

South Atlantic Region EwE Ecosystem Model

Lauren Gentry
FWC – FWRI, St. Petersburg
December 2020
Lauren.Gentry@myFWC.com

HISTORY OF THE SOUTH ATLANTIC MODEL

- ▶ **2001** - Strawman 48-group model constructed
- ▶ **2004** - Preliminary 98-group model developed
- ▶ **2014** - Model refined to address forage fish questions (99 groups)
- ▶ **2019** - Model refinement to articulate managed species (143 boxes)

2020 - Model refinement to group together data-poor species (140 boxes, 700+ species)

Diets

April 2019 vs Oct 2020

April 2019

~70 diets for 60 species
representing 40 groups

Species proxies for 30
groups

West Florida Shelf model
data for 50 groups

Best guess data for 20
groups

December 2020

250 diets for 235 species
representing 129 groups

0 Species proxies

West Florida Shelf model
data for 17 groups
(inverts)

0 Best guess data

Diets

Primarily from SEAMAP, NOAA, and published literature

*Also found single predation events in BBC videos, Okeanos livestreams, photo catalogues, etc.

Origins

- Quantitative detailed diet study (high quality) **36%**
- Quantitative detailed diet study (standard quality) **30%**
- Qualitative diet study **31%**
- General knowledge, expert consult **3%**

Table 1. Diet composition for young of the year (2000 cm fork length, n = 53, 0 stomachs empty) by percent number (%N), percent weight (%W), percent frequency of occurrence (%O), and index of relative importance on a percent basis (%IRI). Numbers of prey categories indicates that prey were not present in the diet at that %IRI less than 0.01.

Prey Item	%N	%W	%O	%IRI
Young of the year				
Birds	5.18	11.4	39.62	6.27
Order Passeriformes	0.21	0.35	1.89	0.01
Hirundo vari	4.97	10.79	39.62	6.06
Order Cypseloides	0.41	0.01	3.77	0.02
Class Anthusia	0.41	0.35	1.89	0.01
Order Arthropods	5.80	2.87	10.81	3.01
Subphylum Crustacea	0.83	0.38	7.55	0.09
Class Malacostraca	4.76	2.49	30.99	2.12
Order Decapoda	2.90	2.47	26.42	1.18
Family Penaeidae	0.83	1.46	7.55	0.18
Order Amphipoda	0.21	0.01	1.89	0.01
Family Scudidae	0.41	0.03	3.77	0.02
Order Mysida	1.86	0.02	1.89	0.01
Other Eucaridiformes	1.24	0.40	7.55	0.13
Family Euphausiidae	1.64	0.56	5.66	0.09
Bryozoa	0.41	0.10	1.89	0.01
Mollusca	0.41	1.53	3.77	0.14
Order Cirripedia	0.21	1.97	1.89	0.04
Unit: Mollusca	0.21	1.56	1.89	0.01
Mollusca	56.11	36.56	56.94	45.79
Class Gastropoda	18.09	36.56	40.40	41.93
Family Naticidae	6.21	2.81	5.66	0.50
Genus parguriformes	6.80	2.77	3.77	0.32
Family Trochidae	0.83	0.57	1.89	0.02
Unit: Gastropoda	40.65	33.30	47.37	37.50
Unit: Mollusca	0.21	0.09	1.89	0.01
Phylum	0.42	0.09	3.77	0.01
Unit: Plutei	0.41	0.09	1.89	0.01
Tadpoles	19.88	43.93	71.70	44.38
Order Perciformes	0.21	1.62	1.89	0.01
Family Serranidae	0.21	0.40	3.77	0.01
Order Cypriniformes	0.41	0.40	3.77	0.01
Family Cyprinidae	0.41	0.40	3.77	0.01
Order Catostomiformes	0.41	0.11	3.77	0.17
Genus Oryziatylus				

Published stomach contents - %W



	A	B	C	D
1	Aines et al 2017 "Feeding habits of the tiger shark, Galeocerdo cuvier, in the northwest A"			
2	Location	Sample size	Units	Factors
3	SAR/GOM	169	% weight	Most were adults
4	Original Data		Changes and Calculations	
5	Latin	% W	Proportion	New Functional Group Decision
6	Hydroprogne caspia	2.07	0.0207	Shelf piscivores
7	Order Charadriiformes	0.29	0.0029	Shorebirds
8	Teuthida	0.02	0.0002	Squids
9	Anthozoa	0.25	0.0025	Encrusting fauna
10	Ovalipes stephensoni	0.13	0.0013	
11	Sicyonia brevirostris	0.47	0.0047	
12	Stomatopods	0.16	0.0016	
13	Callinectes sapidus	0.4	0.004	

Example of final diet list

Functional Groups	Proportion of Diet
Highly migratory pelagics	0.144299
Sea turtles	0.3217
Demersal coastal omnivores	0.072
Other deep grouper	0.0917
Echinoderms and gastropods	0.0626
Small coastal sharks	0.056
Pelagic oceanic piscivores	0.0516
Demersal coastal invertivores	0.045801
Offshore dolphins	0.0442
Birds - Wading piscivores	0.0418
Pelagic coastal piscivores	0.0417
Birds - Shelf piscivores	0.0228
Benthic coastal invertivores	0.0209
Benthic coastal piscivores	0.0199
Red snapper	0.0183
Axius mackerels	0.0129
Pelagic rays	0.0115
Bluefish	0.0113
Birds - Shorebirds	0.0075
Other scaenids	0.0069
Birds - Shelf invertivores	0.0067
Pelagic planktivores	0.0066
Encrusting fauna	0.0062
Rock shrimps	0.0047
Ocean triggerfish	0.00425
Gray triggerfish	0.00425
Blue crabs	0.004
Demersal rays/skates	0.002
Benthic oceanic invertivores	0.002
Bivalves/oysters	0.0018
Stomatopods	0.0016
Mega-invertebrate predators	0.0013
Marsh vegetation	0.0011

*Multiple species in a group are averaged together in the final matrix

Metadata Scoring

Group #	Group Name	Individual species	Score (0-6)				Ecological role?
			Sample size	Year	Location	Diet richness	
62	Red grouper	red grouper	1	5	6	1	4 Ecosystem engineer

6 Metadata Categories and Scores

Sample Size

6	n = 2000+
5	n = 1000 - 2000
4	n = 500 - 1000
3	n = 300 - 500
2	n = 100 - 300
1	n = 10 - 100
0	n = 0 - 10

Diet richness

6	60+ groups in diet
5	50-60
4	40-50
3	30-40
2	20-30
1	10-20
0	0-10

% of group found

6	200% (two diets)
5	100%
4	75-99%
3	50-75%
2	25-50%
1	10-25%
0	0-10%

Year

6	1995-1998
5	1998 - 2019
4	1985 - 1995
3	1975 - 1985
2	1965 - 1975
1	Before 1965
0	No date given

Detail

6	No unknown material, species level ID
5	0-10% unknown material, excellent ID
4	10-30% unknown, some higher taxons
3	30-40% unknown, entirely grouped taxons
2	40-50% unknown, only functional groups
1	50-60% unknown, phylum-level ID only
0	60%+ unknown, most vague (ex. fish and crabs)

Location

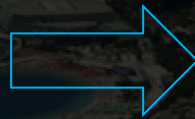
6	SAR
5	SAR + else
4	GOM/North ATL
3	Caribbean/Puerto Rico
2	Other Atlantic
1	Other oceans
0	Unspecified

Analyses – Sensitivity

EwE Monte Carlo
simulation routine
for testing uncertainty
in diet data

Results correlated (40%)
with diet richness scores

Thus isolated groups with
high sensitivity
adjustments **and**
normal/low diet richness



Other deep groupers
Blue runner
Auxis mackerels
Herrings
Menhaden

Analyses – Sensitivity

Can use large adjustments to single predator/prey pairs to identify outliers for closer scrutiny

Predator --- Prey	Solution
-------------------	----------

Halfbeaks --- Seagrass	Incidental ingestion
------------------------	----------------------

Red snapper --- Black seabass	Net feeding, added more diets
-------------------------------	-------------------------------

Coastal bottlenose dolphin --- Weakfish	Confirmed by other diets
---	--------------------------

Bluefin marlin --- Auxis mackerels	High quality data – no change
------------------------------------	-------------------------------

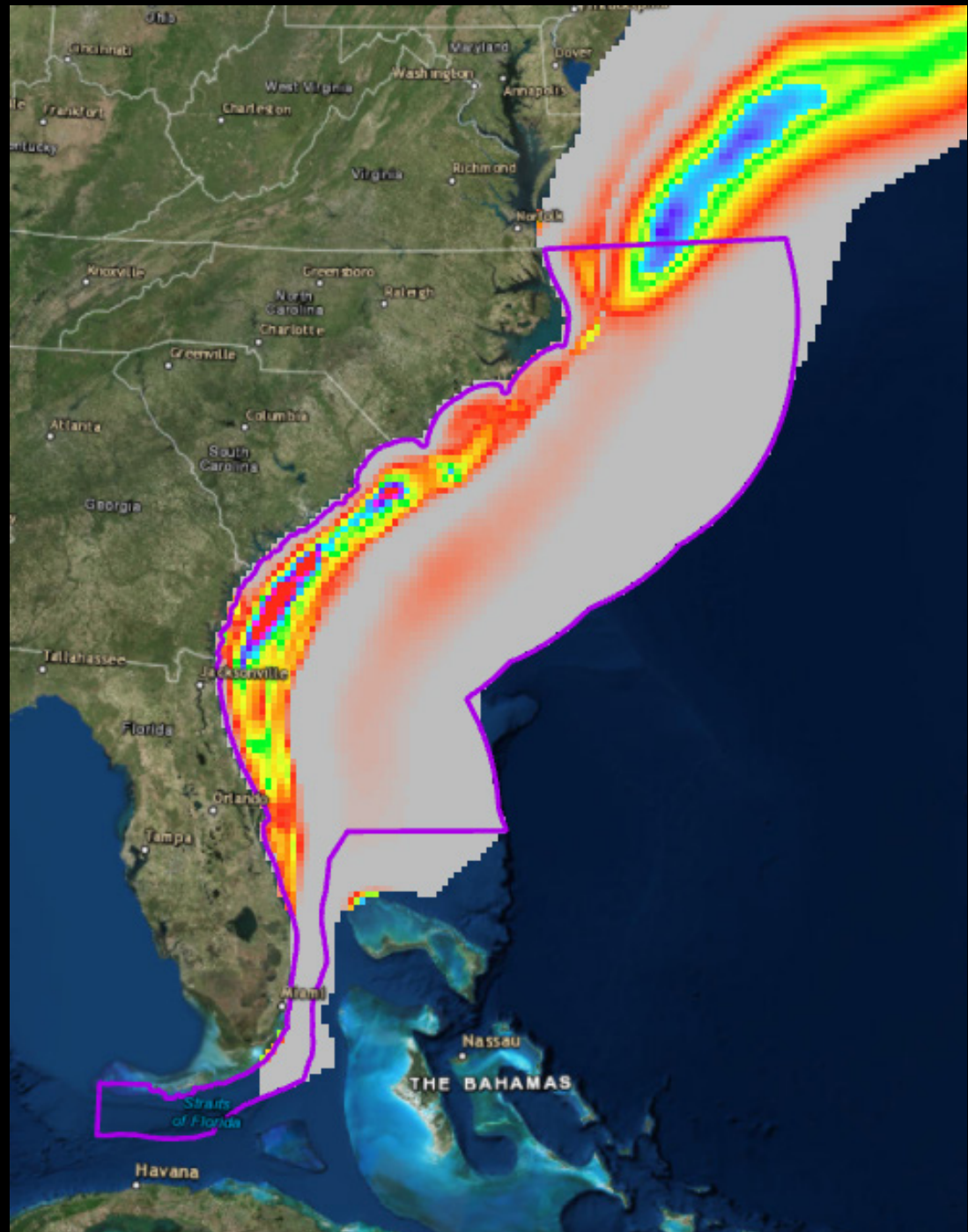
Biomasses

- Primarily from stock assessments
- Others calculated by FWRI staff (manatee surveys, GIS, etc.)
- 61 of 140 input, Ecopath is estimating the rest

Cetacean biomasses

Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico

Developed by Marine Geospatial Ecology Laboratory - Duke University



Landings

Worked with ACCSP to update commercial landings input

- Gear-specific landings for 1100 species from 1995-2019
- Allocated higher taxonomic groups
- Reallocated 90 million pounds of “unknown” landings (seaweed and inverts)
- Examined outliers

Added recreational/headboat landings to time series that formerly contained only commercial landings

- Found expanded list of MRIP species - added 400+ new species' landings
- Now have 153 total time series (formerly 131)
- Quality control on outlying values
 - Contacted NOAA, MRIP, GA DNR, etc. (via Wilson Laney)
 - Scamp, cownose ray outliers a result of extrapolation from <5 catches, removed

Other inputs

Added all discard mortalities currently used by SEDAR stock assessments

- Also added newly published/in-press discard mortalities for deep groupers and gray triggerfish from NCSU

Added time series of primary productivity

- Satellite-derived Chlorophyll a
- Calibrated by NASA from both MODIS and SeaWiFS satellites

Checked outputs against best practices and thermodynamics rules

Created pedigree for all basic inputs

- Ecopath uses these pedigrees to track estimates
- Also helps drive Monte Carlo sensitivity analyses

Where we are now: refining vulnerability parameters

What we need to fine-tune final Ecosim fits:

- Guidance on potential applications
- Workgroup feedback on final fits

Value in the process

Use of diet matrix in other applications

- NOAA Climate Change Vulnerability Assessment
- Ecospecies Database (also long-term repository)
- Comprehensive prey lists for other applications
 - SAFMC discussions of new ecosystem component sp.

Identifying data gaps and outliers for future research

- Diet data poor species from metadata (locality, modernity, sample size, etc.)
- Biomass for species with large impacts on model outputs
- Outliers in catch data records – blueline tilefish is next?

Identifying unusual/valuable interactions

- Shortfin makos consume 80% bluefish
- Blue marlin consume 80% Auxis mackerels

Specifically addresses implementation of FEP II

- Ready to use for some applications and Ecospace will provide even more

Hypothetical Scenario Testing

Black sea bass discard mortality rates

- Ruderhausen et al. 2019 found that descending devices/venting increases survivability by 1.5x vs no intervention
- Reduced recreational discard mortality rate from 14% to 9%
- Model behaved as expected

Biggest Winners and Losers

↑ Biomass

Black seabass
Pelagic planktivores
Encrusting fauna
Squids
Bivalves

↓ Biomass

Anchovies
Shad
Demersal coastal invertivores
Stomatopods
Mega-inverts (crabs)

Prey overlap (%)

	Red snapper	Red porgy	Red lionfish	Red grouper	Black sea bass
Red snapper					
Red porgy	41				
Red lionfish	65	17			
Red grouper	66	67	41		
Black sea bass	43	62	20	65	

Top overlapping diets

Red snapper		Red porgy		Red lionfish		Black sea bass	
Red lionfish	65	Spiny lobster	93	Scamp	75	Golden tilefish	75
Red grouper	65	Queen triggerfish	85	Gag	73	Dogfish sharks	74
Scamp	58	Golden tilefish	80	Red snapper	65	Demersal rays/skates	65

Contributors

SAFMC

FWC – FWRI

NOAA – NMFS

SCDNR

NCDENR

GADNR

ASMFC

UF

UNF

UNC

NCSU

Questions?



Lauren.Gentry@MyFWC.com



A vibrant underwater scene featuring a large, healthy sea anemone with numerous long, greenish-yellow tentacles. Two clownfish are nestled within the tentacles. The primary clownfish is in the foreground, facing left, displaying its characteristic orange body with two prominent white vertical stripes and a thin blue line along the edges of its fins. A second, smaller clownfish is partially visible behind it. The background is a clear, deep blue, suggesting a healthy reef environment.

Appendices

140 groups (part 1)

MAMMALS

Coastal bottlenose dolphin

Offshore dolphins

Pilot whales

Beaked whales

Sperm whales

Baleen whales

Manatees

ELASMOBRANCHS

Planktivorous sharks

Large coastal sharks

Small coastal sharks

Dogfish sharks

Pelagic sharks

Pelagic rays

Demersal rays/skates

TAXONOMIC GROUPS

Mullets

Other sciaenids

Sardines

Anchovies

Silversides

Halfbeaks

Scads

Shad

Sygnathids

Other shallow
grouper/tilefish

Other deep grouper

Other shallow snapper

Other mid-shelf snapper

Other jacks

Other porgys

Other grunts

Herrings

FUNCTIONAL GROUPS

Highly migratory pelagics

Pelagic oceanic piscivores

Pelagic coastal piscivores

Demersal coastal piscivores

Pelagic planktivores

Demersal coastal
invertivores

Demersal coastal omnivores

Benthic oceanic piscivores

Benthic oceanic invertivores

Benthic coastal piscivores

Benthic coastal invertivores

Benthic coastal planktivores

AVES

Birds -- oceanic piscivores

Birds -- shorebirds

Birds -- shelf piscivores

Birds -- herbivores

Birds -- wading piscivores

Birds -- shelf invertivores

Birds -- raptors

REPTILES

Sea turtles

PHOTOSYNTHETICS

Phytoplankton

Microphytobenthos

Benthic macroalgae

Pelagic macroalgae

Seagrasses

Marsh vegetation

140 groups (part 2)

SINGLE SPECIES GROUPS	SINGLES SPECIES CONT.	SINGLE SPECIES CONT.	INVERTS	INVERTS CONT.
Adult king mackerel	Permit	Auxis mackerels	Carnivorous jellies	Bivalves/Oysters
Juvenile king mackerel	Atlantic spadefish	Blueline tilefish	Encrusting fauna	Offshore infaunal crustaceans
Spanish mackerel	Red Lionfish	Golden tilefish	Squids	Offshore polychaetes
Juv Spanish mackerel	Summer flounder	Yellowtail snapper	Stomatopods	Small mobile epifauna
Bluefish	Southern flounder	Mutton snapper	Octopods	Calico scallops
Weakfish	Gulf flounder	Gray snapper	Blue crabs	Benthic meiofauna
Red drum	Hogfish	Lane snapper	Horseshoe crabs	Deep-burrowing infauna
Atlantic menhaden	Ocean triggerfish	Red snapper	Golden crabs	Carnivorous zooplankton
Spotted seatrout	Gray triggerfish	Greater amberjack	Spiny lobster	Other zooplankton
Striped bass	Gag grouper	Almaco jack	Rock shrimps	Ichthyoplankton
Dolphinfish	Red grouper	Bar jack	Penaeid shrimps	Microbial heterotrophs
Snook	Scamp grouper	Queen triggerfish	Megafaunal predators	DEAD
Tarpon	Goliath grouper	Blue runner	Echinoderms and gastropods	Estuarine benthic detritus
Cobia	Nassau grouper	Red porgy	Estuarine infaunal crustaceans	Offshore benthic detritus
Bonefish	Snowy grouper	White grunt	Estuarine polychaetes	Water-column detritus
Sunfish	Black seabass	Vermillion snapper		Dead carcasses
Wreckfish	Rock/Bank seabass			
Great barracuda	Atlantic mackerel			