1981	Illinois State University	2002	Laval University
1983	Illinois State University	2004	Sauðárkrókur, Iceland
1985	University of Guelph	2006	Soka University of America
1987	Lamar University	2008	Boston University
1990	Northern Arizona University	2010	Simon Fraser University
1992	University of New Hampshire	2012	University of Windsor
1994	University of British Columbia	2014	Oregon State University
1996	University of New Mexico	2016	Florida State University

EEEF Student Awards

Dr. Jack A. Ward 1935-1982

Jack Ward[1] Memorial Prize

Carrying on a tradition that goes back many years, the steering committee of the Ecological and Evolutionary Ethology of Fishes Symposium gives the *Jack Ward Award for the Best Student Presentation*. The award is named in honor of Dr. Jack A Ward, a professor at Illinois State University and the founder of the biennial EEEF Symposium. He was a popular professor and co-author of one of the most widely used college biology textbooks of the early 1980s. Dr. Ward is best known for his work on the life history of cichlid fishes of southeast India and Sri Lanka.

Dr. R. Jan F. Smith 1940-1998

R. Jan F. Smith[2,3] Conservation Award

The Smith Conservation award goes to the student whose oral or poster presentation best exemplifies fish conservation. The award is named in honor of Dr. R. Jan Frederick Smith, a professor at the University of Saskatchewan, Saskatoon. Dr. Smith made significant contributions in the area of predation and alarm pheromones in fishes. His innate curiosity led him to examine alternative evolutionary explanations and find creative ways to test his hypotheses. He was a gifted mentor and researcher who had a keen intellect, extraordinary patience, and a generous spirit.

Dr. Gerry FitzGerald 1950-1994

Gerry (Gerard) FitzGerald[4] Award

The FitzGerald award goes to the best poster presentation. The award honors the memory of Dr. Gerry FitzGerald, a professor at Laval University in Quebec. Dr. FitzGerald worked on sticklebacks -- a feisty little fish presenting behaviors allied closely to those of Dr. FitzGerald. He and his students investigated aggressive behavior, kin recognition, and alternate reproductive styles, among other things. He is remembered as a man with high and fair standards, who infected his department with the "art-of-the-possible," and earned the respect of the scientific community.

[1] Wyman, RL. 1983, *in Noakes et al.,* Predators and prey in fishes. W. Junk Publishers
[2] Mathis, A, DP Chivers, BD Wisenden, GE Brown, and RS Mirza. *Oikos* 88(1):100-102, 2000.
[3] Chivers, DP, A Mathis, GE Brown, RS Mirza, BD Wisenden. Environmental Biology of Fishes 56:343-350, 1999
[4] Whoriskey, FG. Environmental Biology of Fishes 42:109-113, 1995

The 20th Biennial Meeting

Ecological and Evolutionary Ethology of Fishes

14-16 June 2016
Tallahassee, Florida

2016 Steering Committee

Dr. Felicia Coleman (Florida State University Coastal and Marine Laboratory, Chair)
Dr. Chip Cotton (Florida State University Coastal and Marine Laboratory, Co-Chair)
Dr. Gary Ostrander (Florida State University, Office of Research)
Dr. Joseph Travis (Florida State University, Biological Science)
Dr. Gene Helfman (University of Georgia)
Dr. David Noakes (Oregon State University)
Dr. Nathan Putman (NOAA, Atlantic Oceanographic and Meteorological Laboratory)
Dr. Colette St. Mary (University of Florida)

With Assistance From

Lara Edwards (Assistant, Florida State University Coastal and Marine Laboratory)
Kelly Starke (Assistant, Florida State University Office of Research)

Many thanks to our wonderful sponsors!

Symposium Themes

The *EEEF Steering Committee* organized the 2016 Meeting around four primary themes, outlined below, and identified keynote speakers for each theme.

I. Population Ecology and Genomics of fishes.

Keynote Speaker –Dr. Joseph Travis, Florida State University

Keynote Speaker - Dr. Kimberly Hughes, Florida State University

II. Sensory ecology, movement patterns, and behavior - Chair, Dr. Nathan Putman

Keynote Speaker: Dr. Dean Grubbs, Florida State University

III. Species Interactions

Keynote speaker – Dr. Felicia Coleman, Florida State University

IV. Biodiversity: Discovery, Variation & Conservation

Keynote Speaker – Dr. Lawrence M Page, University of Florida

Keynote Speaker – Dr. Mark Albins, Auburn University

Program of Events

Monday, 13 June 2015

4:00 – 5:00 pm – Steering Committee Meeting, Marriott Residence Inn- Front Lobby
5:00 -- 7:00 pm -- Welcome Reception, Marriott Residence Inn Dining Room

Tuesday, 14 June 2016

8:00-9:00 am: Registration, Turnbull Center- Registration desk

8:00-8:55 am: Continental breakfast Hallway adjacent to Room 103- Turnbull Center

9:00-9:15 am: Felicia C. Coleman, Florida State University, *Welcome and Announcements*

9:15-9:30 am: Gary Ostrander, FSU Vice President for Research, *History of EEEF*

I. Session Title- Population Ecology & Genomics of Fishes, Chair, Dr. Joseph Travis

9:30-10:15 am: Keynote Joseph Travis - A New Look at an Old Icon, Density-Dependent Selection (and its Adopted Offspring, *r*- and *K*-Selection)

10:15-11:00 am: Keynote Dr. Kimberly Hughes, Genomics, Serendipity and Evolution of Poeciliid Fishes

11:00-11:20 am: (TBA)

11:20-1:00 pm LUNCH (On your own)

II. Session Title- Sensory ecology, movement patterns, behavior - Chair N. Putnam

1:00-1:45 pm: Keynote Dr. Dean Grubbs, Using State of the Art Telemetry to Study Very Large Elasmobranch Fishes: Endangered Sawfish and Deep Sea Sharks

1:45-2:05 pm: Christine N. Bedore, Sensory Ecology of Elasmobranch Fishes: the Cownose Ray as a Case Study (YI)

2:05-2:25 pm: Nathan Putman. The Role of Geomagnetic Cues in Fish Migration

2:25-2:45 pm: Michelle Scanlan, Comparison of Magnetic Orientation Responses of Three Salmonid Species in the Northern and Southern Hemisphere

2:45-3:05pm: David Noakes, Olfactory Imprinting in Salmonids

3:05-3:20 pm: Coffee break

3:20-3:40 pm: Karen Cogliati, The Effect of Rearing Environment on Spatial Learning Ability in Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) (YI)

3:40-4:00 pm: Jacqueline F. Webb, Sensory Ontogeny in Fishes: It's All in the Timing

4:00-4:20 pm: Maria E. Abate, Is Group Foraging in the Convict Cichlid (*Amatitlania nigrofasciata*) Affected by Damage-Released Alarm Cues?

4:20 – 5:00 pm Poster Speed Presentations- Chair, Dr. Felicia Coleman

Kimberly Bolyard, Mercury Contamination and Longnose Dace: Variation in Movement and Habitat Use

David Boyd, Obstacles to Systematics in Biodiversity Hotspots Using Horseface Loaches as an Example

Austin Heil, Spawning in Different Habitats and the Formation of Spawning Aggregations of the Sheepshead (*Archosargus probatocephalus*) in the Northeastern Gulf of Mexico (YI)

Bryan Keller, Assessing the Role of Magnetic-Based Navigation During Philopatric Migrations in the Bonnethead, *Sphyrna tiburo* (YI)

Jonas Rodrigues Leite (Hostim), The Algae Use in Nesting Behavior of the Threatened Brazilian Basslet, *Gramma brasiliensis*

Ashley Marranzino (Webb) Novel Observations on the Mechanosensory Lateral Line System in Stomiiform Fishes

Ryan Mckenzie, The Influence of Social Dominance on Exploitation of the Gulf Black Sea Bass

Collins Ngwakwe, A Precautionary Biodiversity Conservation Model for Estimating Future Substitute Fish Specie: A Collateral Effect

Erin Reed, Investigating Relationships between Climate, Growth, and Fisheries Production in a Commercially Exploited Marine Fish

Matthew Scanlon, Characterizing Elasmobranch Interactions in the Georgia Shrimp Fishery

Olivia Smiaroski, Sex –Specific Risk Averse Behavior in the Zebrafish (*Danio rerio*)

5:00-5:30 pm: POSTER SETUP

5:30-7:00 pm: Poster Reception Room 103

Wednesday, 15 June 2016

8:00-9:00 am: Registration and Continental Breakfast

II. (Cont.) Session Title- Sensory ecology, movement patterns, behavior - Chair N. Putnam
9:00-9:20 am: Timothy Rowell, Quantitative Relationships between Fish Sound Production and Abundance in Transient Spawning Aggregations That Form in Coastal Estuaries (YI)

9:20-9:40 am: Ryan Mckenzie, The Influence of Social Dominance on Exploitation of the Gulf Black Sea Bass (YI)

9:40-10:00 am: Brian Gallagher, Carryover Effects of Partial Migration in White Perch (*Morone americana)* within the Hudson River Estuary (YI)

10:00-10:20 am: Maryam Kamram, Owners Versus Renters: Homing Behaviors in Comparative Species Based on Ownership of Shelters (YI)

10:20-10:35 am: COFFEE BREAK

III. Session Title- Species Interactions – Chair, C. Cotton

10:35-11:20 am: Keynote Dr. Felicia Coleman, Species Interactions and the Dual Effects of Fishing and Invasive Species

11:20-11:40 am: John Pfeiffer, Fish As Habitat: Conservation of Freshwater Fishes and Their Parasitic Bivalves (YI)

11:40-12:00 pm: Douglas Fraser, Strong Interactions with Heterospecific Resident during Colonization Creates an Ecological Paradox Involving the Globally Invasive Trinidadian Guppy

12:00-12:20 pm: Q.M. Tuckett, The Contribution of Biotic Resistance and Feralization to Cold Tolerance in an Introduced Tropical Fish (YI)

12:20-2:00 pm: LUNCH (on your own)

2:00-2:20 pm: Libor Zavorka (Johnsson), Co-Existence with Non-Native Brook Trout Disrupts the Pace-Of-Life Syndrome in Native Brown Trout

2:20-2:40 pm: Brian Moe, Modeling Elasmobranch Growth: An Application of Biphasic Growth Theory (YI)

2:40-3:00 pm: Breanna Degroot, Feeding Behavior and Prey of the Lesser Devil Ray, *Mobula hypostoma*, Off Southwest Florida (YI)

3:00-3:15 COFFEE BREAK

IV. Session Title- Biodiversity: Discovery, Variation & Conservation- Chair Dr. Colette St. Mary

3:15-4:00 pm: Keynote Lawrence Page (UF), The Increasing Role of Natural History Collections in Understanding, Appreciating, and Protecting Biodiversity

4:00-4:20 pm: David Bechler, Should Barrow Pits be Engineered to Preserve Fish Species Assemblages?

4:20-4:40 pm: Elena Nalesso, Marine Megafauna Community Monitoring: Assessment of Fish Refugees in the Sian Ka'An Biosphere Reserve, Quintana Roo, Mexico (YI)

4:40-5:00 pm: Randy Singer, Using High Definition ROV Video to Explore the Biodiversity of Deep Sea Ecosystems (YI)

6:00 Proof Brewery Social

Thursday, 16 June 2016

8:00-9:00 am: Registration and Continental Breakfast

IV. Session Title- (Cont.) Biodiversity: Discovery, Variation & Conservation- Chair Dr. Colette St. Mary

9:00-9:45 am: Keynote Mark Albins, Invasive Lionfish Threaten Biodiversity on Coral Reefs of the Atlantic

9:45-10:05 am: K.M. Lawson, Life History Strategies and Predicting Invasiveness of Non-Native Fishes in Florida (YI)

10:05-10:25 am: K.J. Soda, Geometric Morphometrics and Multilayer Perceptrons Can Assist in the Rapid Acquisition of Population Data for Conservation Efforts

10:25-10:40 am: Coffee Break

10:40-11:00 am: Chris Malinowski, Mercury in Atlantic Goliath Grouper (*Epinephelus itajara*): Sources, Bioaccumulation Patterns, and Potential Impacts to Population Recovery (YI)

11:00-11:20 am: Rebecca Asch (Brad Erisman) Projected Changes in the Distribution and Phenology of Nassau Grouper (*Epinephelus striatus*) Spawning Aggregations

11:20-11:30 am: Vemco raffle drawing

11:30-11:40 am: Award presentations

11:40-12:00 pm: Closing Remarks

12:00 pm: Meeting ends

2016 EEEF Meeting Summary for Oral Presentations and Posters "Fish Behavior, Ecology, & Conservation in the 21st Century"

Monday June 13th

5:00-7:00	Welcome Reception, Opening Remarks - Dr. Gary Ostrander

Tuesday June 14th

8:00 - 9:00	Registration & Check In	
9:00-9:15	WELCOME & OPENING REMARKS (Coleman)	
9:15-9:30	**History of EEEF (Ostrander)**	
Population Ecology & Genomics of Fishes - Chair Coleman		
9:30-10:15	**Keynote Dr. Joe Travis (FSU)**	
10:15-10:30	**COFFEE BREAK**	
10:30-11:15	**Keynote Dr. Kimberly Hughes (FSU)**	
11:15-1:00	**LUNCH (on your own)**	
Sensory ecology, movement patterns, behavior - Chair Putman		
1:00-1:45	**Keynote Dr. Dean Grubbs (FSU)**	
1:45-2:05	Bedore†	
2:05-2:25	Putman	
2:25-2:45	Scanlan	
2:45-3:05	Noakes	
3:05-320	**COFFEE BREAK**	
3:20-3:40	Cogliati†	
3:40:-4:00	Webb	
4:00-4:20	Abate	
Poster Speed Presentations - Chair Coleman		
4:20 - 5:00	Bolyard	Mckenzie†
	Boyd	Ngwakwe
	Heil†	Reed†
	Keller†	Scanlon†
	Leite (Hostim)	Smiaroski†
	Marranzino (Webb)	
5:00-5:30	Poster Set-up	
5:30-7:00	**Poster Reception**	

† Eligible for Young Investigator Award

Wednesday June 15th

8:00 - 9:00	Registration & Check in
Sensory ecology, movement patterns, behavior (cont'd) - Chair Putman	
9:00-9:20	Rowell†
9:20-9:40	McKenzie†
9:40-10:00	Gallagher†
10:00-10:20	Kamran†
10:20-10:35	**COFFEE BREAK**
Species Interactions – Chair Cotton	
10:35-11:20	**Keynote Dr. Felicia Coleman (FSU)**
11:20-11:40	Pfeiffer†
11:40-12:00	Fraser
12:00-12:20	Tuckett†
12:20-2:00	**LUNCH (on your own)**
2:00-2:20	Zavorka (Johnsson)
2:20-2:40	Moe†
2:40-3:00	Degroot†
3:00-3:15	**COFFEE BREAK**
Biodiversity - Chair St. Mary	
3:15-4:00	**Keynote Lawrence Page (UF)**
4:00-4:20	Bechler
4:20-4:40	Nalesso†
4:40-5:00	Singer†
6:00	**Proof Brewery Social**

Thursday June 16th

8:00 - 9:00	Registration & Check In
Biodiversity - (cont) - Chair St. Mary	
9:00-9:45	**Keynote Mark Albins (USA)**
9:45-10:05	Lawson†
10:05-10:25	Soda
10:25-10:40	**COFFEE BREAK**
10:40-11:00	Malinowski†
11:00-11:20	Asch (Erisman)
11:20-11:30	**Vemco raffle drawing**
11:30-11:40	**Award Presentations**
11:40-12:00	**CLOSING REMARKS**
12:00	MEETING ENDS

Abstracts

Is group foraging in the convict cichlid *(Amatitlania nigrofasciata)* affected by damage-released alarm cues? (Contributed Talk)

Maria E. Abate[1], Laura Le[2], and Les Kaufman[3]

[1]Simmons College, Department of Biology, Boston, MA [2]University of Miami, Department of Marine Affairs and Policy, Miami, FL, [3]Boston University, Department of Biology, Boston, MA

A well-documented response of individual fish to a chemical cue that indicates predation risk is to decrease foraging. One strategy for decreasing the cost of lost foraging time under predation risk is to adopt a less efficient foraging tactic that multitasks vigilance and foraging. Alternatively, enhancing group foraging can reduce the cost of vigilance by increasing the number of individuals that can detect predation risk. To date evidence is limited that fish can innately recognize heterospecific damage-released alarm cues from unrelated sympatric species to detect predation risk. A common garden experiment compared the impact of conspecific and heterospecific damage-released alarm cues on group foraging in the convict cichlid *(Amatitlania nigrofasciata)*. Groups of eleven one-month-old siblings were exposed to a distilled water control or skin extract from: 1) conspecifics, 2) the zebrafish *(Danio rerio)*, an allopatric Ostariophysan zebrafish, or 3) the banded *Astyanax* (*A. fasciolatus)*, which is a sympatric Ostariophysan. The juveniles in our study were naïve to skin extract cues. The fish were exposed five consecutive days per week for four weeks. After cue delivery on two days each week, group foraging behavior on horizontal versus vertical food patches was video-recorded for one minute. A random block design ANOVA indicated the percent of fish foraging on horizontal food patches was equal in the conspecific and *Astyanax* treatments and higher than that of the other two treatments. These group foraging results indicate that the convict cichlid recognizes damage-released alarm cue from both conspecifics and an unrelated sympatric species.

Invasive lionfish threaten biodiversity on coral reefs of the Atlantic (Keynote)

Mark A. Albins[1]

[1]University of South Alabama, Dauphin Island Sea Lab

Coral reefs support the most diverse assemblages of vertebrates on Earth. Global losses of coral reef habitat -- caused by a myriad of stressors, including disease, climate change, ocean acidification, coastal development, pollution, and the spread and intensification of destructive fishing practices -- have conspired to constrain this pinnacle of biodiversity to relatively few small, isolated, and/or intensely managed refuges. Until recently, the litany of mechanisms contributing to the loss of biodiversity on coral reefs did not include invasive species, one of the prime culprits in the loss of terrestrial and aquatic diversity. The invasion of Atlantic coral reefs by Pacific lionfish has changed that. Predatory invasive lionfish display a set of characteristics and behaviors that is novel in the invaded system and have demonstrated strong negative effects on native coral-reef fishes, in some cases causing local extirpations and reducing species richness on isolated patches of coral-reef habitat. Lionfish have also demonstrated

the potential propensity to consume rare prey at a disproportionate. The effects of lionfish on particularly sensitive species, such as rare endemics, has not been well studied. Nevertheless, their strong negative effects on common species suggest a high probability that they could also cause global extinctions of rare species, thereby reducing fish community biodiversity on Atlantic coral reefs.

Projected changes in the distribution and phenology of Nassau Grouper (*Epinephelus striatus*) spawning aggregations (Contributed Talk)

Rebecca Asch[1], Brad Erisman[2]

[1]Princeton University, Program in Atmospheric and Oceanic Sciences, [2]University of Texas at Austin, Marine Science Institute

Spawning fishes often have narrower thermal tolerances than other life stages. Consequently, spawning has been hypothesized to constrain how species will respond to climate change. We evaluate this hypothesis by combining a global database of fish spawning aggregations with earth system and ecological niche models to project shifts in the spawning distribution and phenology of Nassau grouper (*Epinephelus striatus*) under the RCP 8.5 climate change scenario. This species is a top predator on Caribbean coral reefs and is listed as endangered due to overfishing of its spawning grounds. The highest probability of encountering *E. striatus* aggregations occurred at sea surface temperatures (SSTs) of 24.5-26.5° C and seasonal SST gradients of 0 to -1° C. Based on a historical climatology, our model projected that the highest probability of spawning occurs around Cuba, the Mesoamerican barrier reef, the Bahamas, and other areas of the Caribbean. This coincides with the observed distribution of grouper aggregations. By 2081-2100, a 50% decline is projected in the number of months and locations with adequate conditions for spawning. Potential *E. striatus* spawning habitat shifts northward and eastward, with slight increases in the probability of spawning around Aruba, Curacao, and Bonaire. The *E. striatus* spawning season is projected to contract and occur later in the year. Two-month delays in phenology are projected at 78% of sites where *E. striatus* is managed through spawning season sales bans and fishing closures. This implies that adaptive management in response to climate change will be needed for management measures to remain effective.

Should barrow pits be engineered to preserve fish species assemblages? (Contributed Talk)

David L. Bechler[1], Desek Gibson[2], Jordan L. Breit[3], Josh Bryan[3], Sean Brazil[4]

[1]Valdosta State University, [2]Pinehurst Surgical Clinic, [3]Public School System GA, [4]USAF

Barrow pits, which often fill with water, are common along many roadsides and are used to provide soil for road beds. This study examined fish assemblages in 12 barrow pits in northern Clinch and Ware counties, Georgia, USA, in 2001 and again in 2010 to assess assemblage structure changes that may have occurred over the intervening nine years. During the intervening nine years, two periods of relatively normal rain fall occurred along with two periods of drought. Nineteen species of fish in nine families were

collected. Species number within families were Centrarchidae, (n = 7), the most specious family, followed by the Fundulidae (n = 3) and Elassomatidae (n = 2). In all other families n = 1. Analyses involving barrow pit structure, location and position (volume, surface area, depth, vegetation structure, juxtaposition to other barrow pits and distance from local streams) revealed no relationships between the variables measured and the structure of the fish communities. From these results it is suggested that community structure may be primarily determined by stochastic events involving colonization, drought and anthropogenic activities. Statistical analyses along with multidimensional scaling and cluster analysis revealed significant changes in assemblage structure between the collections made in 2001 and 2010. These findings raise the question, can barrow pits be engineered so as to serve as long-term refuges for fish assemblages.

Sensory ecology of elasmobranch fishes: the cownose ray as a case study (Contributed Talk)

Christine N. Bedore[1]

[1]Department of Biology, Georgia Southern University, P.O. Box 8042, Statesboro, GA

Sensory systems mediate every life history function for organisms and are tuned to the physical and biological environments in which they are used. Though sensory involvement in navigation, prey detection, and predator avoidance have been well described for several teleost fishes, basic information is lacking for most elasmobranch species. Cownose rays, *Rhinoptera bonasus*, display several "advanced" morphological and behavioral characteristics that reflect their ecological niche and resulting sensory adaptations. Compared to other elasmobranchs, cownose rays demonstrate weaker sensitivity to prey-simulating electric fields, but benefit from a high spatial resolution from the high density of electrosensory pores around the mouth, which likely improves accuracy in locating cryptic benthic prey. Similar to sharks, cownose rays have laterally positioned eyes, which affords them a 360° vertical visual field and may contribute to tracking of schoolmates in all directions around the head. Fast temporal resolution, a physiological measure of retinal processing speed, compared to other batoids also suggests a role of vision in schooling. These adaptations of cownose ray sensory function to their specific ecological roles illustrate the plasticity that exists among the elasmobranch group as whole. Gathering baseline information on more species will aid in understanding of visual and electrosensory contributions to foraging, movement, and communication decisions for species of concern. Sensory systems have also become the target for bycatch reduction methods. Specific adaptations with regards to electrosensory sensitivity, resolution, and behavioral responses to prey-simulating and deterrent stimuli will help to fine-tune bycatch reduction devices and widen their applications to other fisheries.

Mercury contamination and longnose dace: variation in movement and habitat use (Contributed Poster)

Kimberly J. Bolyard[1], Alys Harshbarger[1], Haley Lloyd[1]

[1]Department of Biology, Bridgewater College

Longnose dace (*Rhinichthys cataractae*) are common inhabitants of rocky bottom streams and rivers that flow through the Shenandoah Valley, Virginia. Our studies of dace from two different river systems, South River with a history of industrial mercury contamination, and Dry River with no known mercury contamination, suggest that mercury affects the movement patterns and habitat use of the dace. In a laboratory trial presenting stimuli to trigger anti-predator behavior of dace, the mercury-exposed dace spent significantly less time swimming or moving during the trials and more time resting. There was no effect of the stimuli on either group of dace. A test of substrate preference conducted in a habitat selection box placed within the rivers found that mercury-exposed dace spent more time over open substrate (simulating large boulders) than did the non-mercury exposed dace. Non-mercury exposed dace spent more time over large rocks than did the mercury-exposed dace. As omnivores and prey for top-level predators, dace connect multiple trophic levels in the river ecosystem. Different movement patterns and variation in habitat use by longnose dace may impact ecologically relevant behaviors such as foraging and predator avoidance, leading to shifts in community structure and ecosystem dynamics.

Obstacles to systematics in biodiversity hotspots using horseface loaches as an example (Contributed Poster)

David A. Boyd[1] and Lawrence M. Page[2]
[1,2]Florida Museum of Natural History, University of Florida

The geno- and phenotypic characters separating North American fish species, as well as their evolutionary and ecological relationships, are increasingly well understood. On the other side of the planet the rivers of Indo-China teem with similarly impressive levels of species richness, yet knowledge of their ichthyofauna is decades behind that of the freshwater ecosystems of the Southeastern United States. The challenges inhibiting studies of fishes and other taxonomic groups in Southeast Asia include lack of access to types and other specimens in institutional collections, shortcomings in the circulation of scientific literature internationally, and a general lack of appreciation for systematics. Horseface loaches of the genus *Acantopsis* offer one example of the obstacles facing taxonomic, and consequently ecological, study of fishes in this region. Distributed from India east to Laos and Vietnam and south to Borneo and Java, only five species of *Acantopsis* are recognized taxonomically, despite estimates by local fisheries biologists that as many as five new species occur in the Lower Mekong Basin alone. Horseface loaches are commercially important and commonly found in fish markets, deepening the mystery surrounding the understudied status of this genus and heightening the need for systematic groundwork to inform conservation and management efforts. They are not alone; the *Acantopsis* puzzle is one of many that remain to be solved to develop a holistic understanding the fish diversity of SE Asia.

The effect of rearing environment on spatial learning ability in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) (Contributed Talk)

Karen M. Cogliati[1], Julia R. Unrein[2], Carl B. Schreck[3], David L. G. Noakes[4]

[1]Department of Fisheries and Wildlife, Oregon State University,[2]Department of Fisheries and Wildlife, Oregon State University, [3]Oregon Cooperative Fish and Wildlife Research Unit, United States Geological

Survey, Department of Fisheries and Wildlife, Oregon State University, [4]Department of Fisheries and Wildlife, Oregon State University, Oregon Hatchery Research Center

Juvenile salmonids are faced with many novel challenges when released from hatcheries and must quickly adapt to their new environment. Complex rearing environments may promote behavioral flexibility and cognition, which is thought to improve post-release survival. In this study, we reared juvenile Chinook salmon originating from hatchery broodstock at the Oregon Hatchery Research Center (OHRC) on two treatments: bare tanks or tanks with both complex structure and substrate. We reared fish at densities below conservation hatchery standards and fed fish a low-lipid experimental diet. We tested the effects of complex rearing environment on fish cognition as assessed by learning ability in a spatial navigation task. For the behavioral trials, we tested individually marked fish for 7 consecutive days in a maze and recorded the number of mistakes (entered incorrect exit arms) and the time to exit the maze. In addition to our two treatments, we acquired hatchery reared fish from a state facility 1 week prior to behavioral trials. We found no significant effect of rearing environment in our spatial task for fish reared with and without structure at the OHRC. When compared to hatchery reared fish, fish reared at the OHRC made significantly fewer mistakes but took longer to exit the maze. Hatchery reared fish showed the greatest degree of learning, but the number of mistakes and time to exit were both significantly greater for hatchery fish on the first day of trials. These results suggest that complex rearing alone may not promote learning ability in this spatial task

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Species interactions and the dual effects of fishing and invasive species (Keynote)

Felicia C. Coleman[1], Robert D. Ellis[2], and Christopher C. Koenig[1]

[1]Florida State University, Coastal and Marine Laboratory; [2]Florida Fish and Wildlife Research Institute

The web of species interactions – from predation and competition to parasitism and commensalism – has a profound effect on the distribution, abundance, and diversity of organisms in space and time. Interactions are influenced by natural conditions – including the presence of ecosystem or habitat engineers that increase the abundance and diversity of associated species -- as well as by anthropogenically-induced conditions, such as climate change and intensive fishing, that can reshuffle species associations, lead to unexpected responses, and present considerable problems for conservation and management. This talk consists of three related components: (1) an overview of fishing effects on species interactions in the marine realm and the effects on ecosystem resiliency, providing a global view of the problem and consequences; (2) a focus on the interactions that develop around habitat engineered by Red Grouper, a species supporting the most productive grouper fishery in the southeastern U.S. and the second most valuable reef fish fishery in the U. S. Gulf of Mexico; and (3) a discussion of the potential consequences to Red Grouper and associated habitat following from two human-induced pressures -- overfishing and contact with invasive species. Overfishing ecosystem engineers removes habitat otherwise available for a suite of species in areas generally lacking benthic structure, while invading Lionfish reduce local biodiversity to such an extent that it could influence prey availability, parasite loads, and excavation behavior of resident Grouper.

Feeding behavior and prey of the lesser devil ray, *Mobula hypostoma*, off Southwest Florida (Contributed Talk)

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The lesser devil ray, *Mobula hypostoma*, has been the subject of observation and catch-tag-release studies off southwest Florida from 2012 to present. Although sightings of *M. hypostoma* have increased in recent years, much remains unknown about this animal's biology and feeding behavior. From 2012-2015 we observed 212 sightings of *M. hypostoma*; in 21 of those sightings rays were actively feeding. Observed feeding behaviors included using barriers such as seawalls and jetties (n=4), shallow feeding in less than 1m water depth off the beach (n=9), and shallow bay feeding in less than 2m depth (n=8). Sightings of feeding rays occurred in both the Gulf of Mexico (n=11) and inside Sarasota Bay (n=10). Group sizes of *M. hypostoma* observed feeding ranged from one to fifty. In addition to passive observation, plankton tows (n=5) were opportunistically collected during some feeding events; and gastric samples (n=9) were collected during two chronological days of capture-tag-release studies. Preliminary analysis of tow and gastric samples suggest *Lucifer spp.*, brachyuran crab spp., and mysida spp. to be the main components. The observation of various feeding behaviors helps expand our knowledge about *M. hypostoma* and give insights into the distribution and abundance of zooplankton and how that may influence the occurrence of this species along the southwest Florida coastline.

Strong interactions with heterospecific resident during colonization creates an ecological paradox involving the globally invasive Trinidadian guppy (Contributed Talk)

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A single species introduction into a habitat that contains one or more heterospecific residents, but is otherwise suitable, may fail when the resident both controls the resources and preys on the invader (intraguild predation, IGP). We investigated such an IGP involving a species pair in which each eats the other's babies, making it a bidirectional-IGP. Importantly, the strength of predation is highly asymmetric with guppies the stronger predator. We performed an introduction experiment in Trinidad, transplanting guppies from a high predation river site into four low predation upstream sites, each containing a single heterospecific resident, a killifish. Mark-recapture revealed that by the end of a year the introduction had resulted in a 2/3rds reduction (3 of 4 streams) of resident killifish densities, compared with those in upstream control reaches lacking guppies, just as earlier studies had reported from 11 other streams. However, IGP theory predicts that one species should eliminate the other in conditions common to these streams. Why then does this "benchmark" two-thirds reduction persist across streams creating an ecological paradox? Recent studies suggest density-dependent selection (guppy densities high, killifish low) leads to rapid evolution of life history traits in both taxa, and the resulting eco-evo interaction of these phenotypes contributes stabilizing the reduction. Here we present evidence for another explanatory hypothesis, namely recruit replenishment from microhabitats that are favorable to the

killifish. We show that consideration of this habitat structure is relevant to understanding the paradox and needs to be considered in modeling and testing the eco-evo interaction.

Carryover effects of partial migration in white perch (*Morone americana*) within the Hudson River Estuary (Contributed Talk)

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Partial migration is defined as the presence of multiple groups with distinct migration behaviors (contingents) within a single population. Divergent migration behaviors in fishes are thought to be primarily determined by conditions experienced early in life, where migration trajectories are subsequently adopted based upon thresholds of growth or condition. Previous studies of white perch (*Morone americana*) populations consistently documented a resident contingent, which remained in natal freshwater habitats throughout life, and a migratory contingent, which dispersed from the natal habitat and primarily used brackish water. The objectives of this study were to assess the occurrence and carryover effects of partial migration in juvenile and adult white perch within the Hudson River Estuary. Juvenile contingents were identified using otolith strontium:calcium (Sr:Ca) profiles, while age determination and length back-calculation were employed to compare hatch dates, larval size-at-age and late-juvenile growth rates between contingents. Adult contingents were identified using otolith Sr:Ca profiles taken within the first annulus of the otolith, and adult size-at-age data was used to construct separate von Bertalanffy growth models for each contingent. Results indicated that migrants displayed earlier hatch dates, smaller larval size-at-age and faster late-juvenile growth rates than residents, while von Bertalanffy growth models suggested that migrants attained a larger maximum size as adults. These findings support the notion that early life conditions influence the adoption of different migration behaviors, which carry over to juvenile and adult growth characteristics.

Using state of the art telemetry to study very large elasmobranch fishes: endangered sawfish and deep sea sharks (Keynote)

R. Dean Grubbs[1]

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Unraveling the ecology and behavior of large marine predators is challenging due to their naturally low abundances, a concealing environment and the logistical constraints associated with capture and handling. These difficulties are compounded for rare, imperiled and deep sea taxa. Advancements in biotelemetry technologies including active and passive acoustic tagging, archival and real-time satellite tagging, and the development and use of multi-sensored transmitters and biologgers offer increasingly powerful tools for studying such species. I will present research using some of these techniques to study the ecology of large elasmobranch fishes including smalltooth sawfish (*Pristis pectinata*) and bluntnose

sixgill sharks (*Hexanchus griseus*), two species that are top-level predators, but inhabit very different marine environments. The smalltooth sawfish inhabits coastal tropical to subtropical waters in the Atlantic Ocean and is among the largest of all living batoids. It is listed as Critically Endangered in the IUCN Red List of Threatened Species and is the only native marine fish listed as *Endangered* under the United States' Endangered Species Act. The bluntnose sixgill shark is a poorly-studied, deep-water species with a patchy worldwide distribution in tropical and temperate seas, typically inhabiting 200-1000 m depths associated with insular and continental slopes and submarine canyons. It is among the largest of living shark species and is typically the apex predator in the communities in which it occurs. I will present data using acoustic and satellite telemetry to examine patterns and drivers of movements and habitat use in these taxa on diel to annual scales.

Spawning in different habitats and the formation of spawning aggregations of the sheepshead (*Archosargus probatocephalus*) in the Northeastern Gulf of Mexico (Contributed Poster)

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Many fish species are confined to specific habitats or certain environmental ranges when actively spawning. However, the sheepshead (*Archosargus probatocephalus*) can tolerate a wide range of environmental conditions within both inshore and offshore habitats during their spawning season, which occurs from February to April in the northeastern Gulf of Mexico. , Fishers primarily target sheepshead during their spawning season, making them highly susceptible to exploitation. The main purpose of this research is to better delineate sheepshead spawning habits and habitat preferences in the Florida panhandle area. The specific objectives of this project are: 1. Determine if there are variations in the reproductive status of sheepshead between individuals caught in different habitats (offshore, nearshore and inshore) and 2. Understand the population structure, movement patterns, and residence time of suspected spawning aggregations on offshore reefs. Reproductive status of individuals from different habitats will be determined using histological techniques throughout the reproductive period. Monthly abundance (from fishing data and in situ visual surveys) was assessed on three offshore artificial reefs to determine sheepshead movement and population structure. Preliminary results indicate that actively spawning individuals occur around offshore or nearshore structures. Although still in progress, preliminary results suggest the formation of sheepshead spawning aggregations offshore from late January to early April, with peak abundance in January and February. Understanding the dynamics and location of spawning aggregations for fisheries species may facilitate more proactive management of this economically important species.

Genomics, serendipity and evolution of poeciliid fishes (Keynote)

Kim Hughes[1]

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Affordable, high-throughput genetic and molecular data is bringing new tools and new insight into fundamental questions in evolution, ecology and behavioral biology. Genome-wide gene expression profiling is a particularly accessible tool because it can be used in any organism and does not require a genome assembly. Today I will describe some ways my laboratory has used this technique to investigate evolution and behavior in poeciliid fishes. For example, we have used transcriptome analyses to ask if phenotypic plasticity accelerates adaptive evolution, if parallel phenotypic evolution is regulated by conserved molecular mechanisms, and if an unusual type of mating preference is a form of sensory bias. Many of these results were surprising, and would have been difficult to address without access to genome-scale data.

Owners versus renters: homing behaviors in comparative species based on ownership of shelters (Contributed Talk)

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The ability to navigate successfully to and from sites rich in resources is essential for survival for many organisms. In particular, the ability to repeatedly locate a shelter is critical for avoiding predation. Way finding behaviors are observed across the animal kingdom, with both vertebrates and invertebrates demonstrating highly efficient methods of navigating. The spatial scale of the movement may vary with some animals traveling several hundred kilometers while others may only need to travel a few meters. With a rich behavioral repertoire and relatively simple nervous system crayfish prove to be ideal models for comparative research. Studies have demonstrated their spatial learning abilities within arenas to place and response cues. However, little is known about crayfish and homing to shelters following foraging. The homing behaviors of two comparative species of crayfish were examined, both of which utilize burrows, but only one constructs the burrows (primary burrowers). The species were selected based on the varying complexity of the environments within which they reside as well as the amount of energy invested in constructing burrows. Detailed analysis of the movement kinematics revealed patterns in behavior demonstrating an exploratory phase and a homing phase with both species of crayfish homing to burrows with significant differences between the two. Additionally, burrows were displaced in space to determine possible behavioral mechanisms of homing. Results demonstrated homing to burrows was not based on a local cue associated directly with the burrow.

Assessing the role of magnetic-based navigation during philopatric migrations in the bonnethead, *Sphyrna tiburo* (Contributed Poster)

Bryan Keller[1], Bryan Frazier[2], Chip Cotton[1], & Dean Grubbs[1]

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Determining the ecological roles that a species plays in the environment is contingent upon the delineation of habitat and space use patterns. In the Northwest Atlantic Ocean, the bonnethead, *Sphyrna tiburo*, is commonly found in nearshore and estuarine environments and is abundant, making the animal an ideal model species for studies of habitat and space use. Recently, research conducted by the South Carolina Department of Natural Resources (SCDNR) has demonstrated that individuals are philopatric and return to the same estuaries on an annual basis. Additionally, the Florida Atlantic Coast Telemetry (FACT) network has detected tagged individuals from the present study as far south as Cape Canaveral, FL. This fidelity suggests *S. tiburo* has the ability to recall an environment and successfully navigate back to the area from an alternate location, however, the mechanism behind this behavior remains unknown. For decades, researchers have postulated that the philopatric behaviors of elasmobranchs are facilitated by an ability to navigate using the earth's magnetic field. In conjunction with SCDNR, an array of acoustic receivers is being developed to monitor and further quantify seasonal residency of *S. tiburo* in an estuary that has been surveyed for 14 years. A magnetic geologger will document the spatial occurrence of magnetic variables during migration, which will subsequently allow us to assess the reliance of *S. tiburo* on magnetic cues during navigation. Laboratory investigations will also further our understanding of the impact of magnetic variables on the spatial ecology of S. tiburo. A synthetic-magnetic field, representing what individuals encounter *in situ*, will be manipulated to allow for the observation of *S. tiburo* while exposed to a continuum of magnetic variables. This research will provide a framework to investigate the prevalence of magnetic-based navigation in elasmobranchs and propose additional techniques for investigating the philopatric tendencies of *S. tiburo*, a model species for studying movement patterns in coastal sharks.

Life history strategies and predicting invasiveness of non-native fishes in Florida (Contributed Talk)

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Non-native fishes threaten native biodiversity in many regions. While non-native fishes are common throughout the U.S., Florida, in particular, has a large number of established non-native fishes compared to most other regions due to its favorable subtropical climate. Life history traits have been used to predict the risk of establishment for non-native fish with varying levels of success. These profiling studies have been conducted for non-native fish in California and the Great Lakes, but not yet for Florida, despite the elevated risk of establishment and potential for impacts to native biota. We used the triangular life history model proposed by Winemiller and Rose to visualize the overall life history strategies for three different groups: native fishes, fish species that are currently established in Florida, and fishes that have been introduced but failed to establish in Florida. Fish were plotted according to their fecundity, investment per progeny, and size at maturity. Overall life history strategies (opportunistic, periodic, equilibrium) were then identified. The resulting 3-dimensional graph revealed that many successfully established species such as those in the family Cichlidae, are equilibrium strategists. Fishes in this category tend to have a high degree of parental care, low to intermediate fecundity, and a larger maturation size. Understanding the life history strategies and traits that aid in the prediction of non-native fish invasiveness is key for effective risk assessment and management.

The algae use in nesting behavior of the threatened Brazilian Basslet, *Gramma brasiliensis* (Contributed Poster)

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Nesting behavior is a common strategy that has been described for several taxa in order to enhance reproduction success. It is expected that nest-building behavior should be under strong natural selection, and that nest design, construction and structure should be adapted by processes of natural selection to local environmental conditions. According to previous studies, at least nine thousand fish species are nest builders, either for laying eggs, or for shelter from predators. Although, this important parental behavior has not yet been deeply analysed for fishes on coral reefs and several nesting behavior remain unreported and undetailed. The present study describes the algae use in the complex nesting behavior by the unique Grammatidae from outside Caribbean, the South-western Atlantic Ocean endemic *Gramma brasiliensis*. Algae selection, associated behaviors and the ecological implications of this behavior were discussed. It is likely that *G. brasiliensis* is very selective in the choice of algae species, have some particular behavior to pick algae thalli and is meticulous in algae tangling.

Mercury in Atlantic Goliath Grouper (*Epinephelus itajara*): sources, bioaccumulation patterns, and potential impacts to population recovery (Contributed Talk)

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Coastal fish populations are facing burgeoning and unprecedented threats to their health and sustainability, and many have undergone substantial declines in recent decades. Along with overfishing and habitat destruction, elevated levels of industrial contaminants are at the epicenter of this issue. Of particular concern is mercury (Hg) because of its neurotoxic effects, its ability to bioaccumulation in some forms, and because we have tripled Hg levels in the upper ocean since the beginning of the Industrial Revolution, primarily through the burning of fossil fuels and mining. Mercury has been used as an indicator of environmental contamination and methylmercury (MeHg) is generally considered the most toxic form. In high concentrations, MeHg can have debilitating effects on organisms. For large, long-lived fishes, like the Atlantic Goliath Grouper (*Epinephelus itajara*) (*i.e.,* can grow up to ~3 meters/400 kilograms), this may result in severe tissue damage, neurological impairment, reduced growth and development, starvation, disrupted blood chemistry (*e.g.*, immune system function), reduced

reproductive success, and higher rates of mortality. Goliath Grouper life history and behavioral traits— long-lived, late maturation, large, and strong site fidelity— make them a useful species to model regional, habitat-specific, and ontogenetic patterns in bioaccumulation of Hg and its effects. For this study, we investigated (1) the effects of Hg on health, reproduction, and survival; and (2) diet and stable isotope patterns (N, C, S, Hg) to determine the sources of Hg and the relationship between Hg intake, Hg assimilation and accumulation in various tissues, and Hg concentrations in the prey community.

Novel observations on the mechanosensory lateral line system in stomiiform fishes (Contributed Poster)

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The mechanosensory lateral line (LL) system in deep-sea fishes, especially with regard to the Stomiiformes, is relatively unknown, especially because specimens are quite fragile. Among deep-sea fishes, the LL system reveals at least two evolutionary strategies: 1) Melamphaids and gadiforms have obvious widened cranial LL canals with large neuromasts. 2) Other taxa have highly proliferated superficial neuromasts. In contrast, the one report on the LL system in any stomiiform (Handrick, 1901) describes only one LL canal (supraorbital) and only a small number of superficial neuromasts. Thus, we examined the LL system in two stomiiform taxa: hatchetfishes (*Argyropelecus*) and bristlemouths (*Cyclothone*). Fish were collected at sea or obtained from museums and examined using clearing and staining, whole mount hematoxylin staining, histology, µCT imaging, and SEM. *Argyropelecus* spp. has lines of very small, densely placed superficial neuromasts in several regions on the head and in vertical lines on the trunk. Canal neuromasts are found in partially enclosed or unossified supraorbital and mandibular canals. *Cyclothone* spp. have small superficial neuromasts in similar locations, but are not as highly proliferated; no cranial LL canals are present. These surprising observations were dependent upon the ability to obtain high-quality specimens. A proliferation of superficial neuromasts is likely important in the hydrodynamically quiet, and light-limited environment of the deep sea, but the role of the LL system in these fishes remains unknown. This work was funded by an NSF Graduate Research Fellowship and an ANMH Lerner Grey Fund Award to ANM.

The influence of social dominance on exploitation of the Gulf Black Sea Bass (Contributed Talk)

Ryan Mckenzie[1]

[1]Florida State University, Coastal and Marine Laboratory

Our knowledge of the reproductive behavioral ecology of many economically important marine fish species in Florida is remarkably poor. This limits our ability to understand their susceptibility to exploitation and design effective management policies. My current study describes the behavioral dynamics involved in the reproduction and exploitation of the Gulf Black Sea Bass (*Centropristis striata melana*), an economically important fish species in the Northeastern Gulf of Mexico for which there are

few data of any kind. The main objectives are to 1. Determine the effects of sex and relative body size on social dominance during the spawning season and 2. Determine if the catchability and susceptibility of individuals to angling are correlated to these sex and size specific trends in social dominance. A combination of captive behavioral trials and fishing surveys are used to address these objectives, and I report on my findings this past spring spawning season.

Seasonal population dynamics of the Gulf Black Sea Bass in the Northeastern Gulf of Mexico (Contributed Poster)

Ryan Mckenzie[1]

[1]Florida State University, Coastal and Marine Laboratory

Relatively little is known about the ecology of the Black Sea Bass in the Northeastern Gulf of Mexico which contributes to both commercial and recreational fisheries along the west coast of Florida (annual catch in Florida averaging ~ 470,000 pounds since 2006; Addis et al. 2011). In fact, life history data have not been collected since the 1960's and its reproductive strategy is poorly known (Addis et al. 2011, Hood et al. 1994). Along the west Florida shelf, adult Black Sea Bass inhabit relatively shallow (< 30m deep) live-bottom reef habitats with the highest recorded densities occurring between Tampa Bay and Apalachee Bay (Godcharles 1970). My current study uses a fixed-station fishery-independent sampling survey to explore seasonal population dynamics variation of the Black Sea Bass on live-bottom reef habitats along the Northeastern Gulf of Mexico. I report on the relative abundance, size distribution, and sex ratio of reef populations surveyed thus far. My study, the first to describe the seasonal dynamics of the Gulf Black Sea Bass, will provide valuable insights into the reproductive ecology, management, and conservation of this economically important marine fish species.

Modeling elasmobranch growth: an application of biphasic growth theory (Contributed Talk)

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The von Bertalanffy growth model is the most commonly used growth model in elasmobranch literature. However, this model has been criticized for its failure to account for the change in energy allocation at the onset of maturity, and therefore growth that occurs after a fish matures. The Lester growth model (LGM) is a biphasic alternative to the von Bertalanffy growth model that incorporates life history trade-offs between reproduction, growth, and survival to describe lifetime growth as a straight line (immature phase) and a curve (mature phase). We used 52 datasets from 29 elasmobranch species to compare the performance of the LGM to four conventional growth models (von Bertalanffy, Gompertz, logistic, and a two-phase von Bertalanffy). According to Akaike Information Criterion (AICc), the LGM was the best fitting

model for 80.8% of datasets. Our results show clear support for the LGM as a means of describing lifetime growth of some of the world's most common, endangered, and economically important elasmobranchs; and bring into question the default status of conventional growth models in the elasmobranch literature.

Marine megafauna community monitoring: assessment of fish refugees in the Sian Ka'An Biosphere Reserve, Quintana Roo, Mexico (Contributed Talk)

Elena Nalesso[1], Sergio Marcos[1], Jacobo Caamal[1], Stuart Fulton[1]

[1]Comunidad y Biodiversidad

Sharks and rays are apex predators and play an essential role in maintaining the ecological balance of marine ecosystems. Management of shark fisheries is complicated. In the Mexican Caribbean the economic and ecological importance of the resource has not always received the appropriate attention by the institutions responsible for fisheries management. Declines in the biomass of different species of elasmobranchs are now a global concern. A community monitoring program for marine megafauna in Quintana Roo, Mexico, was initiated in 2014 within the Sian Ka'an Biosphere Reserve (SKBR) in which 20 fishermen from two cooperatives were trained to conduct the biological evaluation of community marine reserves (fish refuges) established by the fishers in 2012. The fishers have been trained to gather relevant biological information on sharks, rays and sea turtles, using a variety of methodologies such as longlines (to tag and release sharks and rays), visual transects and BRUVs (Baited Remote Underwater Videos) for identifying species. The continuous monitoring effort has generated information on the density and abundance of megafauna in the SKBR, identifying the presence of at least five species of rays (*Aetobatus narinari, Dasyatis americana, Himantura schmardae, Narcine bancroftii* and *Urobatis jamaicensis*), with two individuals of *D. americana* tagged and released. Six individual sharks have been captured, tagged and released from three different species (*Carcharhinus perezii, Ginglymostoma cirratum* and *Carcharhinus sp.*). Three species of sea turtles identified (*Caretta caretta, Chelonia mydas* and *Eretmochelys imbricata*) and more than 28 species of commercial fish recorded.

A precautionary biodiversity conservation model for estimating future substitute fish species: a collateral effect (Contributed Poster)

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Enhancing fish sustainability requires a synergy of efforts from both fisheries experts and non-fisheries managers whose policies in other economic subdivisions affect fish biodiversity. Whilst various methods have emerged for the integration of environmental concern into fish stock valuation; none of these have integrated the potential collateral effect of exploitation and concomitant depletion in one fish species on other substitute species, but the UN FAO laments that inability to estimate fish stock is a huge setback to fish conservation. Accordingly, inclining on the principle of collateral damage, this paper presents a model

for precautionary estimation and accounting for a substitute fish species whose close substitute is currently under exploitation with threats of extinction. This model is reliant on biodiversity interaction in which excessive exploiting and depletion of some fish species may cause a concomitant diversion of exploiters' attention to close substitute species. Therefore adopting the precautionary theory, this paper presents a deconstruction of biodiversity population estimation to derive what this paper refers to as *"A Precautionary Fish Biodiversity Population Estimation and Accounting Model"* (PFBEAM). This model thus offers a precautionary tool for managers of fish conservation to make effective long-term fish conservation plan to forestall future excessive exploitation of substitute fish species whose close substitutes are currently under threat of depletion. This paper offers an agenda for further research by applying this estimation model in various coasts and regions.

Olfactory imprinting in salmonids (Contributed Talk)

David L. G. Noakes[1], Andy Dittman[2], Joe Lemanski[1], Marc Johnson[3], Joseph O'Neil[4], Ryan Couture[4]

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Juvenile salmonids imprint to the chemical cues they experience during seaward migration as smolts, and home to those cues when they return to freshwater as spawning adults. We are examining the factors that affect olfactory imprinting in Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) in relation to management concerns about interactions of wild and hatchery salmon. Wild salmon are characterized by their return migrations to spawn in their natal locations. In contrast, returning adult hatchery salmon often fail to return to their designated sites, and stray into other areas. The stray rates of hatchery fish can sometimes exceed management guidelines, with concerns for negative ecological and genetic effects on native fish. We have shown that Chinook salmon and steelhead preferentially respond to the water in which they develop as embryos, but only if it is surface water, and not well water. Dissolved free amino acids appear to be the chemical cues responsible for their behavioral responses. We are testing the hypothesis that hatchery fish may not effectively imprint on the olfactory cues during their early life history that are responsible for the precise homing of adult fish. We have shown that hatchery operations do not change the dissolved amino profile of water from the source river. We are now testing responses of juvenile fish to selected amino acids, to select candidate chemicals for imprinting in hatcheries and increasing the return rates of returning adults to their hatchery origins.

The increasing role of natural history collections in understanding, appreciating and protecting biodiversity (Keynote)

Lawrence M. Page[1]

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Natural history collections contain more information about biodiversity than all other sources combined, exclusive of nature itself. In recognition of this, the U.S. National Science Foundation has committed $100M over 10 years to digitize collections data and make the data available online. Integrated Digitized Biocollections (idigbio.org) at the University of Florida (UF) and Florida State University (FSU) is the national coordinating center for NSF's Advancing Digitization of Biodiversity Collections (ADBC) Program. The ADBC program was developed in response to the need for a sustained effort to digitize and make available online the vast amount of information in the nation's biodiversity collections, which contain up to 1 billion specimens. Digitization of specimen data includes databasing names of species, localities, and dates of collection, images, sound, video, and 3-D models. The availability of digitized information about specimens greatly enhances the ability to conduct research on biological diversity and to address some of the most fundamental questions in biology: How are species distributed in temporal, spatial, and ecological space? What is the history of life on Earth? What factors lead to speciation, dispersal, and extinction? What connections between biodiversity and ecosystem functions and services contribute to human welfare? Digitized information from all U.S. collections leads to new discoveries through research and a better understanding of biodiversity through improved education and outreach, which then leads to improved environmental and economic policies. iDigBio is working with staff in 450 collections in 270 institutions in all 50 states, and currently has 53 million specimen records searchable online.

Fish as habitat: conservation of freshwater fishes and their parasitic bivalves (Contributed Talk)

John Pfeiffer[1] and Larry Page[1]

[1]Florida Museum of Natural History, University of Florida

The ongoing global biodiversity crisis has precipitated concerted conservation efforts focused on preventing biological extinction, from local and national legislation to worldwide conservation initiatives. The most commonly implemented approach to such conservation efforts is often taxon-based (e.g. Endangered Species Act, International Union for the Conservation of Nature), and by definition, is focused largely on the conservation of a particular species. While this species-centric approach is laudable and has dramatically helped preserve global biodiversity, multi-species and ecosystem-based approaches are becoming more commonplace and are fundamentally changing biological conservation and natural resource management. This paper describes some evolutionarily interesting and ecologically important interactions between freshwater fishes and their parasitic freshwater bivalves (Family Unionidae) and explores the importance of understanding these co-evolutionary relationships and interactions in the context of the conservation of freshwater biodiversity generally.

The role of geomagnetic cues in fish migration (Contributed Talk)

Nathan F. Putman[1]

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The sensory basis of animal navigation remains subject to considerable speculation and debate as results often appear contradictory from one study to the next. For instance, a number of laboratory-based experiments clearly demonstrate that diverse animals are capable of using the Earth's magnetic field for navigation, as a map to assess their location and as a compass to maintain a heading. By contrast, field-based experiments that deprive animals of magnetic cues often show minor or no effects compared to controls. Do animals in the laboratory use magnetic orientation because other (and preferred) environmental cues are not present? Do animals in the field successfully navigate without magnetic information because they possess back-up (and seldom-used) orientation systems? Both laboratory and field-based manipulations have limitations and it is challenging to know the importance of magnetic cues to an animal navigating under normal (i.e. entirely unmanipulated) conditions. Here, I present analyses on long-term fisheries datasets related to juvenile recruitment and adult homing. In both datasets, spatiotemporal variation in catches is well-accounted for by the hypothesis that fish use the geomagnetic field to assess their position and make movement decisions. Specifically, long-term changes in fish distribution appear tightly linked to gradual drift of the geomagnetic field. These findings, when paired with experimental evidence, point to (1) the importance of magnetic information for guiding fish migrations and (2) the potential to use knowledge of navigational mechanisms in fishes to solve long-standing fisheries management problems.

Investigating relationships between climate, growth and fisheries production in a commercially exploited marine fish (Contributed Poster)

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Climate change is an abiotic stressor that is affecting fish populations and fisheries production in a variety of ways, including inducing measurable fluctuations in fish recruitment, growth, condition, and fisheries production. Unfortunately, the details of linkages between climate, fish populations, and fisheries for most exploited species is poorly understood and therefore hinders effective management. The purpose of this study is to use the Gulf Corvina (*Cynoscion othonopterus*), a heavily exploited marine fish in the Gulf of California, Mexico, as a model to investigate the relationship between the Multivariate ENSO Index (MEI) and three parameters: adult fish condition, fish growth rate, and fisheries production. Fish condition is assessed using annual variations in length to weight ratios in relation to MEI using both a linear and exponential model. Fish growth rate is measured using otolith growth- increment chronologies. Lastly, annual catch data is compared to MEI to assess relationships between climate and fisheries production. Preliminary results indicate a positive relationship between climate, fish condition, and fisheries production. Specifically, we found a significant positive linear relationship between the annual average of MEI and fish condition. Likewise, climatic conditions during the birth year showed a positive relationship with fisheries production at the peak age of capture five years later, suggesting these relationships can be correlated and used in predictive manner. Favorable conditions established by warming sea surface temperature driven by El Niño events indicate an encouraging platform for future work of this study assessing juvenile and adult growth rate using growth-increment chronologies with climate.

Quantitative relationships between fish sound production and abundance in transient spawning aggregations that form in coastal estuaries (Contributed Talk)

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The management and conservation of fish populations requires accurate measurements of density to estimate fish abundance and biomass. Fisheries-independent surveys utilizing active acoustics (echosounders) may provide accurate estimates for fishes that form spawning aggregations (FSAs), but this method has not been applied to coastal estuaries and is often hindered by the cost and complexity of data collection and processing. The broad occurrence of sound production in fishes that form FSAs in estuaries provides an opportunity to use passive-acoustic methods to estimate fish abundances from measurements of sound levels in a more cost-effective and efficient manner; however, difficulties in correlating sound production with fish density have prevented the widespread use of this approach. In this study, we compared Gulf Corvina (*Cynoscion othonopterus*) sound levels with measurements of density from active-acoustic surveys. We found that the relationship between measurements was variable across the duration of surveys but stabilized during the timing of spawning, resulting in an equation to estimate density directly from sound level measurements. Our results confirm that active-acoustic methods provide robust, independent measurements of density, abundance, biomass, and spatial distribution of fish at FSAs in shallow estuaries. They also indicate that sound levels can be used to determine fish density and distributions, which may be used to estimate the abundance and biomass of fishes at FSAs. We anticipate that our approach is broadly applicable to other soniferous fishes that form FSAs in estuaries, representing a cost-effective and efficient method to assess fish populations and associated fisheries in these habitats.

Comparison of magnetic orientation responses of three salmonid species in the northern and southern hemisphere (Contributed Talk)

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Recent studies suggest that Pacific salmon (*Oncorhynchus species*), steelhead trout (*O. mykiss*), and translocated Atlantic salmon (*Salmo salar*) use spatial variation in the Earth's magnetic fields to navigate during oceanic migrations. When juvenile Chinook and steelhead with no prior migratory experience were exposed to simulated magnetic fields that exist at the latitudinal periphery of their oceanic foraging range, they elicited orientation responses consistent with movements to their oceanic foraging grounds.

We also tested whether juvenile Atlantic salmon that were trans-located from Maine to Oregon for a recreational fishery possessed similar magnetic orientation responses. These fish were exposed to the same simulated magnetic fields found at the boundaries of their introduced range in the North Pacific. Additionally, we examined the orientation responses of Pacific salmon, trout, and Atlantic salmon to magnetic fields representative of locations in the southern hemisphere. Our findings suggest that there is a family trend of deriving positional information from the Earth's magnetic fields within the northern hemisphere, and this ability is influenced by genetic and environmental factors. Conversely, we observed a family-wide trend toward maladaptive orientation responses in the southern hemisphere.

Characterizing elasmobranch interactions in the Georgia shrimp fishery (Contributed Poster)

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Shrimp fisheries represent a significant contribution to the Georgia coastal economy. Incidental catch of elasmobranchs in this fishery is largely unmonitored by regulatory agencies. In addition, fishermen have expressed frustration with sharks that damage their trawls by attempting to predate on the catch. These interactions cost the fishermen time and money as they repair and replace damaged gear. Although bycatch is a known threat to shark populations, depredation events have not been described. I observed commercial shrimping vessels out of Brunswick, GA in summer 2016 to evaluate incidental catch of small elasmobranchs and to investigate: a) how often nets get damaged; b) which species are causing the damage; c) seasonality of these interactions; and d) time and money costs incurred. Two species of stingray (*Dasyatis sabina* and *Dasyatis americana*) and one species of shark (*Rhizoprionodon terraenovae)* contributed the largest biomass to elasmobranch bycatch 43.3 and 42.9 % respectively. Elasmobranch bycatch also included species listed by the IUCN as endangered (*Sphyrna lewini*) and near threatened (*Rhinobatos lentinginosus*). Damage to nets from shark bites occurred in 31.2% of nets towed. For each fishing day, an average of 180 minutes of net repair was added due to shark bites (22.5 minutes per net, per trawling event). Sharks causing this damage have been exclusively of the Family *Carcharinidae*. Most damage appears to occur during hauls while nets are at the surface when the boat is still. Future work will implement metal deterrents as an effort to reduce net damage during these short periods of vulnerability.

Using high definition ROV video to explore the biodiversity of deep-sea ecosystems (Contributed Talk)

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Through modern advances in satellite communications, high definition video capture devices, and robotics, we have been able to explore more extreme environments than ever before. We have all heard

of NASA's Curiosity explorer mission that involved brief video streaming and numerous photos of the planet Mars, but far fewer have heard about the exciting initiatives that organizations like NOAA and the Schmidt Oceanographic institute have to conduct similar exploratory missions in the deepest parts of our oceans. Since 2008, the NOAA Okeanos Explorer has run an exploration-based oceanic survey of the deep-sea that utilizes remote operated vehicles (ROVs) and high definition video cameras to explore previously unexplored areas of the ocean and record its findings. This paper discusses the novel use of telepresence research and highlights findings from recent Okeanos expeditions including a new species of catshark, observations of deep sea community structure, feeding and swimming behavior as well as biogeographical range extensions of several species. Many of the organisms observed have never been seen alive prior to these types of expeditions. Most interesting is the wide array of behaviors that have been filmed during the numerous dives, many of which have challenged what was previously hypothesized about deep sea community and behavioral ecology. In addition, every dive is live-streamed to audiences of thousands of viewers, making these missions novel in that they provide real time interaction between scientists and the public while they are conducting research. Thousands of hours of video still await analysis for more studies exploring deep sea biodiversity through studies of behavioral and community ecology.

Sex –specific risk averse behavior in the zebrafish (*Danio rerio)* (Contributed Poster)

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Behavioral responses to stress can be broadly categorized as being either proactive risk-taking (bold, exploratory, and anxious) or reactive and risk-adverse (cautious and evaluative, shy and docile). Life history, heritability, and experience can influence the extent to which a fish adopts one of these coping styles. For example, female fish are often risk-averse, but lab and hatchery strains can differ to the extent the species risk-takes compared to wild-derived individuals. As a first step toward exploring the role of estrogen in the adoption of a risk-taking versus risk-averse coping style in the zebrafish (*Dario rerio),* a novel tank test (NTT) was used to test how sex influenced adult coping style in a domesticated strain. Five groups of males and 5 groups of females were housed separately in 19 L aquaria. Each group was composed of 10 individuals. Five individuals from each group were randomly chosen for the NTT. The individual was placed into an 11 L aquarium filled with freshly carbon filtered and UV sterilized water to remove fish chemical cues. The individual's reaction to the novel environment was video recorded for six minutes. Males and females from one pair of groups were tested on the same day to control for previous time spent in social groups. Time exploring the space, freezing and erratic movements reveal that when exposed to a novel environment, females were risk-takers compared to males. These results provide further evidence that domesticated fish can behave differently from wild fish which should prove useful for comparative mechanistic studies.

Geometric morphometrics and multilayer perceptrons can assist in the rapid acquisition of population data for conservation efforts (Contributed Talk)

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The biodiversity crisis is among the post pressing ecological challenges of modern times. In order to address losses in biodiversity, conservationists require efficient methodologies to classify specimens to relevant functional and taxonomic units. Unfortunately, many such methodologies require experienced practitioners. In contrast if there were accurate classification techniques that required little training, the population data required for conservation efforts could be acquired at larger scales and faster rates. Here we assess the efficacy of one possible group of procedures for classification. In order to make a classification, the researcher first uses geometric morphometric techniques to describe a phylogenetically informative structure and then uses a multilayer perceptron, an elementary form of artificial neural network, to implement the actual classification. Assuming that an experienced researcher is able to provide enough information to train the multilayer perceptron, the end-user would only need to be able to identify the relevant landmarks. To assess this system, we attempted to classify each upper, left jaw tooth from 5-15 specimens of *Carcharhinus altimus, C. galapagensis*, *C. obscurus*, and *C. plumbeus* based on a training set of 5 specimens per species. We compared the accuracy of this system to alternatives using linear measurements and linear discriminate function analysis and using geometric morphometric data and linear discriminate function analysis. The comparison demonstrates that although geometric morphometric data incorporated into a multilayer perceptron yields modest overall accuracy levels, the accuracy for each species varies less. The most ideal system, therefore, will depend on the needs and goals of the practitioner.

The contribution of biotic resistance and feralization to cold tolerance in an introduced tropical fish (Contributed Talk)

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Temperature is a central environmental variable affecting species distributions. Because of the importance of temperature, organismal thermal tolerance can be used to identify the risk of establishment for non-native species. Cold tolerance, in particular, is a dominant factor affecting the risk of tropical fish establishment in sub-tropical Florida. However, common methods used to assess cold tolerance in potential invasive species can sometimes lack ecological relevance because they do not include environmental variation nor do they account for feralization leading to thermal adaptation. For example, eastern mosquitofish (*Gambusia holbrooki*) is ubiquitous in Florida and enhances biotic resistance to tropical fish invasion through agonistic interactions. Further, recent evidence suggests cold tolerance can evolve on contemporary time scales, perhaps influenced by feralization. Using a common

garden approach and chronic lethal methodology we investigated the contribution of biotic resistance and feralization to cold tolerance in the green swordtail (*Xiphophorus hellerii*), a common ornamental fish with commercial production and locally persistent populations in Florida. Our findings indicate that feral populations of green swordtail have greater cold tolerance than farmed populations, but this enhanced cold tolerance is offset by the presence of eastern mosquitofish. These results suggest feralization can lead to thermal adaptation which could be an important pathway promoting persistence of tropical non-natives introduced at the periphery of their thermal niche. However, our results also suggest the inclusion of more ecologically-relevant study designs (e.g., competitors or predators) might eliminate any evolutionary gains to thermal tolerance.

A new look at an old icon, density-dependent selection (and its adopted offspring, r- and K-selection) (Keynote)

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Density-dependent selection, the process through which certain phenotypes are favored at high population densities that are not favored at low densities, is a foundational idea in evolutionary biology. It is most widely known through an idea derived from it, r- and K-selection. Despite its theoretical importance, rigorous demonstrations of density-dependent adaptation are remarkably scarce. Here I argue that one reason for the scarcity is that we have been looking for the wrong evidence. I will argue that density-dependent selection is an important force in molding life-history and behavior but that the evidence must be sought in norms of reaction to variation in population density. I will illustrate the arguments with data from the Least Killifish in north Florida and the Trinidadian guppy in, of course, Trinidad.

Sensory ontogeny in fishes: it's all in the timing (Contributed Talk)

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The behavioral responses of fishes to predators, prey, conspecifics, and environmental cues depends on the ability of the major sensory systems to detect and interpret stimuli in the context of the sensory environment. Furthermore, the ontogeny of behavior is dependent upon the pattern and timing of the ontogeny of those sensory systems, and resultant changes in their functional capabilities. The mechanosensory lateral line system detects unidirectional or oscillatory water flows at short-range, which arise from predators, prey, environmental flows and obstacles. The lateral line system goes through dramatic changes in structure through the larval stage and metamorphosis to the juvenile stage. After the initial establishment of an array of neuromast receptor organs on the skin of the head and trunk in young larvae, neuromasts may increase in number (proliferation) and size and change shape. Then, typically at metamorphosis, a subset of neuromasts becomes enclosed in pored lateral line canals on the head and trunk, changing them from velocimeters to accelerometers. The timing of these changes has important

implications for flow sensing capabilities in developing fishes. This paper will examine the absolute and relative timing of the development of the lateral line system in fishes as diverse as zebrafish, cichlids, butterflyfishes, and gobies, with reference to behavioral demands, sensory environment, and the potential role of multimodal integration of sensory inputs in the formulation of behavior. Supported by NSF grants 0843307 and 1459546 to JFW.

Co-existence with non-native brook trout disrupts the pace-of-life syndrome in native brown trout (Contributed Talk)

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One key prediction from the pace-of-life syndrome hypothesis is that behavioral, physiological, and life–history traits are associated within an adaptive phenotypic syndrome linked to the ecological niche use and life-history productivity of an individual. However, phenotypic traits in the wild and their associations are also likely to be sensitive to variable environmental conditions. Here field studies in a natural stream are combined with standardized estimates of behavioral, physiological and morphological traits in the lab to address the novel hypotheses that co-existence with a non-native invader induces a novel environmental pressure which disrupts the adaptive association among phenotypic traits in the native species with negative consequences for its fitness. We compared the strength of associations among key phenotypic traits and the ecological niche of an allopatric group of native brown trout (*Salmo trutta*) with a group of brown trout living in sympatry with a non-native invader (brook trout, *Salvelinus fontinalis*). We found that the strength of the phenotypic syndrome was considerably reduced in the sympatric group of brown trout. This breakdown of phenotypic associations in the sympatric situation was accompanied by a decrease in growth rate, as well as a shift in ecological niche (e.g. diet and home range) and body shape. These novel results suggest that invasive species may undermine the individual fitness of native species by disrupting their adaptive pace-of-life syndrome.

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