Floundering Around

Evaluating a Declining Species in the SE United States

GULF STATES MARINE FISHERIES COMMISSION
LOUISIANA STATE UNIVERSITY
LOUISIANA SEA GRANT

March 29-30, 2022

Embassy Suites by Hilton
Baton Rouge, LA

March 2022 **GSMFC Number 310**

Floundering Around - Evaluating a Declining Species in the SE United States

Gulf States Marine Fisheries Commission • Louisiana State University

Embassy Suites by Hilton • Baton Rouge, LA

March 29–30, 2022

March 29 Agenda

Floundering Around - Evaluating a Declining Species in the SE United States - Session 1 - YouTube

8:30 Welcome and Program Overview – *Dr Mike Dance and Dr Steve Midway (LSU), and Mr Steve VanderKooy (GSMFC)*

Life History and Population Dynamics Session

8:40 – 9:00	Key aspects of Southern Flounder life history: identifying knowledge gaps and potential effects on stock dynamics – Fred Scharf
9:00 – 9:20	Movement and maturity in South Carolina Southern Flounder: Intriguing Insights – Tanya Darden
9:20 – 9:40	Population dynamics and abundance trends in coastal Alabama – Sean Powers
9:40 – 10:00	Monitoring relative abundance of Southern Flounder in coastal Mississippi – Josh Waters
10:00 – 10:20	*Break*
10:20 – 10:40	Environmental correlates of Southern Flounder recruitment in Alabama coastal waters – Troy Farmer
10:40 – 11:00	A novel fisheries independent survey with life history metrics – Erik Lang
11:00 – 11:20	Determining spatiotemporal trends in hatch and metamorphosis timing of young-of-year (YOY) Southern Flounder (*Paralichthys lethostigma*) in Texas bays – Nicolette Beeken
11:20 – 11:40	Quantifying differences in three potential contingents of Southern Flounder from the Northern Gulf of Mexico using otolith microchemistry – Henry Hershey
11:40 – 12:00	Life history variability in Southern Flounder – Steve Midway

March 29 continued

12:00 – 1:20	*Lunch*
1:20 – 1:40	Characterizing the Louisiana Southern Flounder fishery: Angler-informed management of a declining population – Dave Smith
1:40 – 2:00	The impact of nighttime guided-gigging charters on Texas' Southern Flounder fishery – Quentin Hall
2:00 – 2:20	Stock Assessment of Southern Flounder in the South Atlantic – Laura Lee
2:20 – 2:40	Changing climate associated with the range-wide decline of an estuarine finfish – Kenneth Erickson
2:40 – 3:00	Habitat effects on temperature-dependent sex determination of Southern Flounder in North Carolina – John Godwin
3:00 – 3:20	*Break*

Floundering Around - Evaluating a Declining Species in the SE United States - Session 2 - YouTube

Aquaculture and Genetics Session

3:20 – 3:40	Environmental sex determination in Southern Flounder: Implications for aquaculture and stock enhancement – Russell Borski
3:40 – 4:00	Development of a stock enhancement program for Southern Flounder in South Carolina – Aaron Watson and Tanya Darden
4:00 – 4:20	Stock enhancement efforts of Southern Flounder *Paralichthys lethostigma* on Alabama coastal waters – Max Westendorf
4:20 – 4:40	Texas Parks and Wildlife Department Southern Flounder stock enhancement overview – Paul Cason
4:40 – 5:30	Posters Session • Let's Talk about sex, baby: Using genomic tools to characterize temperature-dependent sex determination in Southern Flounder – Sydney Harned • Evaluating regional space use and environmental forcing of Southern Flounder (*Paralichthys lethostigma*) movement in Mississippi's coastal waters – Patrick Graham • Overview of acoustic telemetry array installation in the Sabine Lake System, Texas/Louisiana, USA – Carey Gelpi

March 30 Agenda

Floundering Around - Evaluating a Declining Species in the SE United States - Session 3 - YouTube

Movement and Migration Session

9:00 – 9:20	Movement dynamics of Southern Flounder – Mike Dance
9:20 – 9:40	Movement and egress patterns of Southern Flounder from estuaries in Texas – Landes Randall
9:40 – 10:00	Migratory movements of Southern Flounder, *Paralichthys lethostigma*, in Mississippi coastal waters – Jennifer Green
10:00 – 10:20	Describing Southern Flounder spawning migration from Mobile Bay, Alabama via ultrasonic telemetry - timing, rates, routes, and homing – Dylan Kiene
10:20 – 10:40	*Break*
10:40 – 11:00	Exploring Southern Flounder contingent diversity, contribution to fisheries, and correlations with growth and condition using natural tracers of habitat use – Jared Chrisp
11:00 – 11:20	Scales of movement along the US South Atlantic coast inferred from conventional, electronic, and natural tags – Fred Scharf
11:20 – 11:40	Assessing migration and spawning habitats of Southern Flounder (*Paralichthys lethostigma*) using satellite tags – Shelby White
11:40 – 12:00	Identifying the spawning and offshore migration corridors used by the North Carolina stock of Southern Flounder – Caitlin McGarigal
12:00 – 1:00	*Lunch*

Floundering Around - Evaluating a Declining Species in the SE United States - Session 4 - YouTube

Synthesis Session

1:00 – 1:15 Synthesis introduction, overview, and goals

1:15 – 2:00 Breakout groups (4)

2:00 – 3:00 Large group discussion

3:00 – 3:20 Break

3:20 – 4:30 Return to large group discussion

Beeken, Nicolette S.

Nicolette S. Beeken, Joel Anderson, Mark Fisher
Texas Parks and Wildlife Department

Determining spatiotemporal trends in hatch and metamorphosis timing of young-of-year Southern Flounder (*Paralichthys lethostigma*) in Texas bays

It is important to monitor spatiotemporal shifts in the timing of key life history events (i.e., hatch and metamorphosis) since these can influence larval survival and juvenile recruitment success. We use otolith microstructure analysis to examine spatiotemporal trends in hatch and metamorphosis timing of a widespread and economically-valuable finfish, Southern Flounder *Paralichthys lethostigma*, in Texas. Also, we use young-of-year (YOY) hatchery-reared individuals to indirectly validate the association between otolith accessory growth centers and larval metamorphosis. Our analysis reveals that coastwide, and especially on the upper coast, average hatch and metamorphosis timing are shifting toward earlier in the year across a 39-yr time series. On average, YOY individuals show similar hatch timing coastwide; however, those captured on the upper coast complete metamorphosis and recruit later than those captured on the middle and lower coast. We find that on average, higher water temperature correlates with earlier hatch timing coastwide across a 39-yr time series. Fishery-independent monitoring shows no concurrent evidence of individuals emigrating earlier in the fall to spawn offshore. We interpret the temporal trend from later to earlier average hatch and metamorphosis timing as evidence of a narrowing survival window where individuals that hatch and complete metamorphosis earlier experience higher survival during years with higher water temperature. We highlight the ecological and management implications of the impact of water temperature on hatch and metamorphosis timing and in turn, larval survival and juvenile recruitment success.

Borski, Russell J.

J.L. Mankiewicz[1,5], J.A. Luckenbach[4], P.M. Turner[2], B.L. Holler[1], J.M. Beasley[1], R. Murashige[2], R. Shamey[3], H.V. Daniels[2], J. Godwin[1], R.J. Borski[1]

North Carolina State University – Raleigh [1]Department of Biological Sciences; [2]Department of Applied Ecology, [3]College of Textiles; [4]Environmental and Fisheries Sciences Division, Northwest Fisheries Science Center, NOAA; [5]US Department of Agriculture, Agricultural Research Service, National Center for Cool and Cold Water Aquaculture

Environmental sex determination in Southern Flounder: Implications for aquaculture and stock enhancement

Southern Flounder (*Paralichthys lethostigma*) fisheries are in decline with enhancement efforts underway to replenish stocks in some Southeastern states. Efforts are also aimed at culturing this high value finfish. Southern flounder and other Paralichthids exhibit environmental sex-determination (ESD), a phenomenon by which environmental factors regulate sex determination occurring during a critical period of early development and that is restricted to the presumed XX female genotype. Our group has identified environmental factors that may regulate sex determination and that produce male-skewed sex ratios which could impact stock enhancement efforts aimed at releasing populations of flounder with 50:50 sex ratios. We have also developed protocols that allow for production of all-female populations of flounder, a critical element to more efficient aquaculture of this species. We demonstrate that high (28°C) and low (18°C) temperatures skew sex ratios toward males, while more moderate temperatures of 23°C maintain 50:50 sex ratios. Additionally, we found that the background color in which flounder are raised can also alter sex, whereby blue tanks masculine fish and black and grey tanks produce the optimal 50:50 sex ratios. Cortisol, a major stress hormone in vertebrates, including in fishes, rises during the critical period (35-65 mm body length) of sex determination in those flounder reared in blue tanks, but not those from black or grey tanks. Periodic application of cortisol through the feed during the critical period of sex determination also masculinizes fish at midrange temperature that yields 50:50 sex ratios in control fish. These data suggest that cortisol may mediate the masculinizing effects of suboptimal environmental conditions. We also developed meiogynogenetic protocols to produce offspring composed entirely of the XX genotype. Here, homologous flounder or heterologous sperm of a different species is UV-irradiated to functionally delete male chromosome (null sperm) is used to fertilize eggs. Eggs are subsequently cold-shocked to retain the polar body that would normally be extruded yielding all XX-populations of flounder. When reared at a permissive temperature of 23°C a nearly pure population of faster growing females is produced.

Cason, Paul

Paul Cason[1] and Ashley Fincannon[2]
Texas Parks and Wildlife Department - [1]Lake Jackson; [2]Corpus Christi

Texas Parks and Wildlife Department Southern Flounder stock enhancement overview

Since 2006, the Texas Parks and Wildlife Department (TPWD) has been working to incorporate Southern Flounder into its existing stock enhancement program. To date, TPWD has produced and released approximately 500,000 juvenile Southern Flounder into Texas' coastal waters. In an effort to increase production, significant investments in infrastructure have recently been made at two TPWD facilities. This has facilitated hatchery research and production of this species, leading to numerous advancements in production. However, many bottlenecks still exist. This presentation will provide an overview of culture methods at two distinct TPWD facilities, production levels, as well as a realistic estimate of future flounder production in Texas. The presentation will highlight lessons learned, significant advancements, limitations, and knowledge gaps related to hatchery production of Southern Flounder for stock enhancement.

Chrisp, Jared

Jared Chrisp[1], Meghan Angelina[1], Dana Sackett[2], Reid Nelson[3], Troy Farmer[1]
[1]Clemson University, Department of Forestry and Environmental Conservation; [2]University of Maryland, Department of Environmental Science and Technology; [3]George Mason University, Environmental Science and Policy Department

Exploring Southern Flounder contingent diversity, contribution to fisheries, and correlations with growth and condition using natural tracers of habitat use

Otolith chemistry and stable isotopes have been used as natural tracers for discerning habitat-use of estuarine fishes. For Southern Flounder (*Paralichthys lethostigma*), recent studies using otolith chemistry have revealed a diversity of lifetime residency patterns across salinity gradients. However, the ecological consequences (in terms of growth, condition, survival) and contribution of recruits with specific residency patterns (e.g., freshwater resident, transient, estuarine resident) to the harvestable population is poorly understood. The objectives of this study were to 1) use otolith chemistry and tissue stable isotopes from fishery-independent and fishery-dependent collections from 2004 – 2007 and 2018 – 2019 in Mobile Bay, Alabama to classify lifetime residency patterns in Southern Flounder, 2) determine if lifetime residency patterns in fishery-independent samples matched expected patterns in a given collection region after accounting for annual variation in river discharge, thereby testing for the existence of distinct migratory contingents, 3) examine which migratory contingents contributed to the commercial and recreational Southern Flounder fisheries in nearby coastal waters, and 4) determine how residency patterns impacted growth and condition. Using multinomial logistic regression, we found that age-0 residency patterns in fishery-independent samples were strongly correlated with region of collection and annual river discharge, suggesting that distinct migratory contingents of Southern Flounder exist. Age-0 Southern Flounder collected in freshwater regions (< 1 psu) typically had freshwater residency patterns, while those collected in oligo- or mesohaline salinity regions typically had estuarine (> 1 psu) residency patterns. Stable isotopes (tissue $\delta^{15}N$ and $\delta^{13}C$) improved our ability to assign Southern Flounder to specific regions within the estuary. The majority (58%) of commercially and recreationally harvested Southern Flounder were transients (combination of freshwater and estuarine residency patterns) with estuarine residents (39%) and freshwater residents (4%) being less prominent. Estuarine residents had higher trophic position, growth, and condition than freshwater residents. Ultimately, results from this study suggest that distinct migratory contingents of Southern Flounder exist in coastal estuaries, that growth and condition are affected by habitat use, and that Southern Flounder recruiting to Alabama's fisheries spend significant portions of their lives in saline habitats (> 1 psu).

Dance, Michael A.

Michael A. Dance
Louisiana State University, Department of Oceanography and Coastal Sciences

Movement dynamics of Southern Flounder

Southern Flounder (*Paralichthys lethostigma*) support economically important fisheries in estuarine and coastal waters of the southeastern United States. Despite their economic and cultural value, Southern Flounder have a unique life history that influences their spatial dynamics and complicates management. While immature fish typically inhabit estuarine waters, adults are believed to undergo offshore spawning migrations each fall, spending the winter offshore before returning to estuaries in the spring. Still, the dynamics of these movements are poorly resolved, and an improved understanding of migratory contingents, environmental and temporal drivers of movement, spawning locations, and homing vs. straying behaviors is needed to better define stock boundaries and develop effective management strategies. This talk will broadly review movement behaviors of southern flounder, highlighting key knowledge gaps and research needs.

Darden, Tanya

Tanya Darden, Joseph C. Ballenger, Morgan Hart, Katie Anweiler
SCDNR Marine Resources Research Institute

Movement and maturity in South Carolina Southern Flounder: Intriguing insights

Understanding of life history variability and stock connectivity is critical to the correct identification of stock structure and stock productivity. Subtle changes in reproductive characteristics and movement patterns can drastically alter our understanding of stock status as determined via formal stock assessments. Southern Flounder along the east coast of the US recently were assessed as a unit stock, based on data from historic tagging studies, genetic studies, and an examination of otolith morphology. This extensive mixing was supported by historic conventional tagging studies suggesting sexually mature Southern Flounder moved out of estuaries into offshore waters to spawn in the fall, despite the lack of identification of specific spawning areas or movement patterns. Further, the assessment assumed low overall productivity of the stock, owing to reliance on maturity ogives suggestive of female maturity at large sizes (50% maturity at 40.24 cm; maximum size ~ 83 cm), though there was an acknowledgement of uncertainty and likely latitudinal variability in size- and age-at-maturity. Herein we provide results and preliminary results conducted by the South Carolina Department of Natural Resources (SCDNR) to investigate the size-at-maturity and movement patterns of Southern Flounder in coastal South Carolina, respectively. For the first study, SCDNR histologically staged 963 Southern Flounder ranging in size from 159-627 mm total length (TL; 364 ± 2.50 mm), with developing to actively spawning Southern Flounder encountered during February and July-December in South Carolina estuarine waters. A fitted binomial regression estimated the size at 50% maturity of female Southern Flounder found in South Carolina as 306 mm TL (95% CI: 299-313 mm TL), smaller than the size at 50% maturity estimated for females in North Carolina (408 mm TL). If the methodology employed by Midway and Scharf (2012) is replicated (only October-December data; assume all histologically staged resting (n = 80; TL = 190-585 mm) females are immature), we estimated the size at 50% maturity of female Southern Flounder as 431 mm TL (n = 138, 95% CI: 403-459 mm TL).This methodology suggests female Southern Flounder as large as 585 mm TL are immature, which does not seem practical considering the life history of the species. For the second study, we tracked the movements of 118 acoustically tagged Southern Flounder (>275 mm total length) released into the Ashley River, South Carolina. Results show 96% of fish were detected in receiver arrays, with 88% of the fish staying within the river of release, and only 12% moving into the Atlantic Ocean in the fall. Movement distances between release location and the last date of detection varied from 0 to 263 km, with the largest distances (> 100 km) only occurring during December and January. This, paired with the size-at-maturity analysis, suggests a portion of mature adult female Southern Flounder are overwintering in their estuarine habitats, presumably spawning in these waters, with a general pattern of only the largest females migrating to offshore habitats.

Erickson, Kenneth A.

Kenneth A. Erickson
TechGlobal, Inc.

Changing climate associated with the range-wide decline of an estuarine finfish.

Southern Flounder (*Paralichthys lethostigma*) are a coastal flatfish species that supports recreational and commercial fisheries, but are currently experiencing range-wide declines. To quantify the range-wide declines and investigate the role of climate in these declines, fishery-independent sampling data of age-0 flounder were obtained from 34 estuaries representing four states bordering the Gulf of Mexico (TX, LA, AL, and FL) and three U.S. southeastern Atlantic states (FL, SC, and NC) spanning from 1976 to 2019. Generalized additive models (GAM) were used to estimate age-0 recruitment trends. Spatial and temporal synchrony analyses were then conducted using annual GAM-predicted values to determine if trends were similar between estuaries in close proximity, and if declines occurred at the same time. Because the species is dependent on physical transport (i.e., winds and tides) for recruitment, hourly wind speed, wind direction, water temperature, and air temperature were obtained for estuaries with non-zero sampling totals and long-term data sets. Only six estuaries showed significant relationships between age-0 flounder indices and growing degree days. However, all estuaries with wind data showed significant relationships between age-0 flounder indices and hourly summed wind speed. Southern Flounder also have environmental sex determination, meaning warming estuaries could account for demographic changes that appear as declines. We document that water temperatures in the same space and time where Southern Flounder sexually determine are warmer now than even a decade ago, which could masculinize populations and substantially change population demographics. These results illustrate the vulnerability of estuarine finfish populations to climate change and increased climate variability. Understanding how climate acts on Southern Flounder biology may help managers respond to and prevent fishery collapses.

Farmer, Troy

Troy Farmer and Meghan Angelina
Clemson University, Department of Forestry & Environmental Conservation

Environmental correlates of Southern Flounder recruitment in Alabama coastal waters.

Environmental conditions during early life act as controlling factors of flatfish recruitment, yet little is known about specific mechanisms generating interannual recruitment variability for Southern Flounder (*Paralichthys lethostigma*) populations along the Gulf of Mexico. We used Southern Flounder age-0 catch per unit effort (CPUE) in Mobile Bay from a long-term (1981 – 2018) survey. Our objectives were to investigate long-term trends in juvenile abundance and assess if declines have occurred and quantify relationships between juvenile abundance and winter environmental conditions (i.e., offshore wind, temperature, river discharge) over the past four decades. Generalized additive models (GAMs) were used to relate environmental covariates to age-0 CPUE. While Southern Flounder age-0 CPUE was highly variable from year-to-year, there was a consistent decline across decades with mean juvenile abundance declining 96.6% from the 1980s to 2010s. GAMs indicated positive relationships between prevailing westerly winds, easterly winds, river discharge and age-0 CPUE, suggesting that winter conditions that affect biophysical conditions such as primary production and estuarine salinity have strong effects on recruitment. Southerly winds had a negative effect on age-0 CPUE. Intermediate winter durations had positive effects on CPUE, while extremely short and long winters correlated with low CPUE. In recent years, weak westerly and easterly winds, strong southerly winds, low winter river discharge, and short winter durations help explain dramatic declines in recruitment.

Gelpi, Carey (Poster)

Carey Gelpi[1], Landes Randall[2], R.J. David Wells[2], Shambhu Paudel[1], Jay R. Rooker[2]
[1]Texas Parks and Wildlife Department; [2]Department of Marine Biology, Texas A&M Galveston

Overview of acoustic telemetry array installation in the Sabine Lake System, Texas/Louisiana, USA

An array of 20 acoustic receivers (VR2Tx) has recently been deployed throughout the Sabine Lake System to monitor fish movements and residency within multiple estuarine and nearshore habitat types as well as movement among estuaries along the Gulf of Mexico. The Sabine Lake System Acoustic Array (SLSAA) is part of a network of bay-scale and nearshore acoustic receiver arrays that now exist across the Texas Coast as well as much of the US Gulf of Mexico coast referred to as the Texas Acoustic Array Network (TEXAAN) and the Integrated Tracking of Aquatic Animals in the Gulf of Mexico (iTAG) respectively. The VR2Tx acoustic receivers used throughout the array are able to detect tagged fish within a ~0.5 km radius of the receiver location. Therefore, the Sabine Lake System is well-suited to allow high resolution monitoring of fish movement due to many single access bottlenecks into major portions of the surrounding marsh, rivers, and Gulf of Mexico. Initial year one acoustic tagging in the Sabine Lake System is focusing on southern flounder and spotted seatrout, both of which have undergone regulatory changes recently and are the subject of much debate surrounding population dynamics and the effects of environmental forcings that influence their behavior. Several additional species of interest are being tagged in surrounding estuarine systems, including black drum, juvenile bull shark, juvenile blacktip shark, alligator gar, tarpon, and Asian carp. We anticipate the SLSAA will improve life history understanding of Northern Gulf of Mexico fish species, provide data that presently does not exist for Southeast Texas, and facilitate collaboration between academic institutions and state/federal management agencies. In addition, several other Gulf state agencies are also conducting simultaneous southern flounder tagging studies, which should provide data for flounder migratory comparisons across states.

Godwin, John

J.L. Honeycutt, C.A. Deck, S.C. Miller, M.E. Severance, E.B. Atkins, J.A. Luckenbach, J.A. Buckel, H.V. Daniels, J.A. Rice, R.J. Borski, J. Godwin[1]

[1]North Carolina State University

Habitat variation in juvenile Southern Flounder sex determination: Effects of temperature

Southern flounder (*Paralichthys lethostigma*) exhibit environmental sex determination (ESD) with environmental factors influencing phenotypic sex during early juvenile development (35-65mm TL) in the presumed XX female genotype. Warm and cold temperatures masculinize southern flounder sex ratios while mid-range conditions produce approximately 50:50 sex ratios. Due to sexually dimorphic growth, southern flounder fisheries are dependent upon larger females. Wild populations could potentially be at risk of masculinization from ESD due to globally increasing water temperatures. We evaluated the effects of habitat and temperature on wild populations of juvenile southern flounder with fish from the North Carolina Division of Marine Fisheries Juvenile Monitoring Program (P120). We sexed juveniles using a molecular biomarker approach with females showing elevated expression of gonadal aromatase (critical for estrogen synthesis) and FoxL2 and low expression of Mullerian Inhibiting Substance while males exhibit the opposite pattern. Northern habitats in NC averaged spring temperatures near 23 °C and produced the greatest proportion of females, while more southerly habitats exhibited warmer temperatures (>27 °C) and consistently produced male-biased juvenile sex ratios (up to 94% male). Rearing juveniles in the laboratory under temperature regimes mimicking those of natural habitats recapitulated sex ratio differences observed across the wild populations, providing strong evidence that temperature is a key factor influencing sex ratios in nursery habitats. These studies provide evidence of habitat conditions interacting with ESD to affect a key demographic parameter in an economically important fishery. The temperature ranges that yield male-biased sex ratios are within the scope of predicted increases in ocean temperature under climate change.

Graham, Patrick (Poster)

Patrick Graham[1,2], Robert Leaf[2], Paul Grammer[1], Jennifer Green[3], Austin Draper[2], Jill Hendon[1]
University of Southern Mississippi - [1]Center for Fisheries Research and Development; - [2]Division of Coastal Sciences, School of Ocean Science and Engineering; [3]Mississippi Department of Marine Resources

Evaluating regional space use and environmental forcing of Southern Flounder (*Paralichthys lethostigma*) movement in Mississippi's coastal waters

Electronic tracking technologies (e.g., radio frequency, acoustic, satellite) have allowed researchers to gather high spatial- and temporal-resolution data to describe fish movement, migration, and habitat occupancy. The large quantities of data that arise from acoustic telemetry studies necessitate the use of various methods for analysis and visualization. In this project we use multiple techniques to evaluate acoustic telemetry data to describe space use and movement patterns of the Southern Flounder (*Paralichthys lethostigma*) in Mississippi's coastal waters. Recent work has described the growth and reproductive dynamics of Southern Flounder in the Mississippi Sound, but little to no information exists on movement patterns within state waters. To inform local management, and to contribute to regional conservation efforts, additional descriptions of broad and fine-scale movement is warranted. To address this need, the MDMR and USM-CFRD began a collaborative acoustic tagging project in 2021. A total of 96 individuals were externally tagged between August - November 2021 and yielded 241,320 detections during the first six months of deployment. In this work, we use current detection data to 1.) evaluate spatial movement across region and month using network analysis techniques, and 2.) apply a random forest (RF) machine learning model to identify environmental drivers of Southern Flounder movement in the Mississippi Sound. The network analysis, which uses graph theory to assess pairwise relationships between objects (nodes), revealed similar movement activity across defined regions in the Mississippi Sound, and less movement activity during January when compared to fall months. The results of the RF model indicated that some variables (the starting location of the individual, river elevation, and salinity) had some value in categorizing whether movement occurred between network zones but overall, the model did not capture the observed patterns very well. Our initial results do help us in understanding and further evaluating some candidate predictor variables.

Green, Jennifer

Jennifer Green[1], Patrick Graham[2,3], Joshua Waters[1], Paul Grammer[2], Christopher Lapniewski[2], Elizabeth Greenheck[3]

[1]The Mississippi Department of Marine Resources; [2]Center for Fisheries Research and Development (CFRD), The University of Southern Mississippi; [3]Division of Coastal Sciences, School of Ocean Science and Engineering, The University of Southern Mississippi

Migratory movements of Southern Flounder, *Paralichthys lethostigma*, in Mississippi coastal waters

Southern Flounder (*Paralichthys lethostigma*) is a popular sport fish species along the northern Gulf of Mexico and is the most harvested flatfish species in Mississippi coastal waters. Prompted by evidence of range-wide population declines and stakeholder concern, MDMR recognized a need to develop projects to increase knowledge of the Southern Flounder stock. In response, the MDMR and USM-CFRD began a collaborative acoustic telemetry project aimed at documenting the timing and environmental drivers of Southern Flounder movements from Mississippi estuaries to offshore waters, and subsequent returns to inshore habitats following presumed spawning activity. In 2021, cooperative tagging efforts were conducted in Biloxi Bay and Pascagoula drainages by MDMR and in St. Louis Bay by USM-CFRD. Southern Flounder were collected using fyke nets and traditional fishing methods, and externally fitted with InnovaSea V9 acoustic transmitters between August and November 2021. Tagged flounder (n = 96) ranged in size from 301 – 500 mm, with a mean of 393.6 ± 40.9 mm total length. Southern Flounder movement was monitored using several passive acoustic telemetry arrays deployed throughout the Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the barrier island passes. In total, over 300 acoustic receivers are deployed and maintained by MDMR, USM and other collaborators. As of January 2022, there were a total of 241,320 Southern Flounder detections from 84 individuals (87.5% of total tagged fish). Emigration from the Mississippi Sound was documented between September and December as indicated from detections by 39 individuals on receivers in barrier island passes. Through continued collaborative efforts, we hope to gain a better understanding of Southern Flounder migration patterns and connectivity between coastal drainages to enhance management of the species in Mississippi.

Hall, Quentin

Quentin Hall[1], Daniel Coffey[1], Matthew Streich[1], Mark Fisher[2], Greg Stunz[1]
[1]Center for Sportfish Science and Conservation - Harte Research Institute for Gulf of Mexico Studies; [2]Texas Parks and Wildlife Department

The impact of nighttime guided-gigging charters on Texas' Southern Flounder fishery

Southern Flounder (*Paralichthys lethostigma*) populations are declining in the Gulf of Mexico basin. This is particularly true in Texas, where this unique and culturally important fishery has been in decline since the 1980s despite increasingly stringent regulatory measures. Current angler-intercept creel surveys used to estimate recreational flounder harvest levels are conducted during daylight hours and do not account for the high levels of nighttime flounder gigging (spearing) activity, a popular and efficient harvest method for this fishery. There are legitimate scientific and logistical concerns that have prevented the use of wide-spread nighttime creel surveys to monitor the flounder gigging fishery in the past, however this has made accurate catch and effort estimates difficult to obtain. Given the concern about this economically important fishery's status, we adopted a unique approach utilizing social media to provide unprecedented information into this fishery's impact during periods that are not traditionally monitored. Specifically, we reconstructed seasonal flounder harvest and effort metrics stemming from the nighttime recreational guided flounder gigging sector over 2.6 years using guided flounder gigging charter photo archives publicly available through Facebook. These metrics show large average client party sizes, large trip harvests, and near-perfect bag limit efficiencies. Temporal trends indicated peak recreational guided flounder gigging effort and harvest occurs during the summer months, a time not traditionally associated with flounder gigging. The addition of nighttime guided-gigging recreational harvest estimates from this study to traditional daytime harvest estimates and commercial harvest estimates resulted in total annual harvest estimates nearly two times greater than current estimates. Overall, this study demonstrates the high pressure guided-gigging charters are placing on Texas' flounder fishery and illustrates the critical need for additional information on the nighttime recreational flounder fishery for both guided and private gigging anglers. Moreover, our results also demonstrate the usefulness of mining social media platforms to capture catch and effort data that are otherwise unavailable.

Harned, Sydney (Poster)

Sydney Harned
North Carolina State University

Let's talk about sex, baby: Using genomic tools to characterize temperature-dependent sex determination in Southern Flounder

Targeted both in commercial and recreational fisheries, the high demand for and harvest of southern flounder has led to overexploitation and significant population decline throughout its range. These declines may be at least partly a result of the temperature dependent sex determination (TSD) exhibited by southern flounder, where genetically female flounder possessing two X chromosomes develop into males when exposed to either high or low temperatures early in development while mid-range temperatures produce approximately 1:1 sex ratios. Juvenile flounder inheriting a 'Y' chromosome appear to always develop as males. The proposed study will use genetics to investigate temperature-dependent sex determination and potential selection across habitats in southern flounder populations. Specifically, two goals will be addressed using high-throughput genomic sequencing: 1) investigate population structure and potential genetic signatures of selection across the range of southern flounder, and 2) identify male sex-determining genes to enable differentiation of XX and XY individuals. Results from this study will help illuminate fine-scale population structure and potential selection across populations of southern flounder. Additionally, identifying sex-determining genes should allow for selective breeding of females with XX sex-reversed males in aquaculture settings, facilitating development of all-female stocks.

Hershey, Henry

Henry Hershey[1], Adrian Stanfill[1], Dennis DeVries[1], Rusty Wright[1], Will Patterson[2], Justin Lewis[2]
[1]Auburn University School of Fisheries, Aquaculture, and Aquatic Sciences; [2]University of Florida School of Forest, Fisheries & Geomatics

Quantifying differences in three potential contingents of Southern Flounder from the Northern Gulf of Mexico using otolith microchemistry

Declines in Southern Flounder *Paralichthys lethostigma* populations throughout their range have prompted researchers to investigate spatial variation in life history patterns and stock structure. While it is established that Southern Flounder from the Gulf of Mexico are genetically distinct from the South Atlantic stock, little is known about potential stock structure or life history variation within the Gulf of Mexico. We used otolith microchemistry data from 280 individuals captured from three of the largest estuaries in the Northern Gulf of Mexico (Barataria Bay, Mobile Bay, and Apalachicola Bay) to determine: A) whether they represent distinct population contingents and B) whether there are differences in life history that can be gleaned from microchemical salinity indicators in the otolith. We used laser ablation inductively coupled mass spectrometry to measure the concentrations of 15 elements along cross sectional transects on the otoliths of each individual. We used multivariate techniques and classification to determine that fish could be assigned blindly back to their capture location based on their multivariate microchemical signatures with up to 86% accuracy. We then assigned residency patterns (freshwater, transient, estuarine) to each year of each fish's life based on whether Sr:Ca ratios in the otolith were above or below an established salinity threshold (1.71 mmom/mol Sr:Ca). We found that freshwater residency was most common in the birth year in each estuary, but least common in fish captured in Mobile Bay when compared to the other estuaries. In this presentation we discuss the sensitivity of our results to different Sr:Ca thresholds, and the implications of our results for recovery and management of Gulf of Mexico populations.

Kiene, Dylan

Dylan M. Kiene and Sean P. Powers
University of South Alabama, School of Marine and Environmental Sciences

Describing Southern Flounder spawning migration from Mobile Bay, Alabama via ultrasonic telemetry - timing, rates, routes, and homing

Southern Flounder (*Paralichthys lethostigma*) is a species of great importance both commercially and recreationally throughout the northern Gulf of Mexico. However, certain reproductive aspects of their life history, particularly their migratory spawning behavior, are not well understood. The objective of this study is to quantify and provide a foundation for understanding variability of Southern Flounder spawning egress from Alabama waters. As water temperatures decrease in the fall, mature female Southern Flounder stage in the lower portion of estuaries in preparation for a mass migration to offshore spawning grounds between mid-October and December. To understand more about the timing and factors driving this migration, a network of acoustic receivers was installed to encapsulate Mobile Bay and its surrounding tributaries such that acoustically tagged fish could not leave without being detected. Southern Flounder were then captured via hook and line from mid to late fall and implanted with Vemco V8-4x acoustic transmitters. In the fall of 2019, 55 Southern Flounder were successfully tagged acoustically, and in the fall of 2020, 45 Southern Flounder were successfully tagged acoustically. Data from both years show extensive riverine movement throughout October, followed by a mass egress of larger fish from these tidal river systems around early November. However, subsequent outmigration rates from Mobile Bay range from 25-40% with many larger fish not egressing into the Gulf of Mexico. These observations are not fully understood at this time but could be explained by a number of scenarios, including selective spawning behavior or high mortality associated with migration. For the migratory contingent of tagged fish, timing of egress and migration routes were described. Evidence of homing characteristics were also observed, where some Southern Flounder that left individual tidal river systems in the fall returned to those same river systems six months later. This characteristic potentially underscores the importance of studying Southern Flounder on finer spatial scales and raises important questions about larval transport and the location-specific settlement of juvenile Southern Flounder.

Lang, Erik T.

Erik T. Lang, Clint S. Edds, Christopher A. Levron, Cijii D. Marshall, and Andrew J. Fischer
Louisiana Department of Wildlife and Fisheries

A novel fisheries independent survey with life history metrics

Since the first official stock assessment of Southern Flounder (*Paralichthys lethostigma*) in Louisiana (2010), adult flounder abundance has been monitored with the Louisiana Department of Wildlife and Fisheries (LDWF) trammel net fishery independent survey. However, the trammel net survey has caught an average of 19 Southern Flounder annually since 2015 with a 5% positive catch rate, which indicates a survey that is not optimal to establish an index of abundance. Consequently, LDWF has attempted a small-scale pilot modified fyke net fishery independent survey to investigate alternative methods that may boost the confidence of abundance estimates. A total of 126 net days were fished, yielding 181 Southern Flounder. These results translate to a 43% (CV=0.10) positive catch rate with 2.15 Southern Flounder caught per positive net day (CV=1.03). Because this survey only exists for this year in its current form, only one index of abundance is available (0.92 fish/net-day) with no variance estimate (no correlation coefficient). Additionally, the months of November and December 2021 yielded 120 ovaries for life history analysis. After histological processing, total length at 50% vitellogenesis was identified as 261mm or 10.3 inches. Unfortunately, Southern Flounder ages in the sample were truncated to exclusively age 1 and 2. Therefore, the result for vitellogenesis at age was inconclusive. We are hopeful that, with funding from the Interjurisdictional Fisheries Program, more years of this modified fyke net survey will yield conclusive results towards a functional fishery independent survey design.

Lee, Laura

Laura Lee, Mike Loeffler, and Anne Markwith
North Carolina Division of Marine Fisheries

Stock assessment of Southern Flounder in the South Atlantic

The NCDMF completed a benchmark stock assessment of southern flounder occurring in the South Atlantic in 2018. The development of the assessment included a thorough review of available data and current southern flounder research. A forward-projecting, statistical catch-at-age model implemented in the Age Structured Assessment Program (ASAP) software was applied to data collected throughout the South Atlantic to estimate population parameters and fishing mortality reference points. The model results show that spawning stock biomass has generally decreased since 2006 and recruitment, while variable among years, has a generally declining trend. Fishing mortality did not exhibit much inter-annual variability and suggests a decrease in the last year of the time series. Stock status in the terminal year, 2017, was overfished and overfishing was occurring.

McGarigal, Caitlin

Caitlin McGarigal
East Carolina University

A multidimensional approach to identifying spawning habitat and migration corridors for the North Carolina stock of Southern Flounder (*Paralichthys lethostigma*)

Southern flounder (*Paralichthys lethostigma*) is an economically valuable fishery in North Carolina that is overfished and declining in abundance despite best management efforts. Uncertainty surrounding life history after adults leave the estuary, including where spawning occurs offshore and stock connectivity in other states, are current management challenges. We have taken a multi-dimensional approach to tracking the offshore migration of *P. lethostigma* and identifying potential spawning sites. In Fall of 2020 (n=110) and 2021 (n=100) adult *P. lethostigma* were captured using commercial pound nets in Albemarle, Pamlico, and Core Sound; fish were acoustically tagged and monitored using a network of acoustic receivers deployed in estuarine and coastal waters throughout NC, as well as an SV2 Wave Glider with a VR2C receiver. Additional fish (n=432) were dissected for gonad histology, otolith aging, and otolith microchemistry; results indicate fish were 0-4 years, mean size of females (395 mm TL) was significantly larger than males (325 mm TL), and females exhibited highest GSI (>1) in late Nov. Movement data from n=79 individuals suggest high variation in migration corridors and emigration timing. Some *P. lethostigma* (n=4) overwintered in estuarine waters and some migrated to edge of continental shelf in Jan/Feb (n=3), but most fish migrated to nearshore coastal waters between Cape Lookout and Cape Fear. Larval *P. lethostigma* were collected weekly (Dec-March) by the NOAA Beaufort Bridgenet monitoring site and birthdates, estimated using daily otolith rings, were used in a particle tracking model (CMS) to estimate spawning location. Preliminary results indicate coastal waters South of Cape Lookout have the highest probability of being a source of larval *P. lethostigma*, which supports adult movement data. Current efforts to identify *P. lethostigma* eggs (using DNA barcoding) are ongoing; eggs were collected at sampling sites across the continental shelf from Dec-March and presence of *P. lethostigma* eggs would provide further evidence supporting hypothesized spawning locations.

Midway, Stephen R.

Stephen R. Midway
Louisiana State University, Department of Oceanography and Coastal Sciences

Life history variability in Southern Flounder

Life history traits have importance for both the biology of a species but also for how species are managed, because combinations of life history traits often directly influence population dynamics. Not only is it important to understand species life history traits, but it can be equally important to understand how those traits vary within a species, and often along environmental gradients. Southern Flounder have a wide range from temperate mid-Atlantic waters to the subtropical Gulf of Mexico. Over time, independent studies of life history traits suggest variability across this range. Using growth as a case study we found clear variability in growth rates and maximum asymptotic size in male and female southern flounder from Texas to North Carolina. The hierarchical Bayesian model developed for this case study also shows promise for application in both meta-analytical and reanalysis applications, whereby macroscale life history patterns can be quantified and even help estimate life history traits for missing populations or stocks. Finally, hierarchical Bayesian models may be combined with established life history invariant relationships in order to expand our understanding of macroscale variability for poorly studied traits, such as natural mortality.

Powers, Sean

Sean Powers
University of South Alabama, School of Marine and Environmental Sciences

Population dynamics and abundance trends in coastal Alabama

Southern Flounder (*Paralichthys lethostigma*) is a popular recreational and commercial finfish throughout the Gulf of Mexico. Recent landings by both commercial and recreational fishers indicate lower abundance of Southern Flounder in Alabama coastal waters – an observation also common in anecdotal reports from fishermen. To evaluate these patterns and assess the current status of the stock, we synthesized fisheries-dependent and independent data and applied those data in an age-structured modeling environment. Fisheries dependent sources of information included commercial and recreational landings, age data from commercial and recreational port sampling, and recreational effort data. Fisheries-independent data from a 17-year gillnet survey was also included. From these data sources two indices of abundances (fisheries-independent and recreational CPUE), two catch-at-age matrixes (commercial and recreational) and growth parameters were calculated and entered into the National Marine Fisheries Service's (NMFS) ASAP model (version 3.0 April 2018 release) for the period from 2001-2019, which were the maximum number of years that met the minimum data requirements of the model. The ASAP model is a statistical catch-at-age model that allows internal estimation of a Beverton-Holt stock-recruitment relationship. The assessment model indicates a stock that is experiencing a decline in overall population abundance most likely due to low recruitment. Currently (2017), the stock biomass is above B_{msy} (the stock biomass at maximum sustainable yield) indicating that the stock is not overfished. However, $F_{current}$ (the current Fishing mortality rate) is above the $F_{SPR30\%}$ (0.66 vs 0.50) indicating that the stock is currently experiencing overfishing (the rate of exploitation is too high and will lead to an overfished condition in the future). Although the stock has experienced similar lows in landings in the past (late 1980's), the results of this analysis indicate that management intervention is necessary to rebuild a sustainable stock. An examination of recent landings and fisheries independent indices do not indicate the stock has begun to rebuild.

Randall, Landes

Landes L. Randall[1], Christopher Steffen[1,4], Michael A. Dance[2], R. J. David Wells[1,3], Shane Stephens[1], Jay R. Rooker[1,3]

[1]Texas A&M University – Galveston; [2]Lousiana State University; [3]Texas A&M University - College Station

Movement and egress patterns of Southern Flounder from estuaries in Texas.

Estuarine environments are critical habitats for Southern Flounder, Parlichthys lethostigma, serving as habitat for both early life and adult stages, with adult flounder leaving the estuary to spawn in the fall/winter. Understanding the movement of fish populations that use both estuarine and coastal ecosystems and the environmental drivers that initiate migrations is critical to the conservation and management of estuarine-dependent species. Residency and migration patterns of Southern Flounder have been examined in Galveston Bay and the northern Gulf of Mexico since 2016 using acoustic telemetry. Since 2016, 226 Southern Flounder have been tagged in Galveston Bay and monitored with acoustic receivers placed near shorelines and tidal passages. Southern Flounder show quick, large-scale movements from November through January peaking in December, while moving across multiple receivers in the bay and through the tidal passes. This peak in egress corresponds to periods of increased fishing pressure, making flounder more susceptible to capture and harvest. Additionally, flounder were partitioned by size classes to determine if fish size influenced distance travelled. We found that smaller (40-49 cm total length) sized flounder stay in the estuary longer than larger (50-60 cm total length) individuals, potentially making them more susceptible to commercial and recreational fishers year-round. The results from this study shed new light on the migratory behavior of Southern Flounder along the Texas coast.

Scharf, Fred

Fred Scharf
University of North Carolina - Wilmington

Key aspects of Southern Flounder life history: identifying knowledge gaps and potential effects on stock dynamics

Southern flounder have evolved a complex life history strategy that includes continental shelf spawning, long larval duration (45-60 d) and advection into estuarine nursery habitats, followed by spatially variable benthic settlement, and early shift to piscivory, and rapid growth to maturity. Several aspects of their life history remain poorly understood, with impacts on our ability to model stock dynamics and identify the most appropriate management strategies. This presentation will attempt to describe the major features of southern flounder life history, focusing specifically on those features about which we are less informed. These will include ocean spawning locations, larval delivery to estuaries, settlement dynamics, sources of mortality in the estuary, variation in maturity scheduling, emigration timing, and the extent of ocean residency by adults. Each of these has the potential to contribute to the spatial scale of stock mixing in both the Atlantic and Gulf of Mexico, and inform our ability to accurately model southern flounder stock dynamics and promote effective management.

Scharf, Fred

Fred Scharf
University of North Carolina - Wilmington

Scales of movement along the US South Atlantic coast inferred from conventional, electronic, and natural tags

The application of a diversity of tagging approaches has informed southern flounder movement patterns at multiple spatial scales along the US Atlantic coast. This presentation will summarize findings from several historic conventional tagging studies conducted in the 1980's and 1990's in NC, SC, and GA, as well recent studies using electronic (acoustic) and natural (otolith microchemistry) tags. Major findings from conventional tagging studies were two-fold: first, a high number of recaptures near release locations after considerable time at large indicated sedentary movement behavior in the estuary; and second, recaptures that occurred at large distances indicated the ability for extensive migration throughout the US South Atlantic basin, and that the vast majority of this movement was in a southerly direction. Recent studies using electronic tags confirmed the sedentary nature of estuarine movement patterns, at daily, weekly, and seasonal time scales. The electronic tags enabled emigrating fish to be detected and revealed that pathways and timing were relatively consistent across years and that the cumulative effect of multiple environmental factors acted to initiate migration behavior. The movement of acoustically-tagged fish along the coastline suggested the potential for some large-scale migrations that may not include offshore spawning. Analysis of otolith trace elements and stable isotopes from juvenile and adult southern flounder captured in NC, SC, and FL indicated a considerable level of mixing between the juvenile period and later adult life stages, which may occur post-spawning.

Smith, David R.

David R. Smith[1], Stephen R. Midway[2], Jerrod M. Penn[3], Rex H. Caffey[3], Michael A. Dance[2]

[1]Texas Parks and Wildlife Department; Louisiana State University - [2]Department of Oceanography and Coastal Sciences; - [3]Department of Agricultural Economics & Agribusiness

Characterizing the Louisiana Southern Flounder fishery: Angler-informed management of a declining population.

Fishery-independent indices of the Louisiana Southern Flounder (*Paralichthys lethostigma*) fishery have indicated a sharp decline in abundance and recruitment, particularly in recent years. While the reasons for this decline are not yet fully understood, this decline has prompted a reevaluation of Southern Flounder harvest regulations in Louisiana. In this context, we modeled recreational landings to characterize the trend and seasonality of the fishery. We found that recreational landings have declined in recent years and that this fishery is strongly seasonal. Once defining characteristics of this fishery, we shifted our focus to angler outreach to gain a better understanding of the behaviors and attitudes regarding Southern Flounder regulations. We gauged angler support for specific regulation scenarios and evaluated how these scenarios might alter coastal angling effort. Anglers indicated strong levels of support for each regulation scenario that increased limitations on allowable harvest. Hypothetical angling effort was not significantly affected by any of the regulation scenarios presented in our survey. The information gathered in this study is not only applicable to improved Southern Flounder management in Louisiana but may have relevance for developing sustainable management strategies for other fisheries that are not only biologically warranted, but also inclusive of meaningful stakeholder engagement.

Waters, Joshua

Joshua Waters, Jennifer Green, Trevor Moncrief, Matt Hill
Mississippi Department of Marine Resources

Monitoring Relative Abundance of Southern Flounder in Coastal Mississippi

Southern Flounder (*Paralichthys lethostigma*) is a highly popular finfish for both recreational and commercial fishermen along the Mississippi Gulf Coast. Throughout recent years, a decline in flounder abundance and annual harvest have been observed in the Northern Gulf of Mexico. In addition, flounder are rarely and inconsistently sampled due to the selectivity and sampling regime of current fishery-independent surveys. These irregularities have made it difficult to establish an affective estimate for relative abundance each year. Given this concern, the Mississippi Department of Marine Resources implemented fyke nets as a strategy to sample flounder. The goals of this project are to 1) compare the effectiveness of fyke net sampling to standard independent survey methods (i.e., gill net), 2) analyze data collected from 2018-2021, and 3) explore potential environmental factors that could affect abundance. Sampling sites in Belle Fontaine, Davis Bayou, Deer Island, Pascagoula Bay, and Pascagoula USCG Island were chosen based on the amount of ideal habitat and the sampling accessibility. Sampling occurred from May to November in two-week intervals with a 48-hour soak time. A total of 244 Southern Flounder have been caught with the fyke nets during 53 sampling events from 2018 – 2021. In contrast, from a ten-year span of 2012 – 2021, gill nets observed only 113 southern flounder from 1,008 sampling events. To date, of the 244 fish sampled, 243 have been immature or developing females, while 1 was an immature male. The observed size distribution from 2018 to 2021 was 194 mm – 482 mm total length (TL). Observed weight ranged from 88 g – 1547 g. Ages ranged from < 1 – ≥ 3 year. When comparing environmental factors, higher or lower salinity levels and temperature result in an affect on abundance of fish collected. Results of this study will aid in informing future stock assessments and management recommendations for Southern Flounder in the Mississippi Sound.

Watson, Aaron

Tanya Darden, Aaron Watson, Joey Ballenger
SCDNR Marine Resources Research Institute

Development of a stock enhancement program for Southern Flounder in South Carolina.

A regional stock assessment, which included data from South Carolina Department of Natural Resources' (SCDNR) long-term surveys, strongly indicated Southern Flounder were depleted and that overfishing had occurred over the last 30 years throughout the southeastern Atlantic region (North Carolina, South Carolina, Georgia, and the east coast of Florida). Regionally, fewer adult fish have translated to fewer young fish spawned each year and SCDNR data indicates overall abundance and the number of young fish produced each year in South Carolina waters are at all-time lows. In addition to regulatory changes, last year the South Carolina legislature mandated the commencement of a stock enhancement research program for Southern Flounder to supplement traditional management measures.

The SCDNR has a long history of state-of-the-art aquaculture, stock enhancement, genetics, and applied fisheries research. In July 2021, we began applying our expertise in each of these areas to the 10-year development plan of a new stock enhancement program for Southern Flounder in South Carolina. All stocking research will follow Responsible Approach guidelines and adhere to a strict internal policy that ensures the health and well-being of the resource. These guidelines require us to evaluate the potential impacts and be capable of identifying stocked fish from their wild cohorts to determine contribution, for which we rely on our standardized surveys for sampling and genetic tools for analyses.

Our priorities during our first year included planning and implementation of needed infrastructure renovations for Southern Flounder production at the Marine Resources Research Institute in Charleston as well as the Waddell Mariculture Center in Bluffton, field survey design and implementation for initial broodstock collection, coordination of genetic sample collection along the southeastern US coast, beginning development and optimization of a genetic marker panel, and experiments to begin the optimization of both captive husbandry and spawning protocols for Southern Flounder.

Westendorf, Max J.

Max J. Westendorf and John Mareska
Alabama Department of Conservation and Natural Resources, Marine Resources Division

Stock Enhancement Efforts of Southern Flounder Paralichthys Lethostigma in Alabama Coastal Waters

In Coastal Alabama, and throughout the Gulf of Mexico, Southern Flounder (*Paralichthys lethostigma*) is and has been a popular recreational and commercial species. Recent commercial and recreational landings indicate lower abundance of Southern Flounder in Alabama coastal waters – an observation also common in anecdotal reports from fishermen. A stock assessment on of the species was performed in 2018. The results indicated a decline in overall abundance due to an extended period of low recruitment. In addition, the results showed the stock was not currently overfished, but experiencing overfishing which would result in an overfished condition in the future if management changes were not implemented.

One of the suggested tools for improving management of Southern Flounder was use of a stock enhancement program. The Alabama Department of Conservation and Natural Resources, Marine Resources Division maintains the Claude Peteet Mariculture Center (CPMC) located in Gulf Shores, Alabama. The CPMC facilities include a 23,000-square foot building containing rooms for broodstock maturation and spawning, algae and live food production, egg incubation, larval rearing, and juvenile holding. Complementary infrastructure includes thirty-five - 0.2-acre PVC lined ponds, a greenhouse complex containing re-circulating tank systems, and two seawater pipelines (brackish and full-strength sea water).

Southern Flounder broodstock were acquired locally beginning in 2018 and held in temperature and photoperiod-controlled tanks at CPMC. Utilizing Ovaplant®, an experimental hormone for this species, an estimated 12,236 fingerlings were released to Alabama inshore waters in 2020, and 34,591 fingerlings were released in 2021. In 2021, investigations began at CPMC attempting to identify and refine cryopreservation techniques for Southern Flounder milt to improve fertilization success and gene diversity.

White, Shelby

Shelby White[1], Michael S. Loeffler[1], Anne Markwith[1], Mason Collins[2], Fred Scharf[2]
[1]North Carolina Division of Marine Fisheries; [2]University of North Carolina Wilmington

A Piece of the Puzzle: Identifying Southern Flounder (*Paralichthys lethostigma*) Migration Patterns and Spawning Aggregations in the South Atlantic with Satellite Tagging.

The coastwide stock assessment for Southern Flounder (*Paralichthys lethostigma*) indicates a need to better understand offshore migration and movement patterns of the species. This multi-state collaborative research between the North Carolina Division of Marine Fisheries and the University of North Carolina Wilmington uses two Pop-Up Satellite Archival Tag (PSAT) models to identify offshore spawning locations and timing of spawning movements for Southern Flounder. Tagging efforts occurred over two years with tags released throughout North Carolina and South Carolina. Female Southern Flounder were captured using commercial pound nets, hook-and-line, gill net, and independent sampling gears. Models suggest that the timing of satellite tag release is a significant indicator of movement to inner and outer shelf habitats. Results of PSAT releases indicate that while some fish migrate out of the estuaries to inner and outer shelf habitats, others remain inshore. The PSAT model that collects temperature and depth suggests that fish migrating to outer shelf habitats fluctuate between depths, which may be indicative of batch spawning behavior. The relationship between temperature range and depth will be further analyzed to determine migration patterns and timing. Remaining PSATs will be released throughout the South Atlantic in Fall 2022, focusing primarily on releases in South Carolina and Georgia as an effort to understand population connectivity. An understanding of Southern Flounder migration patterns and offshore spawning habitats will offer valuable information on the spatial scale for management of the South Atlantic population and provide avenues for future research on histology and reproduction of Southern Flounder.

ATTENDEES

Jason Adriance
LDWF
River Ridge LA
jadriance@wlf.la.gov

Charles Alexander
LDWF
Grand Isle LA
calexander@wlf.la.gov

Kevin Anson
ADCNR/AMRD
Gulf Shores, AL
Kevin.Anson@dcnr.alabama.gov

Patrick Banks
LDWF
Baton Rouge LA
pbanks@wlf.la.gov

Emily Baukema
LDWF
Baton Rouge LA
ebaukema@wlf.la.gov

Nicolette Beeken
TPWD
Palacios TX
nicolette.beeken@tpwd.texas.gov

Kori Blitch
LDEQ
Baton Rouge LA
kori.blitch@la.gov

Robert Boothe
LDWF
Grand Isle LA
robert.boothe@la.gov

Russell Borski
North Carolina State Univ.
Raleigh NC
russell_borski@ncsu.edu

Nancy Brown-Peterson
Univ. of Southern Mississippi/GCRL
Ocean Springs MS
nancy.brown-peterson@usm.edu

Erika Burgess
FWC
Jacksonville FL
erika.burgess@myfwc.com

Rick Burris
MDMR
Biloxi MS
rick.burris@dmr.ms.gov

Robert Caballero
LDWF
New Orleans LA
rcaballero@wlf.la.gov

Joel Caldwell
LDWF
Bay Saint Louis MS
joel.caldwell@la.gov

Brady Carter
LDWF
Bourg LA
bcarter@wlf.la.gov

Paul Cason
TPWD
Lake Jackson TX
paul.cason@tpwd.texas.gov

Willie Cheramie
LDWF
Bourg LA
wcheramie@wlf.la.gov

Jared Chrisp
Clemson Univ.
Brunswick GA
chrisp2@g.clemson.edu

Hailey Conrad
Virginia Tech
Blacksburg VA
haileyconrad@vt.edu

Glenn Constant
USFWS
Baton Rouge LA
glenn_constant@fws.gov

Michael Dance
Louisiana State Univ.
Baton Rouge LA
mdancee1@lsu.edu

Tanya Darden
SCDNR
Charleston SC
dardent@dnr.sc.gov

Suzanne Delaune
LDWF
Grand Isle LA
sdelaune@wlf.la.gov

Dennis Devries
Auburn Univ.
Auburn University AL
devridr@auburn.edu

Clint Edds
LDWF
Grand Isle LA
cedds@wlf.la.gov

Katherine Ellis
LDWF
Prairieville LA
kellis@wlf.la.gov

Kenneth Erickson
TechGlobal, Inc.
Arlington VA
kerick6@lsu.edu

Aimee Eschete
LDWF
Bourg LA
aeschete@wlf.la.gov

Troy Farmer
Clemson Univ.
Clemson SC
tmfarme@clemson.edu

Joe Ferrer
GSMFC
Ocean Springs MS
jferrer@gsmfc.org

Gabrielle Fignar
Louisiana State Univ.
Baton Rouge LA
gfigna1@lsu.edu

Ashley Fincannon
TPWD
Corpus Christi TX
ashley.fincannon@tpwd.texas.gov

Andy Fischer
LDWF
Baton Rouge LA
afischer@wlf.la.gov

Traci Floyd
MDMR
Biloxi MS
traci.floyd@dmr.ms.gov

Jordan Frantz
LDWF
Lacombe LA
jfrantz@wlf.la.gov

Jason Froeba
LDWF
Baton Rouge LA
jfroeba@wlf.la.gov

Carey Gelpi
TPWD
Port Arthur TX
carey.gelpi@tpwd.texas.gov

John Godwin
North Carolina State Univ.
Raleigh NC
john_godwin@ncsu.edu

Patrick Graham
Univ. of Southern Mississippi/GCRL
Ocean Springs MS
patrick.m.graham@usm.edu

Paul Grammer
Univ. of Southern Mississippi/GCRL
Ocean Springs MS
paul.grammer@usm.edu

Jennifer Green
MDMR
Biloxi MS
jennifer.green@dmr.ms.gov

Mary Grigor
LDWF
Lake Charles LA
jgrigor@wlf.la.gov

Quentin Hall
Texas A&M - Corpus Christi
Corpus Christi TX
quentin.hall@tamucc.edu

William Hano
LDWF
New Orleans LA
whano@wlf.la.gov

Sydney Harned
North Carolina State Univ.
Raleigh NC
spharned@ncsu.edu

Hannah Hart
FWC
Titusville FL
hannah.hart@myfwc.com

Henry Hershey
Auburn Univ.
Auburn University AL
hjh0027@auburn.edu

B.J. Hilton
GADNR/CRD
Brunswick GA
bj.hilton@dnr.ga.gov

Jack Isaacs
LDWF
Baton Rouge LA
jisaacs@wlf.la.gov

Dylan Jones
LDWF
New Orleans LA
djones@wlf.la.gov

Dylan Kiene
Univ. of South Alabama/DISL
Dauphin Island AL
dkiene@disl.org

Holly Kindsvater
Virginia Tech
Blacksburg VA
hkindsvater@vt.edu

Erik Lang
LDWF
Baton Rouge LA
elang@wlf.la.gov

Jenny Lang
LDWF
Baton Rouge LA
jlang@wlf.la.gov

Laura Lee
NCDMF
Morehead City NC
laura.lee@ncdenr.gov

Michael Lee
MDMR
Biloxi MS
michael.lee@dmr.ms.gov

Eddie Leonard
GADNR/CRD
Brunswick GA
eddie.leonard@dnr.ga.gov

Chris Levron
LDWF
Grand Isle LA
clevron@wlf.la.gov

Julie Lively
Louisiana Sea Grant
Batron Rouge LA
julieann@lsu.edu

Michael Loeffler
NCDMF
Manteo NC
michael.loeffler@ncdenr.gov

John Mareska
ADCNR/AMRD
Dauphin Island AL
john.mareska@dcnr.alabama.gov

Anne Markwith
NCDMF
Wilmington NC
anne.markwith@ncdenr.gov

Caitlin McGarigal
East Carolina Univ.
Greenville NC
mcgarigalc20@ecu.edu

Debora Mcintyre
GSMFC
Ocean Springs MS
dmcintyre@gsmfc.org

Paul Mclaughlin
LDWF
Lake Charles LA
pmclaughlin@wlf.la.gov

George Melancon
LDWF
Lake Charles LA
george.melancon@la.gov

Steve Midway
Louisiana State Univ.
Baton Rouge LA
smidway@lsu.edu

Link Morgan
LDWF
Metairie LA
lmorgan@wlf.la.gov

David Nieland
Louisiana State Univ.
Baton Rouge LA
dniela@lsu.edu

David Norris
LDWF
Houma LA
davidnorris89@gmail.com

Sean Powers
Univ. of South Alabama/DISL
Mobile AL
spowers@disl.org

Landes Randall
Texas A&M – Galveston
Galveston TX
lrandall@tamu.edu

David Reeves
NFWF
Baton Rouge LA
david.reeves@nfwf.org

Lance Renoux
LDWF
Lafayette LA
lrenoux@wlf.la.gov

Thomas Rowley
LDWF
Lacombe LA
trowley@wlf.la.gov

Andrew Scalisi
LDWF
Lake Charles LA
ascalisi@wlf.la.gov

Fred Scharf
Univ. North Carolina - Wilmington
Wilmington NC
scharff@uncw.edu

Thomas Sevick
LDWF
New Orleans LA
tsevick@wlf.la.gov

David Smith
TPWD
Tyler TX
david.smith@tpwd.texas.gov

Shane Stephens
Texas A&M - Galveston
Galveston TX
shanestephens@tamu.edu

Philip Stevens
FWC
St Petersburg FL
philip.stevens@myfwc.com

Maryam Tabarestani
LDWF
Baton Rouge LA
mtabarestani@wlf.la.gov

Geoffrey Udoff
LDWF
New Orleans LA
gudoff@wlf.la.gov

Steve VanderKooy
GSMFC
Ocean Springs MS
svanderkooy@gsmfc.org

Claire Walker
LDWF
New Orleans LA
cwalker2@wlf.la.gov

Kym Walsh
LDWF
Baton Rouge LA
kwalsh@wlf.la.gov

Joshua Waters
MDMR
Biloxi MS
joshua.waters@dmr.ms.gov

Aaron Watson
SCDNR
Charleston SC
watsona@dnr.sc.gov

Max Westendorf
ADCNR/AMRD
Gulf Shores AL
maxwell.westendorf@dcnr.alabama.gov

Shelby White
NCDENR
Elizabeth City NC
shelby.white@ncdenr.gov

Christian Winslow
LDWF
Lacombe LA
cwinslow@wlf.la.gov

Zach Zuckerman
LDWF
Grand Isle LA
zzuckerman@wlf.la.gov

LSU | College of the Coast & Environment