

Abstracts for the 26th Annual Meeting of the Florida Chapter American Fisheries Society

Arnold, W.S.

Presented by: Arnold, W.S. • Non-Student • Symposium platform presentation

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Non-indigenous species: Experience suggests a new approach

Efforts to understand and manage non-indigenous species in Florida waters involve considerable activity and substantial funding but little direction and even less success. Even the nomenclature is confused, with terms such as "invasive", "non-indigenous", "exotic", "alien", etc used interchangeably with little appreciation for important distinctions among these terms. My own experience with non-indigenous species in Florida waters is with the Asian green mussel, *Perna viridis*, whose vector of introduction is assumed but not known and for whom the predicted range of impact has not been realized. However, many other examples of non-indigenous species whose presence may be desired, opposed, or controversial are available from Florida and from other areas throughout the world. The suminoe oyster *Crassostrea ariakensis* is being considered for introduction into Chesapeake Bay while there is considerable concern in that same region regarding the introduced rapa whelk *Rapa venosa*. The bay scallop *Argopecten irradians* was introduced into China and supports a lucrative aquaculture industry there. Such unpredictable outcomes and opposing philosophies suggest that a new approach to non-indigenous species introductions should be considered for Florida and U.S. waters. This approach would be based upon a comprehensive policy regarding species introductions that takes into account economic opportunity, ecological impacts, and species diversity issues. Research also must be redirected to identify ecosystem features that support a successful invasion, rates and attributes of population expansion (and contraction), and factors that contribute to the elimination of a non-indigenous population.

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Preliminary trophic dynamics of the Atlantic angel shark in the northern Gulf of Mexico

Atlantic angel sharks (*Squatina dumeril*) were collected for stomach content analysis from a trawl fishery in northeastern Florida on 11 February (n=50) and 29 April (n=59) 2005. Angel sharks consumed mostly teleost fishes (90% occurrence in stomachs containing food), with Atlantic croaker (*Micropogonias undulatus*) being the most common prey item from both sampling trips. Other prey items that contributed to the diet but were less important than teleosts overall were squid (*Loligo sp.*) and crustaceans, occurring in 17% and 14% of non-empty stomachs, respectively. Cumulative prey curves were used to assess the sample sizes for both sampling trips and indicated that the diets were well described in both cases. To estimate the potential prey size and abundance available to angel sharks, portions of the trawl catch in which angels sharks were landed were sampled using a stratified random design during normal sorting operations. These samples were used to quantify prey availability based on total catch numbers recorded by the fishery. The diet from these two sampling trips was approximately proportional to the available prey, indicating that Atlantic angel sharks are opportunistic predators and not selective in their foraging.

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Using acoustic telemetry to estimate natural and fishing mortality of common snook in Sarasota Bay, Florida

The common snook *Centropomus undecimalis* is a popular, saltwater gamefish found in southern Florida that has been actively managed by the state management agencies to prevent overexploitation since the 1950's. Despite increasingly restrictive management regulations, the status of the population and the effectiveness of these regulations remain uncertain. Most fisheries management activities are focused on regulating fishing mortality (F). Because of this, an important aspect of population assessments is an accurate estimate of F to provide insight into the magnitude of fishing mortality relative to natural mortality (M). We used telemetry methods to estimate total mortality (Z), F, and M for adult common snook in Sarasota Bay, Florida. The "fates" of each fish were determined through a combination of active tracking and observations from a series of remote, autonomous receivers. These relocations were evaluated using a suite of *a priori* assumptions to determine whether an animal was live or dead. These fates were then converted to mortality rates using known-fate type models in program SURVIV. For the period from October 2004 through September 2005 our models estimated a range of Z values (0.78 – 0.84) and a range of F values (0.29 – 0.6) depending on how assignments of natural mortality related to red tide events were made.

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Seasonal abundance and size of common snook, *Centropomus undecimalis*, in the Peace and Myakka rivers, Florida: Implications for overwintering

Common snook are popular gamefish that support a large recreational fishery in coastal south and central Florida. Anglers and scientists have long assumed that common snook are migratory – moving inshore to the rivers during fall to overwinter and moving back out to the bays and passes during spring – yet there are no conclusive studies published to substantiate this theory. The goal of the present study is to test the overwintering paradigm – more specifically, does common snook abundance vary seasonally in rivers? If so, are there any distinct changes in the length distribution that would indicate only certain sized fish are migratory? Seasonal stratified-random and fixed-station electrofishing was conducted in the Peace and Myakka rivers from fall 2004 through winter 2006. A total of 1,078 common snook (278 to 1055 mm TL) were collected widely throughout both rivers. During the first year of the study, abundance shifted from the lower to the upper Peace River, possibly indicating a return of common snook into the upper river after avoiding a low dissolved oxygen event associated with Hurricane Charley (Aug. 13, 2004). Aside from this post-hurricane movement, common snook abundance was greater during fall and winter than in spring and summer in the Peace and Myakka rivers. The inverse trend in seasonal abundance was evident from long-term fisheries monitoring in the bay. Common snook in the rivers typically ranged from 300 to 900 mm TL each season. There were no distinct changes in the length distribution that would indicate only certain sized fish are migratory. In summary, preliminary data show some evidence

for the overwintering theory; however, the relatively high abundance of common snook in the rivers during summer suggests that a resident or semi-resident population exist. More understanding is needed about common snook that inhabit rivers to determine how they interact with populations in the open estuary.

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Preliminary population responses of sport fish species to a habitat enhancement at West Lake Tohopekaliga

A habitat enhancement project was conducted at West Lake Tohopekaliga (Toho), Florida, during 2003-2004 to improve fish habitat and remove dense inshore vegetation. This study aims to assess the long-term effects of this enhancement on populations of bluegill *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, and redear sunfish, *L. microlophus*. Population growth, recruitment, mortality, size structure and roving creel estimates will be compared between pre-enhancement and post-enhancement periods for all three species. Preliminary results indicate that largemouth bass and redear sunfish size structures, as indexed by PSD and RSD_p, are similar between pre- and post-enhancement periods, but RSD_m for largemouth bass may have declined. Bluegill size structure may have shifted as well, with declines in both PSD and RSD_p. Total annual mortality (*A*) for largemouth bass from 2001-05 remains similar over time, averaging 38% and ranging from 35 to 42%. Total (*A*) for bluegill has fluctuated considerably and has ranged from 20% to 51% and averaged 39%. Total (*A*) for redear sunfish remains similar over time, averaging 43% and ranging from 39% to 51%. Although angler catch rate of sunfish remained unchanged, effort has declined in recent years. Fluctuations in angler effort and catch rate for largemouth bass may be related to hydrilla coverage; thus, other factors aside from the enhancement may influence the population dynamics of these species. Additional post-enhancement data are needed to further evaluate the effect of the habitat enhancement on these populations, including the assessment of recruitment and growth.

Bortone, S.A.

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The status and trends of the historical recreational tarpon fishery in southwest Florida

Tarpon (*Melalops atlanticus*) along Florida's southwest coast have provided and continue to provide recreational fishing activity for a substantial number of anglers. However, questions regarding the sustainability of tarpon fisheries have been asked in other regions of the world where the species has been intensely fished for more than a century. Nearly 1,000 tarpon scales housed in the Olde Marco Inn on Marco Island, the Collier Inn and Tarpon Bar on Useppa Island, and the Gasparilla Inn on Gasparilla Island recently became available for examination. Historically, fishers captured tarpon and subsequently recorded information regarding their catch directly on a scale. The data recorded on tarpon scales were analyzed to provide a perspective on the long-term changes (or stability) of this fishery. The information recorded on each scale was often incomplete or unreadable: nevertheless there was sufficient information on date of capture and size (i.e., total length in inches and/or weight in pounds) to be useful

in providing insight into the historical population structure. Data from fish captured between 1902 and 1998 were tallied relative to annual catch, season of capture, size and condition factor (Fulton's K). Historically, tarpon from this area were caught chiefly during March, April, and May with most fish between 140 and 160 cm Fork Length. There was a subtle, but significant, decline in fish length during the past century. Also, the modern fishery catches substantial numbers of tarpon from April through July, indicating a possible shift in their movement patterns. Unlike the results from a similar study conducted in Texas, here there was indication of an increase in the condition factor (Fulton's K) among tarpon over time. With acknowledge of several important assumptions, data on historical fisheries are potentially invaluable in giving perspective to the species' long-term status.

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The Borg Assimilation Hypothesis: Fact or prevarication?

Hybridization is widely regarded as one of the most deleterious interactions between native and nonindigenous species due to the potential for detrimental alteration of evolutionary trajectories and increased extinction risks. The red shiner *Cyprinella lutrensis*, a gregarious, invasive minnow native to the Midwestern United States, has a history of causing negative interactions when introduced, including the formation of hybrid swarms with congeners. A hybrid swarm between introduced red shiners and native blacktail shiners *C. venusta stigmatura* was discovered in North Georgia in 2000. Because the swarm was expanding towards the largest population of a threatened endemic, the blue shiner *C. caerulea*, a behavioral study was instigated to determine if red shiners would electively hybridize with blue shiners. Repeated experiments were conducted between small spawning assemblages of blue shiners and red shiners. Analysis of progeny from mixed species assemblages disclosed a vexing and alarming hybridization rate of 88%. Although this extraordinary result is contrary to species and ecological theory, red shiners are known to have precipitated at least three hybrid swarms in which hybrids are fertile. Observations of spawning in mixed assemblages revealed that red shiner males aggressively hybridize—even when multiple red shiner females and spawning sites were available. After review of the zoogeography, historical ecology, and life history strategies of the red shiner, we conclude that aggressive hybridization may be an adaptation to rapidly acquire local fitness to novel ecological settings, a curious but testable hypothesis.

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Habitat use by juvenile gag (*Mycteroperca microlepis*) in subtropical Charlotte Harbor, Florida

Estuaries play a key role in the juvenile stage of gag (*Mycteroperca microlepis*). The use of estuarine habitats by juvenile gag has been examined in temperate estuaries, which are at the northern limits of the range of this species, but the importance of subtropical estuaries during the early life history of this species has been little studied. Charlotte Harbor is a large subtropical estuary in southwestern Florida that supports many suitable habitats for juvenile gag (e.g., seagrass beds, fringing mangrove shorelines).

Juveniles have been collected from seagrass beds within Charlotte Harbor during ichthyofaunal surveys, but their distribution, seasonality, habitat use, and relative abundance have not been examined in detail. Gag were collected during routine monthly sampling from January 1996 to December 2002 as part of an ongoing fisheries-independent monitoring program. Juvenile gag were collected using a 21.3-m seine, a 183-m haul seine, and a 183-m purse seine. A total of 738 individuals ranging from 30 to 489 mm standard length (SL) were captured. Most (96%) gag were probably young-of-the-year (<288 mm SL). The majority of juveniles were collected in Gasparilla and Pine Island sounds from April to December, with a few larger individuals captured year-round. The observed period of gag settlement was similar to that in other subtropical and temperate estuaries, but gag in Charlotte Harbor remained in the estuary longer and egressed at a larger size than did gag in other estuaries. Habitat use by juvenile gag within Charlotte Harbor was greatest on shallow seagrass shoals but was also high along mangrove shorelines, which is a habitat not previously reported for gag.

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Non-indigenous fishes of Caloosahatchee River oxbows

Periodic electrofishing, begun in October 2005, is being conducted in remnant oxbows of the Caloosahatchee River to determine the presence and relative abundance of non-indigenous fishes and for comparison to the indigenous resident fishery. Caloosahatchee River flows are subject to high variability in timing and volume due to partial conversion of the watershed to agriculture and regulated flows upstream from Lake Okeechobee. Flows are further regulated by a series of three lock and dam structures that create a multiple reservoir effect. It was theorized that the highly variable river hydrology may lessen "biotic resistance" and facilitate invasion by non-indigenous fishes. As of this writing, sampling is on-going and results are preliminary. However, the shore perimeter of seven oxbows have been surveyed (a total of 2.33 hours of electrofishing) and as of January 2006, six species of non-indigenous fishes have been collected, including: *Pterygoplichthys* sp. (sailfin catfish), *Oreochromis aureus* (blue tilapia), *Ctenopharyngodon idella* (grass carp), *Hemichromis letourneauxi* (African jewelfish), *Cichlasoma urophthalmus* (Mayan cichlid), and *Clarias batrachus* (walking catfish). Only two non-indigenous species, *Pterygoplichthys* sp. and *O. aureus*, are relatively abundant (more than two individuals collected to date) compared to indigenous species. CPUE for *Pterygoplichthys* sp. and *O. aureus* was 11.2 and 4.7 per hour respectively. CPUE for stock size *Micropterus salmoides* (largemouth bass) >200 mm TL, and *Lepomis macrochirus* (bluegill) > 80mm TL was 9.0 and 3.0 per hour respectively. The most commonly collected indigenous species (CPUE of 15.0 per hour) was *Lepisosteus platyrhincus* (Florida gar). This preliminary evaluation indicates that *Pterygoplichthys* sp. (sailfin catfish), native to South America, has successfully invaded the Caloosahatchee River system and in many freshwater oxbow environments is more abundant than recreationally important sport-fish. The impact of *Pterygoplichthys* sp. on this system is unknown.

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Evaluating effects of size-selective harvest on growth parameter estimates in gizzard shad

Fish growth parameters from the von Bertalanffy model (e.g., Brody growth coefficient, asymptotic length) are used to estimate natural mortality and fishery yield. However, exploited fish populations often have biased growth parameters due to selective removal of fast-growing individuals. Evaluating these biases is problematic because it requires data on unfished populations, which rarely exist. We evaluated bias in growth parameters of gizzard shad *Dorosoma cepedianum* following commercial gillnet harvest from Lake Dora, Lake County, Florida. Gizzard shad growth was estimated via experimental gillnets immediately before and after harvest at a fished lake (Lake Dora) and at two unfished control lakes (Lakes Eustis and Harris). We used Akaike's Information Criterion to test for differences in growth parameters between pre- and post-harvest growth models at the fished lake versus the unfished lakes, and we assessed effects of biased growth parameters on natural mortality and yield estimates. Asymptotic length (L_{inf}) decreased by 31.7 mm after harvest at the fished lake but the growth coefficient (K) and time at zero length (t_0) did not differ between time periods. Time at zero length (t_0) decreased by 0.26 yr at an unfished control lake whereas parameter estimates did not differ between time periods at a second unfished lake. Biases in growth parameters at the fished lake did not substantially influence yield and natural mortality estimates. However, variation in growth parameters at the unfished control lake indicated that biases due to sampling error or seasonal effects on fish selectivity may have overshadowed biases due to shad harvest.

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Diet of the Atlantic cownose ray *Rhinoptera bonasus* in Charlotte Harbor, Florida, USA

Cownose rays are benthic, suction feeders whose foraging activities have been implicated in severe damage to commercial shellfish industries and seagrass habitat. With jaws highly modified for durophagy, it has been assumed that they are crushing specialists, feeding primarily upon hard molluscan prey. Stomach contents from cownose rays caught within the Charlotte Harbor estuary between July 2003 and July 2004 were analyzed using the index of relative importance (IRI). A total of 92,576 prey items from 38 families fell into 9 distinctive groups: bivalves, gastropods, crustaceans, brachiopods, chordates, echinoderms, nematodes, polychaetes, and detritus. Adult and juvenile diets showed significant overlap. Shoalmates had more similar diets than non-shoalmates, indicating group feeding. Crustaceans, polychaetes, and bivalves were the dominant groups present over all stomachs examined. Crustaceans (%IRI = 56.85) and polychaetes (%IRI = 25.90) were the most important prey groups, with cumaceans (*Cyclaspis* sp. and *Oxyrinchus smithii*) accounting for the majority (94%) of crustaceans and *Pectinaria gouldii* representing the bulk (70%) of the polychaetes. Bivalves were the least abundant of the three dominant groups (% IRI = 12.93). *Cyclaspis* sp., *O. smithii* and *P. gouldii* are prevalent benthic

invertebrates within Charlotte Harbor and can occur in extremely high densities. All cumaceans and polychaetes within ray stomachs were intact, indicating capture through suction feeding. All larger, hard prey (bivalves, echinoderms, and brachiopods) showed evidence of crushing (fractured and broken shells). Although currently believed to be a hard prey specialist, these results suggest the cownose ray may behave as an opportunistic generalist, modifying feeding behavior to consume any readily available prey.

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Evaluation of two types of gravel as sunfish attractors

Methodology and effectiveness of using gravel for attracting sunfish was tested from Spring 2004 through Spring 2005. In November 2004, gravel was placed along the Eustis Lake Walk pier (ELW) in twenty frames (3.05 x 3.65 m) constructed of 5 x 15 cm pressure treated wood. Lime rock (#57 size) and quartz gravel (#7 size) were each placed in 10 randomly assigned frames. Electrofishing samples indicated that the gravel attractors were effective in concentrating sportfish. Catch rates of sunfish increased significantly from the 2004 pre-attractor (23.9 fish/hr) to the 2005 post-attractor sites (501.1 fish/hr). Angler catch for sunfish on the ELW was estimated to have increased from 220 ± 125 fish in the 2004 survey to 2883 ± 1305 fish in the 2005 survey. Sunfish angler success rate increased from 0.54 fish/hr in 2004 to 2.56 fish/hr in 2005 (a 374% increase). There was no significant difference in the number of sunfish caught from the two types of gravel, so the less expensive #57 lime rock is recommended to be used around public docks, boat ramps, and seawalls to improve sunfish catch for anglers.

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Estimating reef fish communities at artificial reef sites using a remotely operated vehicle

We estimated reef fish abundance and community structure at 27 unreported artificial reef sites located between 15 and 20 miles south of Santa Rosa Island, Florida. Three reef types were sampled (A, B, and C), with reefs of each type (n=3) located in three depth strata. Type A reefs were solitary pyramids made of concrete and rebar and having a height of about 3m and a base of about 3m. Type B reefs were paired pyramidal concrete modules with a smaller pyramid insert inside. Type B outer modules stand about 1.8m tall and have a base of about 3m. Type C reefs were paired concrete Reef Balls with a height of about 1.5m and a base of about 1.8m. Quarterly video sampling was conducted at all sites from November 2004 through September 2005 using a novel remotely operated vehicle-based methodology. Species then were identified and enumerated from video in the laboratory. Estimated fish abundance was significantly different among reef types, depth strata, and sampling quarters (ANOSIM; p<0.001 for each). The most abundant fish observed was red snapper, which increased from fall 2004 through summer 2005. Other snapper species (gray, vermilion, and lane) followed similar patterns of increasing abundance with time. Groupers (gag, red, and scamp) showed an opposite trend with steady decreases from fall to summer. In all quarters, single high-profile pyramid reefs had consistently lower abundances than lower profile paired modules. Fish size, as estimated with lasers attached to the ROV, also was different among reef types for several species. Results will be discussed in the context of a larger study examining the ecological function of unreported artificial reefs.

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A preliminary look at impingement at a Gulf Coast power plant

Gulf Power's Plant Crist is located on Governor's Bayou in the Lower Escambia River system which is considered to be in a tidal area of Escambia Bay. Approximately 155.4 million gallons of water per day are drawn from Escambia Bay by Plant Crist for use as cooling water. The water is drawn through large screens intended to prevent the intake of organisms and/or debris. Some organisms become trapped or "impinged" against these intake screens. According to 40 Code of Federal Regulations, Section 316b, Gulf Power is obligated to demonstrate that Plant Crist will reduce impingement mortality between 80 to 95 percent of calculation baseline. Beginning in June 2005, a year-long study was undertaken to determine the calculation baseline and impingement rates of fish and shellfish at Plant Crist. Impinged organisms are being sampled monthly using a 3/8" mesh basket that collects all organisms that are washed off the intake screens in a 24 hour period. Based on data collected in this study, Gulf Power will evaluate several compliance alternatives, including the reduction of the screen intake velocity and credit for the location of the cooling water intake structures. Thus far, impingement levels have been extremely low when compared to a similar study done in the 1970's. This may be due, at least in part, to implementation of reduced intake volume and use of closed cycle cooling. The impingement study for Plant Crist conducted in the 1970's demonstrated that impingement is highly episodic. In this historical impingement study at Plant Crist it was found that the major fraction of total impingement was due to the periodic occurrence of schools of Gulf menhaden in the intake lagoon.

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Fishes of the Brooker Creek Preserve, Pinellas County, Florida

Though the earliest records for freshwater sampling in the area of Lake Tarpon and Brooker Creek Preserve are from 1896, freshwater fish samples from Pinellas County are not well represented in museum records or County documents. In the fall of 2001 and summer of 2002, personnel from the Pinellas County Water Resources Management Section and Lands Management Division conducted a preliminary fish survey of the main channels and associated ponds and marshes of the Brooker Creek Preserve. Sampling sites were ephemeral pools. Seventeen orders and 11 families of fishes were found on the Preserve. This included 15 native and two non-native species. Gambusia holbrooki represented 84% of all fish captured. The other dominant species represented were Chaenobryttus gulosus - 4%, Fundulus chrysotus - 3%, non-native cichlid Cichlasoma bimaculatum - 3%, Heterandria formosa - 2.5%, and Elassoma everglade - 2%. Five walking catfish, Clarias batrachus, a non-native species, were collected. There was a considerable difference in abundance between the end of the 2001 wet season and the beginning of the 2002 wet season. Due to the dry conditions in December 2001, specimens were concentrated in isolated pools and channels. In 2001, 16,413 specimens of 18 species were captured. Sampling in 2002 began one month into the rainy season, after the wetlands refilled; the fish were dispersed over a much larger area than the 2001 sampling set. In 2002, 280 specimens of 11 species were captured.

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Isolation and characterization of 13 polymorphic microsatellite loci for the Florida pompano, *Trachinotus carolinus*

The Florida pompano, *Trachinotus carolinus*, is an economically important gamefish found from Massachusetts to Brazil and in the Gulf of Mexico. It is not known if the fish in these locations represent a single genetic stock or multiple stocks. To examine genetic stock structure we have used PIMA, a polymerase chain reaction (PCR)-based method to isolate 13 polymorphic microsatellite loci from *T. carolinus*. These loci averaged 11.38 alleles per locus in a sample of 46 pompano. For these loci, expected heterozygosities ranged from 0.15 to 0.94 (mean = 0.69). Significant departures from Hardy-Weinberg equilibrium expectations were not observed for any of the loci. Exact tests for linkage disequilibrium gave no evidence for linkage between pairs of loci. Thus, these markers are consistent with Mendelian inheritance and suitable for studies of stock structure and connectivity. Many cross-species primer assays yielded PCR fragments of the expected size for two additional *Trachinotus* species: *Trachinotus falcatus* (Permit) and *Trachinotus goodie* (Palometa), suggesting that these loci may also be useful for population studies of these species, as well as for species identification and investigation of interspecific hybridization.

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Presented by: Dorfman, J.M. • Non-Student • Poster presentation

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Brood size variation in the sex-role reversed pipefish *Syngnathus scovelli*

In polyandrous, sex-role reversed pipefish with female-biased operational sex ratios, males might be expected to maximize fitness by filling brood pouches to capacity. If so, the number of eggs in the pouch should increase predictably with an increase in fish length and pouch size. However, in Gulf pipefish, a species known to exhibit extreme polyandry, the relationship between male length and brood size is very weak. We are examining the basis for this relationship and have found that in Tampa Bay, brood pouches are often not filled to capacity, despite high densities of fish that would presumably enable males to easily find mates. We found no relationship between pouch fullness and either egg diameter or egg developmental stage, and no evidence that brood size increases with an increase in population density. In males carrying early stage eggs, large variation in the fish length-brood size relationship and a high proportion of unfilled pouches suggest that males either do not always fill pouches to capacity when mating and/or that they frequently expel eggs soon afterwards. The implications of these results are being investigated further.

Dutterer, A.C.¹ and M.S. Allen²

Presented by: Dutterer, A.C. • Student • Platform presentation

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Trends in spotted sunfish habitat utilization and their potential application in setting minimum flows and levels for Florida Rivers

Spotted sunfish *Lepomis punctatus* is a common member of streamfish communities that occur throughout Florida and the southeastern U.S. The relationship of decreases in spotted sunfish abundance following prolonged periods of low streamflow and stage level has recently been identified. Thus, the species may serve as an indicator species for flow and stage conditions, possibly providing insight for establishing Minimum Flows and Level (MFL) regulations for Florida rivers. We quantified microhabitat used by adult and juvenile spotted sunfish to predict how fluctuation in streamflow and stage may affect the availability of important spotted sunfish habitat at the Anclote, Manatee, and Little Manatee Rivers of the central Gulf Coast of Florida. Spotted sunfish were sampled using boat electrofishing gear and habitat parameters were measured within an interval defined by a one meter radius surrounding the location of each individual, from stream surface to substrate. We compared characteristics of microhabitat used by spotted sunfish versus characteristics of habitat intervals at randomly selected locations to identify habitat characteristics important to the species. Spotted sunfish utilized areas with structurally complex cover such as woody debris, snags, exposed roots, and aquatic macrophytes. Because these habitat types are located along stream margins, they are particularly susceptible to dewatering during low river stage, possibly explaining observed spotted sunfish population response to fluctuation in water level.

Flaherty, K.E.¹ and R. Lehnert²

Presented by: Flaherty, K.E. • Non-Student • Platform presentation

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Seasonal distribution and abundance of blue crabs (*Callinectes sapidus*) in the Tampa Bay Estuary using fisheries independent monitoring data

Blue crabs (*Callinectes sapidus*) are an integral part of the estuarine ecosystem both as predators and prey. Many of the studies on blue crabs in Florida are based on adult trapping data, but this study describes the relative abundance and distribution patterns of juvenile and adult blue crabs in the Tampa Bay estuary using fisheries independent data. Stratified-random sampling collections were made monthly using center-bag seines and otter trawls during 1996-1997. Catch rates and least square means indices of relative abundance were calculated for recruits (0-20 mm CW), juveniles (21-80 mm CW), and adult (>80 mm CW) blue crabs caught during the 2-year study. Gear, month, and depth were shown to significantly affect the catch of all size classes of blue crabs. Recruits were collected in all months, confirming an extended spawning season, but there were elevated catches in January, February, and September. Recruits and juveniles comprise the largest portion of the overall catch from August through April. Adults were caught year-round with males generally tending to be larger and more abundant than females. Salinity played a significant role in the distribution of larger juveniles and adult crabs, while geographical region of the bay affected the distribution of recruits. The Manatee River and lower regions of the bay had the highest densities of recruits. These initial densities may be driven by proximity to the mouth of the bay, with the larval supply coming from offshore. Using monthly seine data from 1996-2004, year was shown to significantly affect catch rates for recruits and juveniles. A decline in juvenile abundance began in 1998, with a significant low in 2002. A similar pattern was observed for adults in commercial landings. The combination of increased fishing pressure due to the entanglement net ban and unfavorable salinity regimes may have contributed to these abundance trends.

Fuller, P.

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USGS Nonindigenous Aquatic Species Database and Alert System

The U.S. Geological Survey's Nonindigenous Aquatic Species (NAS) Database <http://nas.er.usgs.gov> is a repository for occurrence information on introduced aquatic species nationwide. The database contains information on more than 1500 freshwater and marine species including location and status of introductions. Queries of the database can be performed using a variety of parameters including species, location (by state or drainage), pathway, and status. The result is a list of species that link to an occurrence database, a reference database, a fact sheet database, and a GIS system that dynamically generates distribution maps. Users can navigate the maps on our web site to link to the supporting records for each introduction location. Each record is supported by literature, a personal communication, and/or a voucher specimen or photo. Species fact sheets contain information on the taxonomy, identification, native, and introduced ranges, method of introduction, status, and known impacts.

The NAS database acts as a reporting center for newly discovered species or populations. Sighting reports can either be submitted through our web site or a toll-free phone line (1-877-STOP-ANS). As part of an early warning system, in July 2004, we activated the 'NAS Alert system' which notifies registered users of new occurrences via e-mail. Users can sign up for "State Watches", "Group Watches" and/or "Species Watches". The system also allows users who are not registered to review and query archives of alerts that are sent. To view alert archives or register to receive alerts go to <http://nas.er.usgs.gov/AlertSystem/>

Galleher, S.N.¹ and K.J. Smith²

Presented by: Galleher, S.N. • Student • Poster presentation

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Seasonal distribution of *Fundulus heteroclitus* in the St. Marys, Nassau and St. Johns Rivers of northeast Florida

Fundulus heteroclitus (mummichogs) are one of the most common resident salt marsh fishes along the East coast. These fish are ecologically important in the salt marsh food web, serve as a model fish for experimentation because of their hardy nature, and are used as live bait for recreational fishing. Understanding seasonal differences in fish distribution can help assess population size of these fish. The distribution of *F. heteroclitus* was assessed using the stratified random sampling methods of Fish and Wildlife's Fisheries Independent Monitoring (FIM) program from 2001-2004. Sampling was conducted in the three major estuaries in the Jacksonville area St. Mary's, Nassau, and the St. Johns River. We analyzed samples from 21.3-m seines (mesh size = 3.2mm) set from a boat. From a total of 1409 seine net sets, 318 contained *F. heteroclitus* (N=11,379 individuals) ranging from juvenile to adult in size (mean = 36.8 ±12.4, range = 11 to 83 mm SL). Seasonal average water temperatures were compared to fish abundance and size distributions using ESRI ArcMap. St. Marys River showed a higher maximum abundance in one sample (n = 1,304) than either Nassau (n = 522) or St. Johns Rivers (n = 680). Also, in warmer seasons there was a trend toward higher fish abundance near the inlet and larger schools were collected in individual seine net samples. No apparent seasonal abundance trends were seen for Nassau and St. Johns Rivers.

Gestring, K.B., P.L. Shafland, and M.S. Stanford

Presented by: Gestring, K.B. • Non-Student • Poster presentation

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The status of Loricariid Catfishes in Florida with emphasis on Orinoco Sailfin (*Pterygoplichthys multiradiatus*)

Loricariid catfishes are widespread and abundant throughout much of Florida and as a group they currently exist throughout most of their potential Florida range. The Orinoco sailfin catfish (*Pterygoplichthys multiradiatus*) and vermiculated sailfin (*P. disjunctivus*) ranges overlap north of Lake Okeechobee, with the vermiculated sailfin dominating to the north and the Orinoco sailfin catfish to the south. The suckermouth catfish (*Hypostomus* sp.) occurs in several urban canals in metropolitan southeast and west-central Florida. These distributions appear related to differences in their lower lethal temperatures. Gonadal-somatic indices indicate sailfin catfish spawning occurs primarily between April and September in Florida. Fecundity estimates for ripe female sailfin catfish averaged 1,983 eggs (5 eggs/gram). Male sailfin catfish grow larger than females, and only 6% of the sailfin catfish ≥ 450 mm TL were females. Detritus, algae and crustaceans were the principal food items of Orinoco sailfin catfish. Sailfin catfish are one of the more successful established exotic fish in Florida in terms of their range extension and abundance, yet their presence has not had any measurable effect on native fishes although they have contributed significantly to the carrying capacity of some fish communities. Moreover, none of the 30 professional water managers, engineers, lake management, and shoreline stabilization company owners contacted in 2004 considered erosion caused by the burrowing activity of loricariid catfishes a major problem, except in some small, man-made lakes in the southeastern part of the state.

Gestring, K.B., P.L. Shafland, and M.S. Stanford

Presented by: Gestring, K.B. • Non-Student • Symposium platform presentation

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Florida's exotic freshwater catfishes

Three loricariid catfishes are established in Florida, two of which are widespread and abundant. Life history data indicate the Orinoco sailfin catfish (*Pterygoplichthys multiradiatus*) spawns primarily between April and September, has an average of about 2,000 eggs per ripe female, primarily consumes detritus, algae and crustaceans, and has a lower lethal temperature of 9^oC. During the last 15 years the Orinoco sailfin has become very successful and they currently make up as much as 40% of the biomass in some fish communities; however, even when abundant the Orinoco sailfin does not appear to be detrimentally affecting the abundance of native fish populations. It has also been speculated that loricariid burrowing could cause serious shoreline destabilization problems, but none of the professional water managers, engineers, lake management, and shoreline stabilization company owners contacted considered them a major problem, except in some homeowner association lakes in southeastern Florida.

Brown hoplo (*Hoplosternum littorale*) have spread into many different aquatic habitats in central and southern Florida since their discovery in 1995. Their rapid dispersal has likely been facilitated by recreational and commercial castnetters who value brown hoplo as food. Life history information is presented including gonadal-somatic indices that indicate brown hoplo primarily spawn between April and October, eat crustaceans, aquatic insects, detritus, and decaying plant matter, produce an average of about 10,000 eggs per ripe female, and has a lower lethal temperature of 10^oC.

Walking catfish (*Clarius batrachus*) were first discovered in 1967. Although they occur throughout most of peninsular Florida south of Gainesville and can be locally abundant in some areas, their total abundance appears to have decreased since the 1980's. Generally speaking, the very serious detrimental effects originally predicted for walking catfish have not materialized.

Gibson, S.M.¹, W.F. Patterson², R.P. Phelps³, and W.P. Patterson⁴

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Distinguishing wild from hatchery produced juvenile red snapper with otolith chemistry

Stock enhancement has been proposed as a means to rebuild Gulf of Mexico red snapper populations. Most enhancement programs employ some tagging or mass marking methodology to estimate the contribution of hatchery fish to wild populations. We tested whether red snapper otolith elemental concentrations and C and O stable isotope values could be used as a natural tag to distinguish wild from hatchery produced juveniles. We obtained otolith samples from 60 hatchery reared fish and 146 wild fish collected over the continental shelf from northwest Florida to Texas. One sagitta from each fish was ground to a fine powder and analyzed with isotope ratio-mass spectrometry (IR-MS) to test for differences in C and O stable isotope delta values between hatchery and wild fish. The second sagitta was cleaned, dissolved in ultrapure nitric acid, and analyzed with sector field-inductively coupled plasma-mass spectrometry (SF-ICP-MS) to test for differences in otolith elemental (Ca, Ba, Mg, Mn, Sr, and Pb) concentrations. Results from IR-MS and SF-ICP-MS analyses indicated significant differences existed in otolith elemental and stable isotope signatures between hatchery and wild juveniles (MANOVA: Pillai's Trace; $p < 0.001$). Results from jackknifed classification accuracies from discriminant function analysis indicated hatchery fish could be distinguished from wild fish with 100% accuracy based on otolith elemental and stable isotope signatures. These results suggest otolith chemistry may be employed as an effective natural tag for mass marking future stockings of red snapper or other marine finfish to estimate hatchery contribution to wild populations.

Hardin, S.

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The Exotic Species Coordination Section: FWC's strategic approach to introduced species

Approximately 400 species of introduced fish, wildlife or marine plants have been observed in Florida, and at least 125 of these species are established. FWC has had a program dedicated to the study of introduced freshwater fishes for 40 years. However, prior to agency reorganization in 2004, there had been no comprehensive approach to exotic species management. In July 2004, an Exotic Species Coordination Section (ESC) was created to facilitate a seamless intra-agency initiative to deal with non-native fish and wildlife species. Concurrently a Standing Issue Team representing several divisions within the agency was created to consider policy and regulatory issues. ESC is tasked with (1) providing policy recommendations to guide agency actions; (2) coordinating education and awareness projects as a primary prevention tool; (3) developing a consistent regulatory framework for possession and importation of non-native species; (4) integrating data on exotic species from all FWC divisions; (5) seeking funding for rapid response, long term management, and research; and (6) implementing management plans for problematic or noxious exotic species. In response to increased attention to invasive species at the national level, the Florida Invasive Species Working Group was formed in 2001 to coordinate state agency action "to manage and prevent biological invasions." The Gulf and South Atlantic Regional Panel on

Aquatic Invasive Species was re-constituted in 2002, under the auspices of the federal Aquatic Nuisance Species Task Force. FWC's participation in these interagency organizations provides for vertical and horizontal integration of agency efforts to curtail the introduction and minimize impacts of non-native species.

Hill, J.E.

Presented by: Hill, J.E. • Non-Student • Symposium platform presentation

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Negative effects of nonindigenous freshwater fishes in Florida: What do we really know?

Florida has more established exotic fishes than any other state and ranks second behind California in the total number of non-native fish introductions. A number of these species have been in Florida for decades and several species are currently expanding their range and abundance. Non-native fishes in Florida consume native fish, amphibians, and invertebrates; dominate the fish biomass of some systems; overlap in food resource use with native species; alter substrates during nesting activities; dig burrows into shorelines; aggressively defend breeding territories; eat aquatic macrophytes; and invade parks and preserves. It is widely assumed, and indeed often reported, that non-native fishes have caused considerable harm to Florida's native fishes and other natural resources. Nevertheless, there is little documentation of negative effects in the primary literature or in important secondary sources. For example, a recent survey of the USGS Nonindigenous Aquatic Species Database revealed that the effects of 108 of 128 (84.4%) introduced fishes in Florida were listed as unknown. In the same survey, 17 (13.3%) additional species accounts listed speculation or anecdotal observations of effects and only 3 (2.3%) had documented effects for Florida. Given the scarcity of data, it is difficult to evaluate the magnitude of negative effects of introduced freshwater fishes in Florida. A plausible explanation for some of the scarcity of documented effects is a lack of pre-introduction baseline data and directed study. Indeed, most research to date has concentrated on species identity, geographic range, life history, and abundance of introduced fishes rather than actual effects on native species. Generally, described negative effects are highly localized and often speculative or anecdotal. Perhaps surprising given the common perception of widespread harm, most existing analyses of fish populations and communities suggest relatively little effect of non-native fishes on the native freshwater fish fauna of Florida.

Hill, J.E.¹ and C.A. Watson²

Presented by: Hill, J.E. • Non-Student • Symposium platform presentation

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Diet of the nonindigenous Asian swamp eel *Monopterus albus* (Synbranchidae) in tropical ornamental aquaculture ponds in west central Florida

The nonindigenous Asian swamp eel *Monopterus albus* (Synbranchidae) is reported to be a voracious predator that consumes fish. It is established in west-central Florida where it invades tropical ornamental fish production ponds. The tropical ornamental aquaculture industry in Florida is economically valuable (US\$42 million in 2003) and is dominated by the production of small-bodied fishes cultured at high densities in small, earthen ponds. Due to concern about this potential pest species, we collected Asian swamp eels for diet analysis from ornamental aquaculture farms in west-central Florida. Our sampling revealed an increased range within the Tampa Bay drainage and possible invasion of the adjacent Withlacoochee River basin. The density of Asian swamp eels on farms was low and relatively few specimens were collected (N = 71; 94-864 mm total length). Fifty-two percent lacked stomach contents and prey were relatively small and generally few in number. Prey items included amphipods, crayfish,

fish, fish eggs, insects, oligochaetes, organic material, plant material, and a tadpole. Insects were the most frequently occurring prey and fish were second. Fish eggs, probably conspecific, dominated by number. Fish was the heaviest prey category, closely followed by insects, fish eggs, and crayfish. However, only ten fish prey were found in eight Asian swamp eels (including a cannibalized conspecific). Our diet results were surprising given the highly vulnerable prey fish found in the sampled ponds (estimated at 25-60 fish/m²) and the claims that Asian swamp eels are "voracious" predators of fish. We conclude that this species represents a low threat to the Florida ornamental aquaculture industry compared to native predators such as wading birds, turtles, snakes, alligators, eastern mosquitofish *Gambusia holbrooki*, or nonindigenous walking catfish *Clarias batrachus*. We recommend that producers continue to employ best management practices, but aggressive control and eradication of Asian swamp eels are not warranted.

Idelberger C.F., M.J. Hourihan, J.P. Casey, S.E. Erickson, J. Giganti, B. Heagey, and A. Sebastian

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Occurrence and distribution of introduced fishes in tidal waters of Florida

The Fisheries-Independent Monitoring (FIM) program of the Florida Fish and Wildlife Conservation Commission (FWC) is designed to monitor trends in the distribution, abundance, and overall condition of juvenile and adult fish and selected macroinvertebrate populations in Florida estuaries. The FIM program began in 1989 in Tampa Bay and has since expanded to the estuarine systems of Charlotte Harbor, Cedar Key, Apalachicola Bay, Indian River Lagoon, and Northeast Florida. In addition to sampling estuaries, FIM staff also collect hydrobiological data from the tidal portions of various rivers. These rivers include the Hillsborough, Palm, Alafia, Anclote, Caloosahatchee, Chassahowitzka, Weeki Wachee, Little Manatee, Manatee, Braden, Myakka, Peace, Apalachicola, Saint Sebastian, Suwannee, St. Lucie, St. John's, Nassau, and St. Mary's. A stratified random sampling design was used to partition large sampling areas and still proportionately select sites by habitat stratum (shoreline, vegetation, depth). Shallow flats and shorelines with depths less than 1.5 m were sampled with a 21.3-m seine while areas deeper than 1.8 m were sampled with a 6.1-m trawl. Captures of introduced species were recorded along with that of indigenous fishes. To date, at least 20 introduced species have been recorded by FIM sampling in tidal waters of Florida. Long-term monitoring in Florida waters using a stratified-random sampling design can be used to estimate occurrence and distribution of introduced species, identify sources of unintentional releases, and yield information needed to prevent further introductions. Determining hot spots and locations of new populations will be essential for any focused management efforts.

Jackson, M.W., M.S. Allen, M.V. Hoyer, and D. Canfield, Jr.
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A test of the impact of hydrilla introduction on biodiversity in Florida lakes

The addition of exotic species to ecosystems often has been associated with the decline in species richness and diversity of native flora and/or fauna. Hydrilla *Hydrilla verticillata* is native to Asia and was first observed in the United States, specifically in Florida in the late 1950s. Since then, hydrilla has spread across the U.S. resulting in a multitude of problems for water-related recreation and navigation. Although accused of adversely affecting freshwater biota, few studies have compared biodiversity of lakes with hydrilla to those without. We compared species richness and diversity of fish, aquatic birds, and aquatic plants for lakes with and without hydrilla from a sample of 45 Florida lakes. Species richness for aquatic birds, and plants were significantly greater ($p < 0.1$) in lakes with hydrilla present ($N=12$) than at lakes without hydrilla ($N=33$). However, lakes with hydrilla present were also significantly greater in surface area and when lakes of similar size were compared, species richness of fishes did not differ although richness for aquatic birds and plants was still greater for lakes with hydrilla. Results indicate that species richness and diversity of fish, aquatic birds, and aquatic plants may not be adversely affected by occurrence of hydrilla for Florida lakes.

Jeffers, S.A. and W. Patterson
Presented by: Jeffers, S.A. • Student • Platform presentation

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Ecology of inshore lizardfish in the northern Gulf of Mexico

Inshore lizardfish, *Synodus foetens*, are among the most abundant benthic fishes in the northern Gulf of Mexico (Gulf). Little is known about their ecology despite the ecological significance their numbers imply. The goal of this study was to examine habitat-specific density, diet, and growth of inshore lizardfish in sand, shell rubble and hardbottom habitats on the north central Gulf shelf. Density estimates computed from quarterly trawl samples ($n = 113$) taken in 2004 and 2005 were significantly different among habitat types and sampling dates ($p < 0.01$); highest density occurred in mixed shell rubble and sand habitat. Diet, as determined by gut content analysis, consisted of mostly squids and fishes, and was not significantly different among habitat types or sampling dates. Gut content analysis and analysis of muscle stable isotope values (^{15}N , ^{13}C , and ^{34}S ; $n = 44$) indicated the importance of benthic fishes to lizardfish diet increased with fish size. Analysis of otolith microstructure yielded a maximum age of 5 years among samples ($n = 883$) collected and processed for age and growth analysis. Growth analysis from size-at-age data was not completed prior to abstract submission, but differences in growth among habitats will be tested and reported along with density and diet data. Overall, this work represents the first significant ecological study of inshore lizardfish in the northern Gulf. Perhaps similar attention should be paid to other poorly studied, but ecologically important, species if ecosystems management is to become more of a reality in US waters.

Johnson, K.J.¹, M.S. Allen², and K.E. Havens³

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Effects of water level variation on wetland/littoral plants and their associated faunal assemblages, with implications for water management and biota of Lake Okeechobee

We summarized published literature regarding the effects of water level variation on subtropical wetland and littoral plants, as well as the fish and other biota supported by those plant communities. The objective of this study was to enhance the information base that supports the CERP (Comprehensive Everglades Restoration Plan) hydrologic restoration goals for Lake Okeechobee. The review indicated: (1) there is solid literature regarding effects of water level variation on aquatic plants, good local information regarding subsequent effects on wading birds, apple snails, snail kites, waterfowl, information on selected species of fish, and some information regarding alligators; (2) there is very little information regarding amphibians and reptiles other than alligators; and (3) future research should focus on fish community, amphibian, and reptile responses to changes in water level. Based on the studies reviewed and knowledge of anticipated changes in water level regime under CERP, if Lake Okeechobee lake stage varies between 3.7 and 4.6 m msl in most years, shoreline areas can be expected to develop diverse and widespread stands of emergent and submerged aquatic vegetation. If these changes occur, the literature suggests that largemouth bass recruitment and abundance would increase due to enhanced habitat structure and food resources, as well as positive responses for alligator, wading bird, and snail kite nesting success. Effects of water level and littoral plant changes on *Lepomis* spp. and black crappie populations, which also support very important fisheries at Lake Okeechobee, are not well known and warrant further investigation.

Klement, B.W.¹ and S.A. Bortone²

Presented by: Klement, B.W. • Non-Student • Platform presentation

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Spotted seatrout (*Cynoscion nebulosus*) growth as an indicator of estuarine conditions in three southwest Florida estuaries

Spotted seatrout have the potential to serve as excellent indicators of estuarine conditions. Seatrout spend their entire lives within one estuary and it is assumed that prolonged exposure to physiologically stressful conditions is likely to affect growth. Therefore, interestuarine differences in growth rates can be expected as trout are subjected to environmental conditions of varying qualities. Three estuaries located in southwest Florida were sampled for this study resulting in 116 trout (77 males and 39 females) being collected from lower Pine Island Sound, 97 (32 males and 65 females) from Estero Bay, and 71 (20 males and 51 females) from Gullivan Bay. Ages determined from the sectioning and inspection of sagittal otoliths ranged from 1 to 5 years. After examining the relationship of fork length and otolith radius, females were observed to grow at a faster rate than males in all cases. Despite the fact that Pine Island Sound yielded the oldest fish on average, trout taken from Gullivan Bay were found to be significantly larger with males measuring an average of 348.15mm and females 360.49mm in fork length as compared to 312.54mm and 328.77mm in Pine Island Sound, and 272.88mm and 315.88mm in Estero Bay. Back-calculation of fork length at age will reveal any differences in growth rates among year classes for each estuary. Environmental data will then be assessed to determine which factors exert the strongest influence on the growth of spotted seatrout.

Knapp, A.R., C.P. Purtlebaugh, and J.B. Jackson

Presented by: Knapp, A.R. • Non-Student • Platform presentation

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Abundance, distribution and habitat preference of post-juvenile sand seatrout, *Cynoscion arenarius*, in Tampa Bay and Charlotte Harbor, Florida

The sand seatrout, *Cynoscion arenarius*, is a popular unregulated recreational and commercial species that resides primarily in the nearshore waters of the Gulf of Mexico from the southwest tip of Florida westward to the Gulf of Campeche, Mexico. Although several studies have been conducted in the northwestern Gulf of Mexico on the relative abundance and habitat characteristics of sand seatrout, very little is known about the biology of sand seatrout along the Gulf coast of Florida. We examined abundance, distribution and habitat preference of post-juvenile sand seatrout (>100-mm SL) in the Tampa Bay (from 1997 to 2004) and Charlotte Harbor (from 1999 to 2004) estuaries. Sand seatrout were sampled monthly using a 183-m x 5.2-m terminal bag purse seine with 51-mm stretched nylon mesh. A total of 8,881 sand seatrout, ranging in length from 101 to 343 mm SL, were collected within the two estuarine systems. Individuals of all sizes were present throughout the year, with lowest abundances coinciding with decreases in gonadosomatic index within the two estuaries in late summer. Analysis of covariance models indicated that sand seatrout abundances were highest over muddy substrates devoid of seagrass. Abundances were also positively correlated with increasing depth in both estuaries. While juvenile sand seatrout (< 70-mm SL) have previously been shown to associate with sources of freshwater input in these two estuaries, our results indicate that individuals > 100-mm tolerate all ranges of salinity available within these estuaries. Although salinity was not significantly related to sand seatrout abundances in either estuary, a density-weighted mean salinity graph indicated that larger fish generally occupied higher salinity waters.

Kobza, M.¹, M. Cook², and E. Call³

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Nonindigenous fish in the central Everglades: A preliminary survey

Anthropogenic stresses over the past half century have considerably impacted the function of the Everglades ecosystem, causing fish populations to decline and altering their community structure. A potential threat to restoration of the Everglades fish community is the increasing number of nonindigenous fish species in the Southern Florida drainage. To date, 78 nonindigenous freshwater fish species have been identified and 36 have established breeding populations. Canals bisecting and surrounding the Everglades may serve as a thermal refuge and conveyance for nonindigenous fishes, and these canals potentially permit access to the Everglades marsh. Despite the possible negative effects of nonindigenous fish to ecosystem function, their presence in the Everglades marsh and potential effects on marsh community dynamics have received little attention. In this study, an initial survey was conducted to detect the presence and relative abundance of nonindigenous fish species in an area of Water Conservation Area 3A adjacent to the L-67A canal. A goal of our study was to determine if nonindigenous fish distribution was limited by thermal constraints and proximity to a thermal refuge (L-67A canal), and if not, how far into the marsh these species have invaded. We will also relate nonindigenous fish relative abundance and biomass to native fish community data and discuss potential ecological impacts on the Everglades ecosystem.

Leonard, E.E.¹, D.J. Murie², and D.C. Parkyn³

Presented by: Leonard, E.E. • Student • Poster presentation

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Comparative age and growth of greater amberjack in the Gulf of Mexico

The greater amberjack (*Seriola dumeril*) is important in both commercial and recreation fisheries in the southeastern U.S.A. In order to understand the dynamics of their exploitation via stock assessment, the age structure and age and growth of the amberjack stock must be known adequately. Currently, aging greater amberjack is problematic for the Gulf stock, resulting in inadequate age data. In addition, estimates of population parameters must be representative of all areas, gears, and fishing sectors that harvest the amberjack stock. As a step towards this goal, we will develop aging methods for greater amberjack from the Gulf of Mexico, and compare the age and growth of greater amberjack captured by charter boats and headboats within Florida, and by charter boats between Florida and Alabama. Samples of amberjack otoliths with corresponding size measurements have been obtained from several cooperating state and federal agencies. Aging methodology using thin-sectioned sagittal otoliths has been resolved with preliminary aging criteria selected. After obtaining age estimates for all otoliths, an appropriate growth curve will be fit to the data for each stratum and then these models will be compared to evaluate variability in growth rates. Age-length keys will be constructed for assigning age based on length of fish. Future collections will focus on extending the age and growth comparison to all areas, gears, and sectors of the greater amberjack fishery.

Lombardi-Carlson, L.A. and G.R. Fitzhugh

Presented by: Lombardi-Carlson, L.A. • Non-Student • Platform presentation

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Gag (*Mycteroperca microlepis*) from the northeastern Gulf of Mexico differences in age, length and growth between commercial gear types: gear selectivity or depth fished?

Gag were sampled from the commercial harvest of the Gulf of Mexico primarily from waters off the west coast of Florida (n=10,002; 1998-2005). Gag are classified as a secondary component (~ 31%) of the shallow-water grouper complex. This species is highly sought target species in the commercial industry and during the 2001 stock assessment were classified as overfished and undergoing overfishing. Gag are primarily harvested by two gear types: hand-line, using a combination of hooks and lines and manually retrieved, and long-line, consisting of hooks and gangions attached to a monofilament mainline and retrieved mechanically. Hand-line caught fish were significantly smaller (Welch t-test, t statistic = -40.32, df = 9834, p<0.0001; HL 767 ± 123 LL, 880 ± 157) and younger (t statistic = -28.78, df = 9721, p<0.0001; HL 5.8 ± 2; LL 7.5 ± 3) than long-line caught fish. Furthermore, size-at-age data also resulted in significant differences between the commercial gears at ages 3 – 8 yrs old, with long-line caught gag maintaining a faster growth rate than hand-line caught fish at these ages. Based on information returned with otolith samples the commercial hand-line sector fished in shallower depths than the long-line sector, 95% of hand-line caught fish were from waters less than 40ftm (73m) compared to only 82% of the long-line sector. As the depth fished increased, the long-line gear became the dominant gear with a larger proportion of older fish being caught. In order to determine whether the depth fished or gear selectivity accounts for most of the differences in size-at-age data, gag caught by both gears within the same depth bins were examined. Long-line caught gag were significantly larger and older than hand-line caught fish in corresponding depth bins suggesting that the way fish encounter and interact with these respective gears accounts for the selectivity differences in size-at-age.

MacLauchlin, K.

Presented by: MacLauchlin, K. • Student • Poster presentation

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Learning about the fishermen: Anthropology in fisheries research

Anthropology has an important role in fisheries research. Through studies of culture and people's daily lives, fisheries scientists and managers can learn more about the ecosystems and one of the more salient species in them--humans. In order to understand the relationship between commercial fishermen and the marine environment in Biscayne National Park, I considered the relevance of several aspects of culture, including transmission of knowledge through stories; network and community; informal regulation; adaptation to change; and perceptions of the biophysical system. Each aspect is embedded in everyday life and can be examined through sociocultural studies.

Identifying how information is transmitted through the community in the form of stories is a crucial tool in documenting the local ecological knowledge of fishermen. Tight networks are characteristic of fishing communities, and the researcher cannot simply walk in and ask to know fishermen's secrets. Instead, information is extracted from stories, either from personal recollections or passed down from other fishermen. In addition to ecological knowledge, fishing communities also have particular social mechanisms that regulate resource use. Understanding this informal management and the mechanisms that drive it can help resource managers to develop plans that work with regulatory practices already established in the community. Finally, working with fishermen for research and planning purposes allows for collaboration with scientists and increases interest and involvement in conservation of marine resources.

Anthropological studies can contribute to an understanding of the human dimension of fisheries and thus be useful in management plans. Also, a holistic approach is important in maintaining awareness of how all sides of fisheries management fit into the big picture and how each aspect--biophysical, social, political, cultural, economic, etc--is affected by and affects the others.

Marcinkiewicz, L.L.¹, J.P. Bennett², and W.E. Pine³

Presented by: Marcinkiewicz, L.L. • Student • Poster presentation

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Examining movement patterns, essential habitat, and mortality rates of adult common snook in Sarasota Bay, Florida

Common snook, *Centropomus undecimalis*, are an ecologically and economically important estuarine dependent predatory fish species found throughout south Florida. Despite increasingly restrictive management actions over the past 50 years, common snook populations are thought to have declined. Possible reasons for this decline are loss of essential habitat and high harvest rates. We are currently identifying adult snook essential habitat, examining seasonal movement patterns, and estimating mortality rates for common snook in Sarasota Bay using telemetry methods. Results from this study show that snook from Sarasota Bay move longer distances than anticipated, demonstrate strong seasonal fidelity to specific tidal creeks, and appear to seasonally select distinct habitat types. Additionally, anomalous movement patterns and mortalities have been observed concurrently with red tide events in Sarasota Bay. Mortality estimates from this study are similar to methods from catch-at-age models currently used in the FWRI snook stock assessment. This telemetry study has provided important new information related to the ecology of common snook and simultaneously provided insight into harvest rates important for managing this species.

Martignette, A.J¹, S.A. Bortone², J.M. Greenawalt³, E.C. Milbrandt⁴, and B.W. Klement⁵
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Response of fish communities to hurricane and red tide

Large-scale catastrophic natural events can have profound effects on organisms. For example events such as hurricanes can have significant impacts on mangroves. Hurricane Charley (Category 4) that hit southwest Florida in August 2004 destroyed up to 80% of the mangrove canopy cover on Sanibel and Captiva Islands. The waters proximate to the mangrove shoreline experienced increased exposure to sunlight and an increased amount of decomposing organic matter. The response of fish communities in close proximity to mangrove shorelines were examined before and after the hurricane to test the hypothesis that a reduction in mangrove canopy cover would decrease fish diversity and abundances. Overall fish diversity and diversity, based on distance from the eye wall, were examined. No statistically significant changes in diversity were found following Hurricane Charley; however, there was lower mean diversity (0.72) after the hurricane compared to the mean diversity during the Dry (0.83) and Wet (0.88) seasons. In addition to the hurricane impacts, the changes in communities after two red tide blooms were also examined to assess the biological response to another large-scale disturbance. Fish diversity from sampling with the seine during a bloom that occurred during the summer and fall of 2005 along with fish diversity that was collected in 2003 using an otter trawl were examined. During the 2003 bloom sampling diversities averaged the lowest in the year. During the 2005 bloom diversity was significantly lower ($p < 0.001$) than the previous six months. This drop in diversity was not observed during 2004, suggesting that it is not a seasonal change, but rather is because of the red tide bloom.

R.E. Matheson, Jr.¹, R. Ruiz-Carus², and M. Hourihan³

Presented by: Matheson, R.E., Jr. • Non-Student • Symposium platform presentation

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Established exotic fishes in marine and estuarine waters of Florida

Among the numerous exotic fish species established in Florida waters, one is totally marine and various others are euryhaline. The marine Indo-Pacific red lionfish, *Pterois volitans*, appears to be well established along the east coast of Florida. Euryhaline species from Africa and the neotropics are well established in various Florida estuaries, especially along the middle to lower Florida peninsula. The most common euryhaline forms are African cichlids commonly known as tilapia (genera *Tilapia*, *Oreochromis*, and *Sarotherodon*). We will list all of the established species that are known from oligohaline to marine waters (salinities >0.5 ppt) in the state and present notes on their general biology, distribution, and abundance in Florida waters. For several species, we will present abundance trends based on the Florida Fish and Wildlife Conservation Commission's long-term Fisheries-Independent Monitoring Program. Recent reports of marine species that are not known to be established in Florida will also be discussed.

McBride¹, R.S. and M.R. Johnson²

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Sexual and reproductive development of hogfish (Labridae: *Lachnolaimus maximus*), a hermaphroditic reef fish

The sexual development of hogfish (*Lachnolaimus maximus*) is poorly known, relative to other wrasses, despite the conspicuous nature and economic importance of this species. Seasonality, size, age, color phases and sexual dimorphism were identified in relation to ten reproductive classes using histological criteria. These data confirmed earlier conclusions that *L. maximus* are monandric, protogynous hermaphrodites. Sex change was initiated at the end of the spawning season, over a broad range of sizes and ages. It occurred after a functional female stage (postmaturation), and proceeded more slowly (months) than previously believed. Eventually all individuals change sex to a terminal male phase. Females were batch spawners, spawning as often as every day during winter. There was no evidence of precocious sperm crypts in active females, sperm competition, or other alternative male sexual strategies. Mating has been reported elsewhere to be harem. The sexual development of *L. maximus* should be adaptive in terms of Ghiselin's size-advantage model, which links monandric protogyny and polygyny.

McBride, R.S., A.K. Richardson, and A.S. Collins

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Age, growth, and mortality of hogfish (Labridae: *Lachnolaimus maximus*), a hermaphroditic reef fish

This study is the first to validate an otolith ageing method for hogfish, *Lachnolaimus maximus*, and use this method to age fish from two regions of Florida, U.S.A. Maximum age was nearly twice as old for fish from the eastern Gulf of Mexico (age 23) as from south Florida (age 13). Average maximum size (i.e., von Bertalanffy L_{∞}) was over twice as large for the eastern Gulf (917 mm fork length) as for south Florida (428 mm). Mortality rates were significantly lower in the eastern Gulf ($Z = 0.249$) than in south Florida ($Z = 0.356$). We conclude that truncated age and size, coupled with higher mortality, in south Florida arose from higher effective fishing pressure in this region. Significant size and age differences were also evident between sexes because *L. maximus* is a sequential hermaphrodite. A closer examination of growth during sex change, using a repeated measures analysis of backcalculated sizes at each annulus, indicated that terminal males experienced a growth spurt if they changed sex by their fourth winter, but not necessarily if they changed sex later in life.

McBride, R.S., A.K. Richardson, K.L. Maki, and M.D. Murphy
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Florida's wahoo, *Acanthocybium solandri*, fishery

We examined commercial and recreational landings, as well as responses from a special web-based survey, to characterize Florida's wahoo fishery. Total landings of wahoo from U. S. Atlantic waters averaged 1.4 million pounds/year during the years 2000-2004. Approximately 87% (1.2 million lbs.) of these landings were recreational and 13% were commercial. About 41% (0.5 million lbs.) of these recreational landings, and 28% (0.05 million lbs.) of these commercial landings, were harvested in waters adjacent to Florida's Atlantic or gulf coasts. Creel clerks operating the Marine Recreational Fishery Statistics Survey intercepted over 200 wahoo anglers during this same period, 2000-2004. Most of these wahoo-trip intercepts were made on Florida's Atlantic coast. The annual catch rates on these trips averaged 0.12 wahoo/trip on the Atlantic coast and 0.29 wahoo/trip on the gulf coast. The weighted-average for all of Florida was 0.187 wahoo per trip. A total of 260 offshore anglers have responded to our web survey so far, 109 (42%) of whom target wahoo. Anglers who targeted wahoo were mostly male (93%), were of all ages, and resided in 45 (67%) different Florida counties. Mean catch rates were not significantly different between the east coast, keys, west coast, and panhandle regions (range: $0.20 \pm 0.11 - 0.73 \pm 0.27$ mean [$\pm 95\%$ c.l.] fish/trip/region in the past year; $P = 0.08$). Experience did not affect catch rates ($P = 0.27$), but anglers with < 1 year experience fished fewer days offshore targeting wahoo than those with ≥ 1 years experience (4.3 ± 2.2 vs. 11.3 ± 2.7 days in the past year; $P = 0.04$). Wahoo has long been a legendary sportfish, and while encountering wahoo is still an uncommon experience, interest in targeting wahoo appears to have increased in Florida's offshore waters during the past few decades.

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A revised age and growth model for blacknose shark from the eastern Gulf of Mexico using x-ray radiography

Underestimates of age can seriously bias any resulting demographic or stock assessment models. In a previous study on blacknose shark, *Carcharhinus acronotus*, in the eastern Gulf of Mexico, elucidation of bands using thin sections of vertebrae resulting in poor readability and the most successful technique was to count bands on vertebrae half sections. The utilization of half sections can be problematic because of the difficulty in discerning bands on the edge. Consequently, the oldest aged shark from that study was 4.5+ years although tag-recapture data indicated that sharks could be much older. To develop more accurate age estimates, we reexamined the original samples using x-ray radiography and developed a revised age and growth model for blacknose shark in the eastern Gulf of Mexico. Estimates of the von Bertalanffy growth model using revised counts are $L_{\infty} = 1360$ mm fork length, $k = 0.10 \text{ yr}^{-1}$, and $t_0 = -3.22$ yr for females and 1053 mm fork length, $k = 0.22 \text{ yr}^{-1}$, and $t_0 = -2.04$ yr for males. These results were significantly different from the previous estimates. Moreover, the oldest aged sharks are 11.5+ and 9.5+ years for females and males, respectively.

Morris, N.M.B.¹ and W.F. Patterson²

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Ecology of fishes associated with deep-sea shipwrecks in the northern Gulf of Mexico

Deep-sea fishes and their associated habitats have not been well studied in the northern Gulf of Mexico (Gulf). Furthermore, little is known about the ecology particularly diet and source(s) of carbon of Gulf deep-sea fishes. We examined diet and stable isotope values ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$) from fishes associated with six World War II era shipwrecks ranging in depth from 87 to 1,964 m in the Gulf. Fishes were collected using fish traps and a suction sampler attached to a remotely operate vehicle (ROV). Stable isotope analysis of fish and invertebrate muscle samples was conducted to estimate trophic structure and source(s) of carbon. Analysis of stable isotope values (n=107) revealed a range of trophic levels and sources of production as benthic, pelagic, or chemosynthetic. At the two shallowest sites (87 and 143 m depth, respectively), $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values among fishes indicated a range in feeding across trophic levels, and $\delta^{34}\text{S}$ values indicated a range in benthic versus pelagic prey. Stable isotope values among fishes at the *Gulfpenn* (554 m depth) indicated feeding at similar trophic levels and a pelagic source of production. The gulf hagfish, *Eptatretus springeri*, differed from others at the *Gulfpenn* with respect to stable isotope values. Their $\delta^{15}\text{N}$ values indicated feeding at moderately high trophic levels, and their depleted $\delta^{13}\text{C}$ values likely indicated some component of their biomass was derived from chemosynthetic production. At the three deepest wreck sites (1,457, 1,490, and 1,964 m, respectively), $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values among fishes indicated feeding at middle trophic levels, and $\delta^{34}\text{S}$ values indicated a pelagic source of production. Further evidence of chemosynthetic production was seen in a scavenging cutthroat eel, *Synaphobranchus brevidorsalis*, captured at a cold seep site near the *Robert E. Lee*. Diet of fishes (n=56) also was determined by analysis of gut contents and corroborate stable isotope values.

Murie, D.J.¹, D.C. Parkyn², W.F. Loftus³, and L.G. Nico⁴

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Variable growth and longevity of yellow bullhead in south Florida

Yellow bullhead *Ameiurus natalis* were collected from southern Florida in canals and marsh areas in the Everglades during April 2000 to January 2001, and from Oct 2003 to February 2005, to determine age and growth. Fish ranged in size from 97 to 298 mm total length. In total, 143 yellow bullheads were aged using cross-sections of pectoral spines and 60 were aged using sanded and polished cross-sections of lapillar otoliths. Pectoral spine age estimates had relatively high precision between two experienced readers (average percent error [APE] = 4.55%, CV = 6.44%), with 73% of ages having perfect agreement and 93% agreeing within ± 1 year. Lapillar otolith age estimates provided inadequate precision with high APE (16.8%) and CV (23.7%), and low percent agreement (25% perfect agreement and 61% within ± 1 year). Only pectoral spine age estimates were therefore used as input to the growth model. The pectoral spine aging method was validated using oxytetracycline (OTC)-injected yellow bullheads, which were observed to deposit one complete annulus (one translucent and one opaque zone)

over a 12-month period. Yellow bullhead from south Florida ranged in age from 1-12 years based on analysis of pectoral spines. They grew relatively rapidly in their first 3 years, but after age 5 their growth slowed and approached an asymptote of ~214 mm total length. Yellow bullhead in south Florida exhibited relatively slow growth and small size compared to yellow bullhead from other populations throughout the U.S., and were also observed to have a maximum life span of 12 years, which was double that previously reported for any other yellow bullhead population.

Nico, L.G.

Presented by: Nico, L.G. • Non-Student • Symposium platform presentation

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USGS-FISC research on invasive fishes: Past projects and future challenges

In terms of original research on invasive fishes, USGS scientists at FISC conduct investigations in six main areas: (1) taxonomy; (2) geographic distribution; (3) life history; (4) impacts; (5) prevention and control; and (6) risk assessment. These six areas of research are interrelated – none mutually exclusive. Taxonomy and positive identification of non-native fishes is a critical first step in any research study on invasives. FISC biologists recently completed a guide to the identification and biology of introduced foreign carps. We are working on a similar guide to introduced cichlids (a group of >18 species, that includes tilapias). Risk Assessments have become increasingly important—FISC biologists have recently completed two RA's: a 2004 report on Snakeheads and a book this year on Black Carp. Various federal and state agencies use these documents to make decisions concerning the prohibition or regulation of non-native species. Results from studies into the biology and life history of introduced fishes are helpful in discovering ways to control already introduced populations. In addition, we investigate specific control options. For example, we recently completed a manuscript describing experiments testing whether the chemical rotenone could be used as a control for introduced Asian swamp eels. The continuing big challenge is documenting and measuring impacts associated with the introduction of non-native fishes. In large part, impacts—real or perceived—drive the direction of research. In our 1999 AFS book "Nonindigenous Fishes Introduced into Inland Waters of the United States"—we presented accounts for over 200 different non-native fish species. For most we reported that the impact was "unknown" (not intended to mean that there was no impact, but simply that there was a shortage or inadequacy of information on the subject). This represents a major gap in scientific knowledge which has resulted in differences of opinion about whether or not introduced fishes are truly a problem, particularly in Florida. In general, it is extremely difficult to identify impacts and to establish cause and effect relationships in complex biological systems, especially ones that undergo frequent natural and artificial disturbances.

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Population connectivity in Gulf of Mexico red snapper inferred from otolith elemental signatures

Juvenile red snapper (total n = 750) were sampled from three regions [north central (NC), northwestern (NW) and southwestern (SW)] of the U.S. Gulf of Mexico (Gulf) during November and December from 1996 through 2000. The chemical composition (Ca, Ba, Mg, Mn, and Sr) of juvenile sagittae was analyzed with solution-based magnetic sector field-inductively coupled plasma-mass spectrometry (SF-ICP-MS) and inductively coupled plasma-optical emission spectrometry (ICP-OES). Discriminant function analysis of otolith elemental signatures yielded high jackknifed classification accuracies (~80%) for all years except 1998 (62%). Sub-adult and adult red snapper then were sampled in summer 2001 from fishery landings and trawl surveys in each region. One sagitta from each individual was sectioned and aged. Up to 30 fish from the 1996 through 2000 year classes were randomly selected from aged samples collected in each region. The core of the second sagittae from each fish then was mechanically extracted and its chemical composition analyzed with SF-ICP-MS. Year class-specific maximum likelihood models were parameterized with juvenile elemental signatures and computed to estimate the source region(s) of sub-adults and adults. Models revealed little post-settlement mixing between the NC Gulf and the other two regions. Significant mixing was observed between the NW and SW Gulf. Net movement of fish was from the NW to the SW region, perhaps indicating a recruitment subsidy was provided from the NW to the SW Gulf. Overall, results indicated population structure may exist in Gulf red snapper that had not been identified with traditional genetics approaches. Concurrent studies of red snapper population dynamics and genetic effective population size among regions also revealed population structure consistent with otolith chemistry results.

Poplaski, M.R.¹ and A.K. Dukeman

Presented by: Poplaski, M.R. • Student • Poster presentation

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Red drum (*Sciaenops ocellatus*) gill filament counts in relation to size distribution

Red drum, *Sciaenops ocellatus*, is an important sport fish in Tampa Bay, Florida, but numbers have waned in recent years due primarily to over fishing. The Florida Fish and Wildlife Conservation Commission's (FWC) Stock Enhancement Research Facility (SERF) is involved in a multi-faceted stock enhancement program to determine the stocking success of releasing hatchery-reared red drum into a large estuary. At SERF, periodic health checks are performed on red drum in order to assess the viability of the fish stock. During these examinations, a small sample of gill filaments are removed from the fish, enumerated, and observed for parasites. Currently, there is no method to standardize the amount of gill tissue sampled. In this study, we extracted the first gill arch from red drum of various sizes and counted the gill filaments. We found that there was a strong correlation between the number of filaments and the total length of the fish which allowed us to extrapolate the results from our small sub-sample to assess the overall impact a load of gill parasites may have upon an individual fish.

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Presented by: Reinert, T.R. • Non-Student • Symposium platform presentation

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The Battle of Atlanta: control and containment options for a (relatively) northern population of Asian swamp eels

The Asian swamp eel is an exotic, invasive species that has been introduced in the southeastern U.S. on at least four occasions. Populations are known from Florida (Homestead, North Miami, and Tampa), and Atlanta, Georgia. The Atlanta population was introduced into ponds at the Chattahoochee Nature Center (CNC) in the early 1990s. The CNC has direct outflow connections to the Chattahoochee River and given this, recent studies have focused on control and containment options for this population. Swamp eels are protogynous hermaphrodites, obligate air-breathers, and can travel over land and live in a variety of habitats, making them excellent invaders. Swamp eels have been discovered in marsh areas of the Chattahoochee River adjacent to the CNC, although to date, no eels have been found upstream or further downstream. We studied the biology and ecology of this population and investigated physical and chemical methods for removal and/or eradication. Eels are actively reproducing in three CNC ponds and possibly in the marsh. Diet appears to consist mostly of invertebrates but does include some fish (including other swamp eels). Physical removal methods included electrofishing for sub-adults and adults and leaf-litter traps for juveniles. Laboratory studies on effectiveness of antimycin suggest that chemical removal is not a viable option, as swamp eels appear resistant to antimycin and reportedly are also resistant to rotenone. An integrated approach of control and containment involving physical removal and reconfiguring pond outflows appears to be the best plan for addressing this particular population of exotic invaders.

Rock, J.E.¹, D.J. Murie², and K.M. Leber³

Presented by: Rock, J.E. • Student • Poster presentation

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Feeding periodicity of the common snook

Diel feeding periodicity was determined for juvenile common snook, *Centropomus undecimalis*, during May and June of 2005. During this period we performed a series of 24-hr feeding observations in two estuaries (North and South Creeks) of southern Sarasota Bay on the west coast of Florida. In total 127 snook were sampled, 45 snook from North Creek and 82 snook from South Creek. These snook ranged in size from 103 to 466 mm SL (82% <200 mm SL). The presence or absence of food in the stomachs as well as the digestive state of the food items was analyzed and compared to time of capture to determine peak feeding times. Overall, juvenile snook primarily fed between 2100 h (just after dusk) to 0300 h, with some light feeding occurring during the morning hours from 0700 to 1100 h. This information was then used to collect snook during time periods when their stomach contents were relatively undigested and therefore useful for assessing their trophic dynamics.

Rogers, M.W. and M.S. Allen

Presented by: Rogers, M.W. • Student • Platform presentation

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Cold in the Tropics?: Implications of winter on growth and survival of age-0 Florida largemouth bass

Florida's climate changes from sub-tropical to temperate with increasing latitude, which may strongly influence age-0 largemouth bass growth and survival. We sampled the 2003 and 2004 largemouth bass year classes quarterly at 6 lakes in south, central, and north Florida (N=2 lakes per region). Hatching dates and mean daily growth were evaluated using otoliths and hatching periods (i.e., early, middle, late) were assigned based on lake hatching distributions. Instantaneous mortality was estimated for hatching periods using absolute changes in abundance between sampling periods. Initial age-0 largemouth bass hatch dates and hatch duration were inversely related to latitude because hatching started earliest and continued over a longer period at the south region relative to central and north regions during both years. Early hatched fish at south lakes exhibited slow growth and high mortality relative to later hatched fish and fish at other regions, likely due to episodic cool (15-16 °C) water temperatures in January and February when early hatched fish were present at south lakes. Age-0 largemouth bass at the north lakes exhibited rapid growth that nearly compensated for later hatching, resulting in age-1 size distributions that were similar across lakes and regions. Weather patterns influenced growth and survival of age-0 largemouth bass in Florida during both years, indicating that optimal stocking strategies will vary with year and latitude.

Ruiz-Carus, R.¹ and H.J. Grier^{1,2}

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The loricariid and callichthyid catfishes in Florida, with emphasis on those of the Hillsborough River.

To examine spatial distribution and dispersion of the exotic armored catfishes in Florida, we compiled records of suckermouth armored catfishes (Loricariidae) and brown hoplo (Callichthyidae) from five estuaries during 1990–2005. Museum specimens, incidental collections, and a fisheries-independent monitoring study showed that exotic catfishes, like other exotic fishes, occurred at a regular and disturbing rate. The abundance of loricariid fishes and brown hoplo in the west-central part of Florida appeared to increase during the sampling period. We examined a growth-series of *Pterygoplichthys (Liposarcus) disjunctivus* and *Hoplosternum littorale* from the Hillsborough River to describe larval development. We documented morphological changes to distinguish *P. disjunctivus* from other loricariids established in Florida. In addition, we estimated abundance, growth rate, and age of sexual maturation; we compared these estimates with data from native localities in South America. We conclude with some remarks about the ecological effect of armored catfishes.

Shafland, P.

Presented by: Shafland, P. • Non-Student • Symposium platform presentation

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An overview of the Florida Fish and Wildlife Conservation Commission's exotic freshwater fish programs

More exotic freshwater fishes exist in south Florida than nearly anywhere else in the world. Today 23 exotic fish species have permanently established populations here, eight more have reproducing populations, and all but two of these 31 species occur somewhere in the southern half of Florida. Moreover, all but one of these fishes were illegally introduced. The Florida Fish & Wildlife Conservation Commission has responded to the threats posed by illegally introduced fishes by developing and maintaining multifaceted and interrelated programs focused on the prevention, assessment, and management of exotic fishes, the origins of which date back to the early 1960s. Prevention of illegal releases is of paramount importance, and Florida statutes require persons possessing exotic fishes to obey Commission rules that prohibit the introduction of any species not native to the State. Persons found in violation of these statutes may be punished with fines of up to \$1,000 and one year in jail. Once an exotic fish becomes established, the Commission's priority changes from one of prevention to one of assessment. Assessment of exotic freshwater fishes is the primary responsibility of the Non-Native Fish Project, the objectives of which are to document the occurrence and distribution of exotic freshwater fishes, define their life histories, environmental limiting factors, and associations with native species, and to develop best management practices that incorporate these species. Based on the studies conducted by the Commission and others during the past 40 years, I have rejected the presupposition that the introduction of exotic freshwater fish represents an inherently catastrophic event; and I have replaced this presupposition with one based on the historical fact that these fishes have real but much less than catastrophic effects. Although not perfect, I believe the existing combination of Commission regulations and programs provides Florida with one of the most comprehensive and proven approaches for pragmatically dealing with this very serious and complicated issue.

Stevens, P.W., D.A. Blewett, and J.P. Casey

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Short-term effects of a low dissolved oxygen event on estuarine fish assemblages following the passage of Hurricane Charley

Hurricane Charley, a Category 4 storm, passed directly over the Charlotte Harbor estuary and Peace River watershed on 13 August 2004. Following the storm's passage, dissolved oxygen in the Peace River fell below 1 mg/L, and hypoxic conditions extended approximately 15 km into Charlotte Harbor. A long-term fisheries-independent monitoring program (1989 to present) was in place in Charlotte Harbor and sampling was intensified in the month following the storm. Changes in fish assemblages that resulted from the hypoxic event were determined using nonmetric multidimensional scaling and similarity percentages analysis. At the mouth of the Peace River and upper Charlotte Harbor, fish abundance decreased dramatically after the hurricane, and typical estuarine fish assemblages were replaced by those dominated by a few resilient estuarine and freshwater species including the introduced brown hoplo (*Hoplosternum littorale*) and sailfin catfish (*Pterygoplichthys* spp.). Fish assemblages in the Myakka River, located only a few kilometers west of the Peace River, were unaffected. The hypoxic event was short-lived as dissolved oxygen levels and estuarine fish assemblages in the Peace River and upper Charlotte Harbor recovered within a month. The commercial shrimping industry benefited from

high densities of shrimp in the relatively small area of upper Charlotte Harbor during the months following the storm. The results of this study are consistent with other hurricane-related hypoxic events in the literature, which report acute effects to estuarine systems in the short-term, rapid recoveries, and long-term resilience.

Strickland, P.¹, R. Cailteux¹, D. Dobbins¹, and D. Harding²

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Economic expenditures of anglers in four flathead catfish tournaments in the Apalachicola River, Florida

Economic surveys at four flathead catfish *Pylodictis olivaris* tournaments were conducted from April through October of 2004 on the Apalachicola River, Florida. Tournaments were held at Blountstown, Wewahitchka, and Bristol (2), Florida. Angler participation ranged from 163 to 243 people for each respective tournament. Twenty-seven to 41% of participants were interviewed at each respective tournament. Surveys consisted of asking participants the amount of money they spent in each of five categories: gas and oil, fishing tackle, food and beverages, lodging, and other miscellaneous items solely for the current tournament for which they were being interviewed. IMPLAN 2.0 was used to analyze all data. Total expenditures ranged from \$46,625 to \$67,444 for each of the four tournaments. The popularity of these tournaments has continued to grow over the past several years. These tournaments undoubtedly provide a great boost to the local economies of these rural Apalachicola River communities and should continue to in the future.

Switzer, T.S.^{A,1}, B.L. Winner^{A,2}, J.A. Whittington^{B,3}, N.M. Dunham^{A,4} and M. Thomas^{B,5}

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Influence of sequential hurricanes on nekton communities in the St. Lucie estuary

The 2004 hurricane season was unique in that one tropical storm and four hurricanes made landfall in Florida. Most of these storms affected estuaries where long-term fisheries monitoring programs were in place, providing scientists with a unique opportunity to study effects directly attributable to tropical storms. We examined nekton community-level responses to hurricanes Frances and Jeanne, which made landfall 20 days apart in the St. Lucie estuary in September 2004. The passage of these storms contributed to large freshwater discharges that exceeded $150 \text{ m}^3 \text{ s}^{-1}$, as well as estuary-wide reductions in salinity that persisted for several months. Although such environmental variations are not uncommon in the estuary, spatial patterns of community structure immediately following these hurricanes were disturbed substantially. Alterations of community composition were most notable in the North Fork of the estuary, where abundances of several freshwater and oligohaline fishes (i.e., *Dorosoma cepedianum*, *Lepomis macrochirus*, and *Pomoxis nigromaculatus*) rose sharply immediately following the hurricanes while abundances of other fishes (i.e., *Mugil cephalus*, *M. curema*, and *Archosargus probatocephalus*)

declined. Nekton communities recovered quickly, and within four months spatial patterns in community structure were similar to those found during non-hurricane years. This recovery was short-lived, however; communities were disturbed further by large regulatory discharges from Lake Okeechobee in 2005 in anticipation of another active hurricane season. Although nekton communities were resilient to hurricane-related disturbances, projected increases in Atlantic hurricane activity and associated freshwater discharges over the coming decades may test the resilience of estuarine communities in Florida.

Szelistowski, W.A.¹, L.M. Szelistowski¹, and L.E. Bavaro²

Presented by: Szelistowski, W.A. • Non-Student • Poster presentation

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Grackle foraging may enhance feeding success of mangrove snappers and catfish

Positive interactions (mutualism, commensalism) are widespread in tropical environments such as coral reefs but are not well-known in mangroves. This study presents evidence that in the Gulf of Nicoya, Costa Rica, mangrove fishes use disturbances made by foraging grackles to locate and consume tree crabs. Historically, artisanal fishermen in the Gulf were known to mimic grackle disturbances to attract snappers and catfish. We found that: (1) the grapsid tree crabs *Aratus pisonii* and *Goniopsis pulchra* are common items in the guts of four common snappers, *Lutjanus colorado*, *L. aratus*, *L. jordani*, and *L. argentiventris*, and the catfish *Hexanematichthys seemanni*; (2) fishes can be observed preying on tree crabs which enter the water to escape grackles, and appear to follow grackles as they move within mangroves in search of crabs; and (3) snapper and catfish attack rates on crabs introduced into the water are increased following experimentally-generated disturbances resembling those of grackles. Positive interactions in mangroves may be more widespread than currently understood, but the difficulty of making visual observations in this habitat may limit the number of known examples.

Taylor, D.S.

Presented by: Taylor, D.S. • Non-Student • Platform presentation

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Rivulus (Kryptolebias) marmoratus: lessons learned from nearly two decades of groveling in the mangroves

Kryptolebias marmoratus is best known as the only 'selfing' vertebrate with clonal reproduction. This trait was identified in 1961, but until the late 1980's K. marmoratus was relatively unknown in the wild, and collections from Florida numbered only a few dozen, with scattered collections from the balance of the western Atlantic. Since then, a core of dedicated investigators has greatly expanded both the geographical scope of collections and our knowledge of the natural history of this enigmatic fish. Collections from Florida now number over 2,500, with most specimens taken from south and southwest Florida. Kryptolebias marmoratus extends north on the east coast of Florida to an apparently disjunct population in Volusia Co. and to Pinellas Co. on the west coast. Elsewhere in the western Atlantic, we now have extensive knowledge about populations in Belize (where interesting genetic issues are at play), the Bay Islands, Honduras, two locales in the Bahamas and a limited collection from Guantanamo Bay, Cuba. Laboratory colonies of K. marmoratus now contain a variety of lineages from these various locales. These insights reveal a fish with a cryptic 'lifestyle', which helps explain the paucity of historic collections, an unusual genetic system, and a range (Brazil to Florida) that remains largely unexplored. It is interesting to speculate what further surprises might await us, should the balance of the Caribbean islands and the vast coastal areas of South America to southern Brazil be extensively surveyed.

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Cataract prevalence in wild fish from three Florida estuaries

In April 2005, scientists at the Florida Fish and Wildlife Conservation Commission (FWC), Stock Enhancement Research Facility (SERF) observed opaque, white spots in the eyes of several pond-reared juvenile red drum, *Sciaenops ocellatus*. SERF'S aquaculture veterinarian confirmed that the fish had lenticular cataracts. Progression of the disease was monitored leading to development of a categorization scheme that represented the extent of opacities found in the lenses of afflicted fish. From the time of the first observation in April to May, 100% of the fingerlings raised at SERF were affected with cataracts.

Incidence of cataracts in wild fish is unknown, so SERF staff, in conjunction with FWC'S Fisheries Independent Monitoring (FIM) group and FWC'S Fish and Wildlife Health group, conducted a survey of the two major estuaries on the west coast of Florida and one on the east coast of Florida. Background levels in various wild fish species were determined and compared to the level of incidence at SERF. FWC sampled fish from Tampa Bay (June-October 2005), Charlotte Harbor (September), and the St. Lucie River (November).

Sampling effort was focused in Tampa Bay where 33 estuarine species were evaluated from a sample size of (n=729) fish. Fifty-four percent were negative for cataracts. Although red drum constituted a small proportion (11%) of the evaluated fish, they had the highest incidence of cataracts (72%) and were most affected by advanced cataract stages. In Charlotte Harbor, 197 fish were evaluated and the results were similar to those from Tampa Bay. Seventy-five fish from the St. Lucie Waterway were evaluated and only 6% were affected by cataracts. The incidence of cataracts at SERF was significantly greater than that found in wild populations suggesting that, although the development of cataracts occurs naturally, factors were present that intensified the disease within the SERF facility.

Thomas, C.R.

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The fish of the northern Indian River Lagoon: impacts of marsh impoundments

The Merritt Island National Wildlife Refuge (MINWR) employs four different management regimes for its salt marshes. The Wildlife Area Management (WAM) marshes are impounded year-round to encourage migratory bird usage. Using culverts, Rotational Impoundment Management (RIM) marshes are open to the lagoon during mosquito-breeding season in order to flood the marsh surface and closed the remaining time. Open marshes are open to the lagoon year round through culverts, while Restored marshes are open to the lagoon year round through tidal creeks. Lagoon fish are isolated from WAM marshes year round, RIM marshes half the year, and have full access to the Open and Restored marshes, while marsh fish are similarly isolated from the lagoon. Lagoon fish are most dependent on the Open marshes for their carbon, while they get no carbon from the WAM marshes. RIM marsh fish get the least amount of their carbon from those marshes even though they are trapped in there for half the year. Open marshes produce the greatest transient fish biomass, while being a sink for resident fish. Fish in the WAM and Restored marshes contribute more carbon to the detrital cycle and food web of the

marshes than the lagoon, while fish in the RIM and Open marshes contribute more carbon to the lagoon. This is due to the higher fish biomass in the RIM and Open marshes combined with the marshes' connection to the lagoon. Therefore, the different management regimes employed at MINWR are altering fish usage and production within the different marshes. Fish production and usage is highest in the Open marshes and those fish highly contribute to the lagoon's nutrient cycling.

Yeager, L.A.¹

Presented by: Yeager, L.A. • Student • Poster presentation

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Habitat utilization by juvenile reef fishes in Manzanillo, Costa Rica

Identifying nursery areas used by reef fishes is important for fisheries management and understanding community dynamics. Reef fish communities were surveyed using an underwater visual transects in three shallow water habitats (seagrass, mixed seagrass/coral rubble, and reef crest) in Manzanillo, Costa Rica. At each site, abundance, estimated length, and life stage for all fish species were recorded along with benthic composition, depth, and visibility. Distinct fish communities were found among habitat types with mixed seagrass/coral rubble and reef crest sites being most similar and having highest abundances, species richness, and Shannon-Weiner diversity. The percent cover of seagrass was the most important habitat variable explaining fish community composition and habitats grouped distinctly by environmental variables. There was no difference in mean fish length between habitats, but mixed seagrass/coral rubble sites supported higher juvenile densities of selected commercial and recreational species than juvenile densities in seagrass and reef crest habitats or adult densities in any habitat. These results indicate that these three habitats function differently in their support of reef fishes that and mixed seagrass/coral rubble may serve as a more important nursery for selected reef species than other available nursery habitats. These findings have important implications for management and conservation, highlighting the special need to monitor and preserve mixed seagrass/coral rubble habitat.

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Exotic species and aquaculture

Globally, aquaculture is the fastest growing food-producing agricultural sector with over 90% of this production occurring in developing countries based upon 230 different species. Notably, 17% of global finfish aquaculture is derived from exotic species. Similarly, much of U.S. aquaculture is based on exotic species whether they are: Pacific oysters and manila clams on the West Coast, rainbow trout in North Carolina, or tilapia anywhere in the country. Nonindigenous aquatic species are a significant component of food and ornamental aquaculture and a small minority of those species cause ecological and economic damage. The risks posed by exotic species are being exaggerated and public and private aquaculture (state/federal hatcheries and stocking programs or commercial farms) do not possess the means to counter the hysterical messages espoused by environmental advocates and writers. A variety of "tools" are presented that may help aquaculturists respond to regulatory agencies and media inquiries: science, history, management, and partnerships.