The Shellcracker

FLORIDA CHAPTER OF THE AMERICAN FISHERIES SOCIETY

https://units.fisheries.org/fl/

Summer 2021

Greetings from Florida AFS headquarters,

First and foremost, welcome back everyone. Since our virtual meeting, I know many of our members have returned to their office environments and I hope that transition is moving along smoothly. It is likely a bittersweet move for many of our members. Many of our members likely got used to that comfy couch set-up we had at home, but on the other hand we were ready to see each other face-to-face again. Take it all in, plan an office cookout, take an extra minute to check in on coworkers and enjoy each other's company.

Now that we are back in the office keep an eye out for future emails from our Florida AFS committees. Our Continuing Education committee has put on two successful workshops, one on utilizing non-lethal ageing structures for marine and freshwater fish and one on Program R: Basics in Fisheries Analysis. The committee plans on hosting workshops roughly every six months so stay tuned for future workshops. The workshops will utilize both in-person and virtual formats. If you or anyone you know has workshop topics or presenter ideas, please let me know and I will pass on that information. Our Marketing and Membership Committee is also marching forward on refining techniques that Florida AFS can apply to keep our membership diverse, committed, and continue to produce benefits to all our members. Finally, our newest committee, the Fisheries Policy Committee, has hit the ground running. Recently, Florida AFS members have worked with National AFS to draft letters to Florida representatives in support of the Recovering America's Wildlife Act. This committee plans to meet on a regular basis to discuss and partake in local to national level policies regarding the natural resources that we all work in on a daily basis.

The Florida Chapter of AFS continues to have a strong presence in both statewide and national fisheries research, management, and communication. I truly believe that we have come out of this global shutdown more apt to deal with the current issues that we face as scientists. The accolades that Florida AFS has accrued through this time is fully representative of our members. I want to thank you all for being so dedicated to the society and what we all stand for in the conservation of our natural resources.

As always if there are any questions, concerns, or comments please reach out to me or any of the other Executive Committee members. We are all the reason that our Chapter is so successful. And if you have ideas or suggestions for next year's symposium topic, please send them to Chelsey Crandall (Chelsey.Crandall@myfwc.com); be on the lookout for a survey from her soon for final symposium topic selection.

Until next time, I wish you all the best.

Daniel Nelson
Florida Chapter AFS
President

Getting in Touch

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Upcoming Events

August 16, 2021: AFS National Meeting: Abstract Deadline

November 6–10, 2021: AFS National Meeting: Baltimore, MD

Interested in contributing something to the Shellcracker? Email: Scott Bisping at *Scott.Bisping@myfwc.com* with any articles or information that you would like to be included in the next issue. The deadline for the next issue is September 15th, 2021, so start fishing...

Gag grouper and sex change: how spatial management and life history traits affect male abundance

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This article is a summary of the following publication:
Lowerre-Barbieri S, Menendez H, Bickford J, Switzer TS, Barbieri L, Koenig C (2020) Testing assumptions about sex change and spatial management in the protogynous gag grouper, Mycteroperca microlepis. Mar Ecol Prog Ser 639:199-214.

Introduction

Gag grouper (*Mycteroperca microlepis*) are an iconic Florida fish that may be in trouble. All fish begin as females in estuarine nursery grounds, but as they age gag move further offshore, with the oldest, largest fish turning into males. The gag's unique life history and spatial ecology pattern makes it difficult to understand the best way to measure stock productivity based off reproductive parameters. Based on females-only, the last stock assessment in 2014 found gag to not be over-fished or undergoing over-fishing. But the same assessment predicted only ~ 2-3% of the population was male. Since then, commercial fishermen have not been meeting quota, leaving fishermen and scientists concerned that this stock may not be as healthy as assumed.

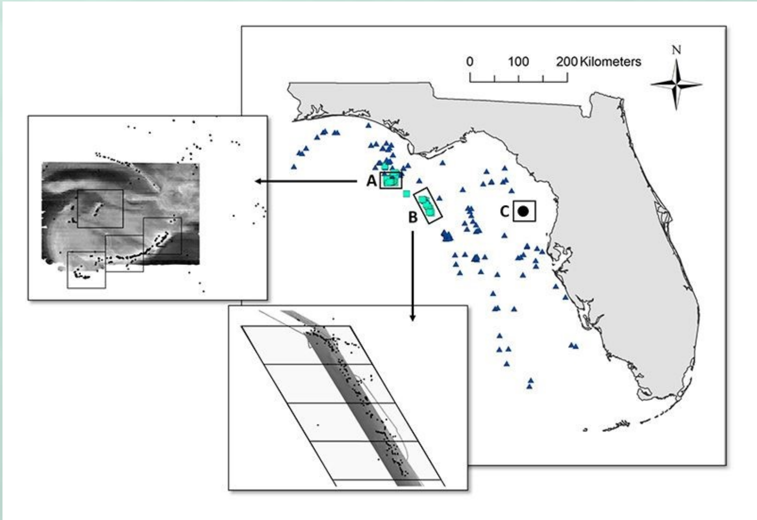


Figure 1. Distribution of gag Mycteroperca microlepis samples with location data by data source: (1) targeted study sites (teal squares, A, B) sampled from December through May; (2) samples from the fisheries-independent reef survey (blue triangles) and (3) samples from a Ed Walker a collaborative fisherman (C). Insets include sampling zones in (A) Madison Swanson and (B) the Edges. Note that comparable spatial information was not available for fisheries-dependent samples collected.

We conducted sampling primarily during gag spawning season, December to May, from 2015 to 2018 in three areas off the Florida Panhandle: (1) Madison Swanson, a marine protected area (MPA), closed all year round to bottom fishing; (2) The Edges, open half the year to fishing; and (3) an Open area (Figure 1). We integrated our directed sampling data with gag data from FWRI programs Fisheries Independent Monitoring and Fisheries Dependent Monitoring and also from Captain Ed Walker, a local commercial fisherman, who kept a portion of his catch for biological sampling prior to their sale. A large, integrated data set gave more power to test the following hypothesis about where and when sex change occurs and the effectiveness of spawning reserves to protect male gag. Our hypotheses were 1) Females form pre-spawning aggregations in December, January, and February and then undergo spawning migrations to deep-water spawning aggregation sites, where males remain year-round and females move only to spawn. 2) Male abundance and male sex ratios will have increased since the 1990s, and within the MPA the male sex ratio will be ~15% based on the predicted efficacy of this management measure. 3) Sex change occurs only on the spawning grounds and is cued by a fish's internal clock or occurs above a minimum size threshold, 800 mm/31.5 in total length (TL) and is cued by male sex ratios on the spawning grounds.

Results

The integrated data set was made up of 1,657 gag and included location and depth sampled for all but the samples from FDM. Fish were sampled along the west coast of Florida from depths ranging from 5-122 meters/16-400 feet. Gonadal tissue was assessed histologically for sex and reproductive development. Histology is the science of producing stained sections of preserved tissue on glass slides that can be examined under a microscope.

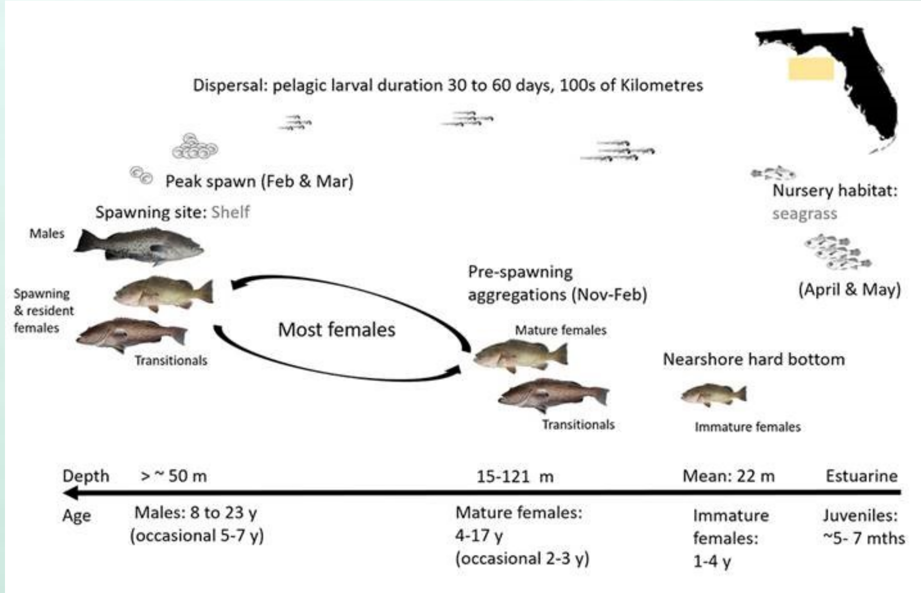


Figure 2. Conceptual model of the spatial ecology of gag. The model shows pelagic gag larvae drift inshore and settle out in estuarine seagrass beds as nursery habitat where they continue to grow into juveniles from 5-7 months old and then move to nearshore hard bottom (in about 22 meters depth) as immature females, typically between 1-4 years old). As female gag mature, they begin to move offshore (in depths ranging from 15 to 121 meters) and form pre-spawning aggregations from November to February and most females migrate further offshore to the shelf in depths greater than 50 meters during spawning season (February-March) where males are thought to remain all year. Seasonal information is in parentheses,

Spatial ecology, how fish were distributed over space

We hypothesized that female gag would form pre-spawning aggregations prior to migrating to deep-water spawning sites, where males remain year-round. Our results supported these hypotheses and showed that gag exhibit clear depth preferences with life stage, sex, and spawning (Figure 2). However, we did not find strong evidence of spawning aggregations, nor that all females leave deep-water spawning sites after the spawning season.

While behavior and migrations associated with spawning accompanied by changes in reproductive organs (gonads) in gag extends from December through May, we found that actual spawning only occurred at our study sites from February 1st through April 18th. Males and females were found at deep-water sites. Although previous gag research reported spawning aggregations of 50-100 fish dating from 1977-1997, this study did not see large numbers of gag on video data nor have large catches (maximum caught during the spawning season in the MPA was 17 gag). Sex-specific movement was evident based on the depths at which fish were captured as average depth at capture differed significantly with sex (Figure 3). Females displayed a minimum capture depth of 4.6 meters/15 feet whereas males started at 49.1 meters/161 feet. Pre-spawning aggregating behavior consistently occurred at the shallow sites that Captain Ed Walker targeted, where he captured fish in November and as late as mid-February. The maximum catch per day at these shallower sites was ~100 fish, and of the 21 fish sampled, 100% of those were female, and 50% had developing or spawning capable ovaries (ramping up to spawn).

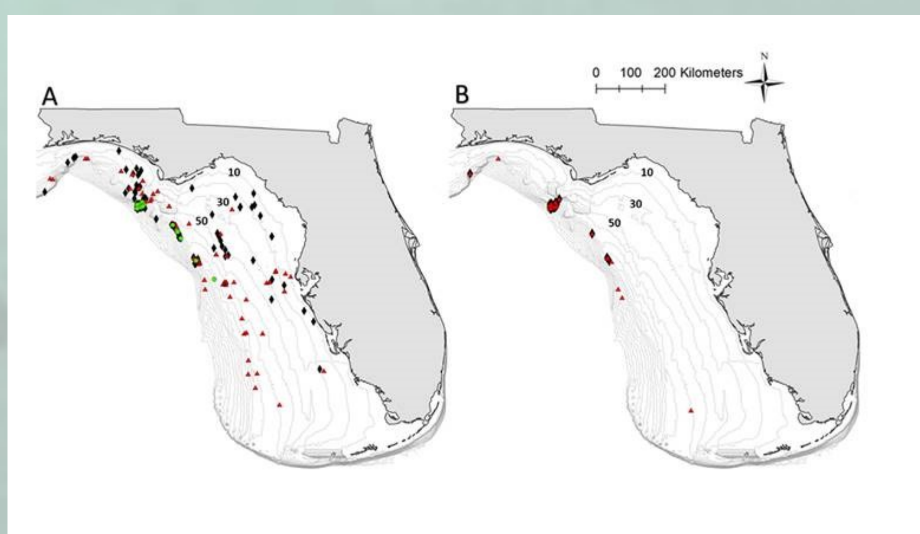


Figure 3 Spatial distribution of gag samples used in this study by (A) females and (B) males. Red triangles denote fish sampled in the spawning season (1 February through 18 April), and black diamonds are fish sampled outside that time period. Green circles denote actively spawning females and the 10, 30, and 50 m depth contours are noted.

Immature females, fish that had never spawned and were not mature enough to spawn at the time of capture, ranged from 1-4 years old and occurred in shallower waters compared to other reproductive phases. Developing females, fish which had received the signal to begin gonadal development for the upcoming spawning season, were as young as 2 years old and sampled over a wide range of depths. Spawning capable females ranged from 3 to 15 years old. Regenerating females, fish that had spawned previously but were not spawning any more this season or skipped spawning that season, had the widest range of ages (2-17 years old). The assumption that females migrate to deep-water spawning sites was supported by the presence of only mature females at these sites, as well as increased abundance during the spawning season. However, not all females left the spawning site after the spawning season ended. Females captured outside of the spawning season during opportunistic sampling – conducted in June, July, October, and November – in these deep-water sites ranged in age from 2 to 10 years old with an average age of 5 years old.

Sex ratio

We hypothesized within the MPA, that male abundance would have increased to 15%, as indicated by previous modelling efforts. We also hypothesized that the age at 50% male (A50) would increase in this protected environment and thus be greater than that seen in the 1990's (10.9 years).

For all months with samples taken in the Madison Swanson MPA (December to May) there was an 11% male sex ratio. However, during the spawning season sex ratios were only 5% male. During spawning season is when most mature males and females are in the same location, so a 5% male sex ratio is what we concluded to be a more accurate representation of the population compared to outside of the spawning season, when some females migrate back to shallower water. During the spawning season we had 0% male in the Edges (seasonally closed) as well as our Open area. Outside the spawning season only 1 male was captured at each of these locations. Although we do not have the data to estimate the optimal gag male sex ratio, several lines of evidence suggest that the current low male sex ratio (5% within the MPA and 0% in the Edges and Open area) is of concern.

We found an A50 of 13 years in Madison Swanson. This suggests the male population in the MPA may be aging with limited recent recruitment of younger males rather than indicating a recovering stock, highlighting our need to better assess male recruitment and the processes driving it. The mating function (relationship between sex ratio and fertilization success) plays an important role in the productivity of protogynous species (fish that begin life as females and transition to males) but is poorly understood. Males displayed low milt (sperm) reserves during the spawning season which is a pattern associated with pair spawners. Because gag are pair spawners and female gag are multiple batch spawners (meaning they produce multiple batches of eggs throughout the spawning season), males would have to spawn with multiple females per day, every day of the ~78-day spawning season. Although male spawning frequencies are unknown, given the low milt reserve gag displayed, this seems unlikely to be accomplished.

With the current low observed sex ratios being close to those seen in the 1990s when gag were considered overfished and undergoing overfishing, the above evidence suggests that male abundance is well below what would be expected in a healthy stock.

Sex Change

To answer if sex change in gag grouper is cued by male sex ratios on the spawning grounds and if there is a minimum size threshold that gag must reach to receive the signal to change sex we examined the occurrence and timing of transition Transitioning fish were very rare – 0.48% of the total samples – and observed from December through May. If the duration of gag sex change (i.e. the time it takes to become a functional male after receiving the cue to change sex) is similar to that of rock hind or black sea bass, approximately 2 months, then if female gag do not receive their sex change cue by December or January, which is when the females form pre-spawning aggregations, they will not be able to contribute as males in the upcoming spawning season, February through April. Male sex ratios are not a requisite cue for sex change, based on our observations that transitionals occur before, during, and after the spawning season and at both all-female pre-spawning aggregation sites and on the spawning grounds. These findings contradict the assumption that sex change occurs only on the spawning grounds and that spawning reserve MPAs will thus protect male recruitment. However, further research is needed to fully understand the proportion of fish transitioning prior to arriving on the spawning grounds.

Sex change was not associated with a minimum size, although males (average TL=1034 mm/40.7 inches) were significantly larger than females (average TL=793mm/31.2 inches) (Figure 4). Males had a larger average TL in the MPA compared to other areas, and the size and age of the transitional sampled in the MPA (14 years and 1107 mm/43.6 inches) was considerably larger and older than observed in the seasonally closed area (6 years old and 845mm/33.3 inches). Sex-specific ages overlapped, with the youngest male being 7 years old and the oldest female aged 17 years. Our results of males and transitionals smaller than 800 mm indicates there is not a minimum size threshold for a gag to change sex. The actual cue which initiates sex change remains unknown. However, the range in sizes and the processes seen in other species suggest that there is a social context to the cue.

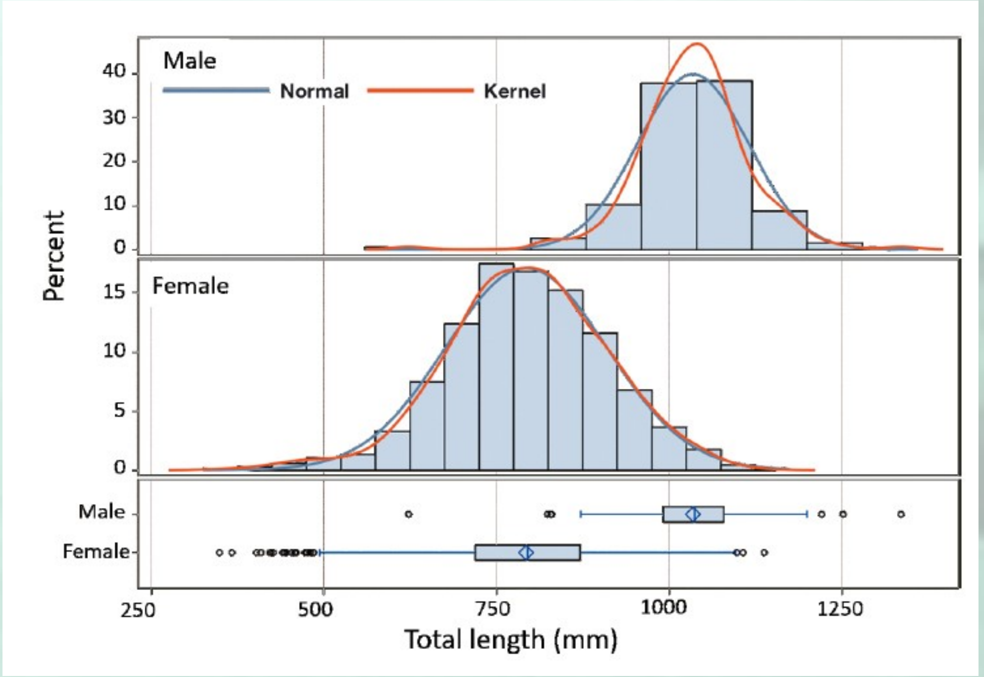


Figure 4 Size distribution of gag by sex compared to expected normal (blue) and kernel (red) distributions. Although size approximated the normal distribution, it did not pass the Wilcoxon Mann-Whitney test, and differences were tested with non-parametric statistics. In the boxplots, mean is denoted by a diamond and median with a vertical line. The ends of the boxes represent the 25th and 75th percentiles, whiskers represent expected range, and dots show data points outside of this range.

We propose a new conceptual model for gag sex change: Presumably, the largest, most aggressive females in a pre-spawning aggregation will transition. On the spawning grounds these female-to-female interactions will be moderated by male abundance and size dominance. However, when male abundance is low, female-to-female interactions will be less influenced by males and/or spawning and result in higher numbers of transitionals both during and after the spawning season on the spawning grounds.

Conclusions

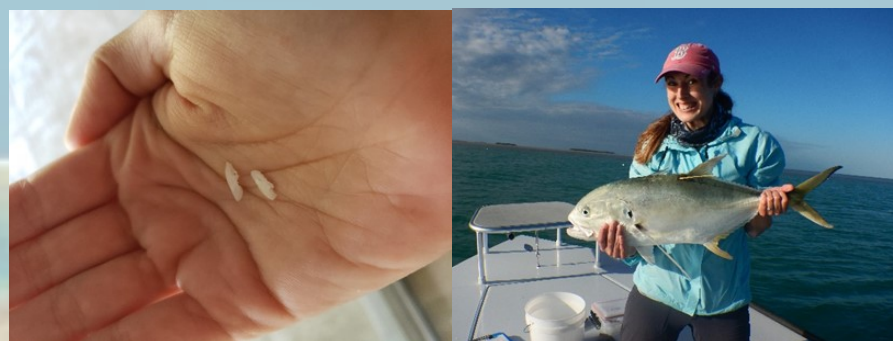
In gag grouper, the spatial distribution of their life cycle, their gender system, and their mating strategy impacts sex change, male recruitment, and the spatio-temporal level of fishing mortality they can sustain.

Given that both gag populations and fishing pressure is greatest in shallow waters, we hypothesize that shallow -water, pre-spawning aggregations are a key spatio-temporal bottleneck to gag productivity because of the potential to remove both fish undergoing transition and females cued to change (but without identifiable gonad restructuring) before they can contribute to gag productivity as males on the spawning grounds.

Gag have an especially complex lifecycle, with the two sexes exhibiting different size and spatial distributions, and this appears to have contributed to the low observed male sex ratios. The very low levels of males seen in this study suggests that all eggs may not get fertilized, decreasing the stocks productivity. This low male abundance and low catches, even in the MPA, suggest gag grouper in Florida may be in trouble.

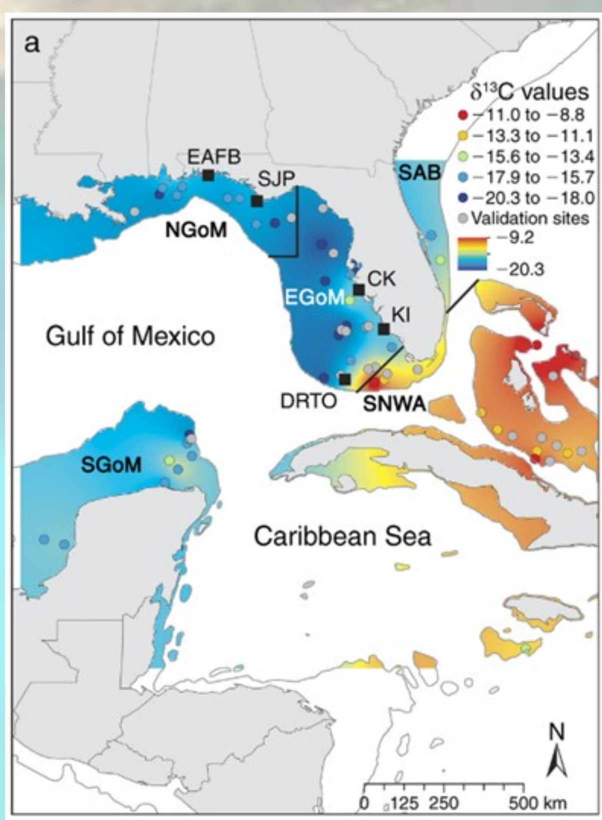
Tiny Tools Tell Giant Stories: Unraveling Fish Life History with a Microscope and a Mini Drill

Carissa Gervasi, PhD Student
Florida International University



Otoliths removed from a Crevalle Jack used for isoscape analysis

In 2018, I was presented with a problem that would turn into a dissertation (a totally new dissertation completely different from the original project I started two years prior, but that's a different story). The problem was that recreational fishing guides in the Florida Keys were catching fewer and fewer Crevalle Jack each year. The decline was alarming enough that it prompted several of these guides to reach out to our lab to see what could be done. The opportunity to tackle a research problem of direct interest to stakeholders and with direct management implications was so good not to pass up I willingly threw caution to the wind and jumped into a new dissertation two years into my PhD program. But that's not the point of this story. This story is about how I attempted to unravel the entire life history of a fish species that has been largely ignored and understudied by thinking really small.



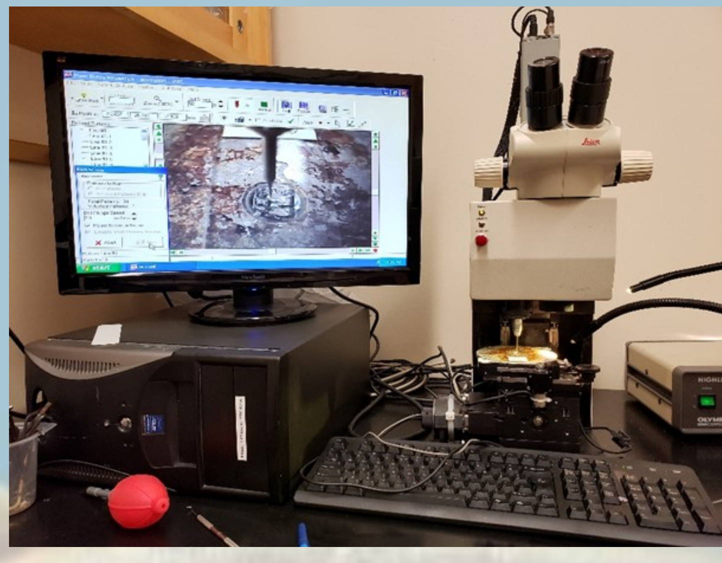
Carbon "isoscape" from Vander Zanden et al. (2015) Ecological Applications

In the fisheries world, the power of the otolith is well known. Otoliths are small structures commonly known as "earbones" that are used by all bony fishes for balance and hearing. Otoliths have some unique characteristics that make them very valuable to scientists. They lay down concentric rings as a fish grows (much like trees do), which allows us to age fish. Also, as the otolith grows with the fish, it retains the chemical composition of the water the fish was living in at a particular point in time. Luckily, water chemistry varies in a somewhat predictable fashion throughout the marine environment. The map below shows the carbon stable isotope landscape (or "isoscape") of Florida.

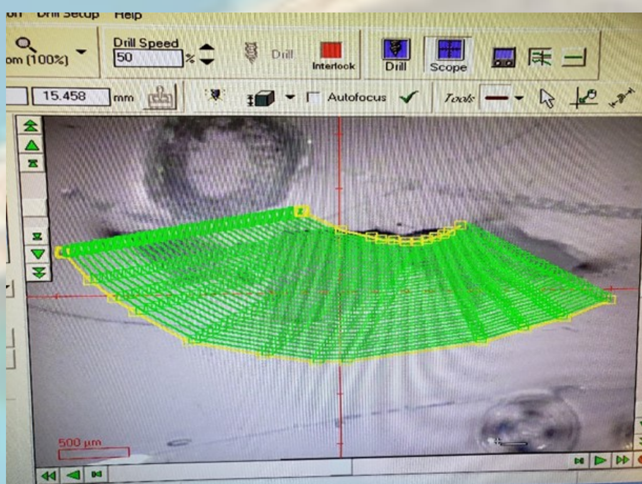
Comparing stable isotopes within a fish otolith to these isoscapes can help us retroactively estimate where our fish might have been. This is what allows us to use otoliths to track fish movements and migrations over their lifetimes, thus unraveling part of their life histories. All we must do is extract the part of the otolith that corresponds to a particular point in time we are interested in and determine the chemical composition of that section. Easy right? Theoretically yes. The problem is that fish otoliths are really, really small. Especially Crevalle Jack otoliths. The photos above show just how small. For a four-year old fish, each year of growth is less than 0.1 mm!

Student Highlight

Fish often live in different habitats throughout the course of their lives. Many coastal fish species will inhabit shallow, warm water estuaries as babies and small juveniles and then migrate to deeper, offshore waters as adults. When we manage a fishery, it is important to know where the baby fish are coming from and when they migrate to their adult habitats where they may be encountered by fishermen. With the Crevalle Jack, we know that adults in the Florida Keys are declining. Part of piecing together why that decline is happening is figuring out where those adults are coming from. The problem is, baby Crevalle Jack are found in coastal estuaries all over the state, in the Northern Gulf of Mexico, and all the way up the Atlantic Coast! It is important for us to find out if the adult Crevalle Jack in the Florida Keys only come from nursery habitats in South Florida or if they come from somewhere else. To do this, I needed to examine the stable isotope signatures present in each otolith ring, so I could figure out where each Crevalle Jack was during each year of its life. But how was I going to remove such tiny sections of otolith? This was going to take some thought.



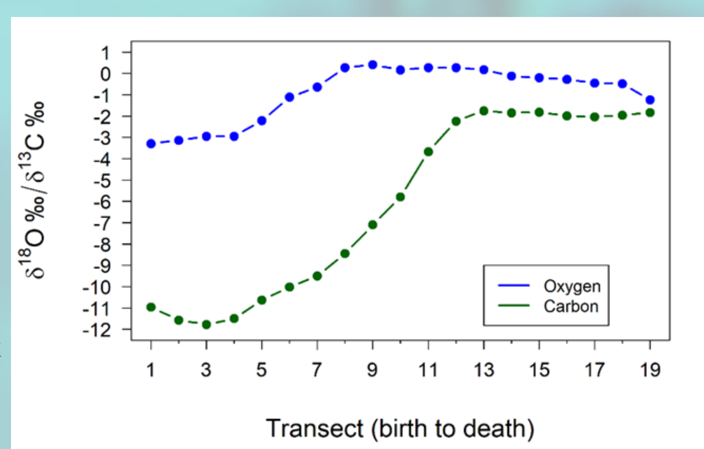
The micromill in the Stable Isotope Lab at the University of Miami RSMAS campus



Looking at an otolith under the microscope. Green lines show the paths the drill will take to remove small sections of otolith from the edge (death) up to the core (birth)

After pouring through the scientific literature and calling labs all over South Florida, I finally found a solution: the micromill. The contraption pictured above contains a teeny, tiny drill bit that is controlled by a computer. On the computer screen, I can see my otolith through a microscope that allows me to zoom in. I can then tell the drill where to go, and drill out tiny sections of otolith that I collect into glass vials using dental tools! The vials of samples then run through an instrument that measures the carbon and oxygen stable isotope concentrations within each otolith section. Once I have my stable isotope measurements, I then plot them on a graph to show how the isotope concentrations in the otoliths have changed over time. And voila, in the graph below we see a substantial shift in both carbon and oxygen that indicates movement from a warm, inshore nursery habitat to a cooler, offshore adult habitat when the fish is about 2-years old.

When I look at these isotope timelines for several Florida Keys fish, I can determine whether they all came from the same nursery habitat or if they moved to Florida from nurseries all over the U.S. This knowledge will help us figure out what might be causing the decline of Florida Keys Crevalle Jack and how we will be able to manage their populations into the future. Tiny tools can certainly tell us a lot!



Graph showing oxygen and carbon stable isotopes throughout one otolith from the core (birth) to the edge (death)

Student Subunit Update

By: Casey Murray

The FL AFS student subunit has been hard at work handling our annual fundraiser and planning future events to bring our student community together. The 2021 Sheepshead shuffle virtual 5K wrapped up in the beginning of July. We had 15 participants from AFS subunits in Florida and from across the country and we raised over $500 to help fund future student travel grants! We appreciate the contribution of all of our shuffle participants, and we hope to have you shuffle again with us next year!

We are currently planning a virtual symposium for all student members to have the opportunity to get together, share our research with each other, and get some practice presenting. We hope to hold this event towards the end of the fall semester, so keep this in mind for your fall plans!

Get Involved

Are you a student interested in promoting your research or developing your science communication skills? Become a contributor to our blog Reefs to Rivers (https://flafsstudentsubunit.wordpress.com) or send us pictures and have your research featured on our Instagram (www.Instagram.com/flafsstudent)

Contact us at flafsstudent@gmail.com for information on how you can get involved. Don't forget to follow our blog, Instagram, and Facebook (www.Facebook.com/AmericanFisheriesSocietyFlStudentChapter).

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