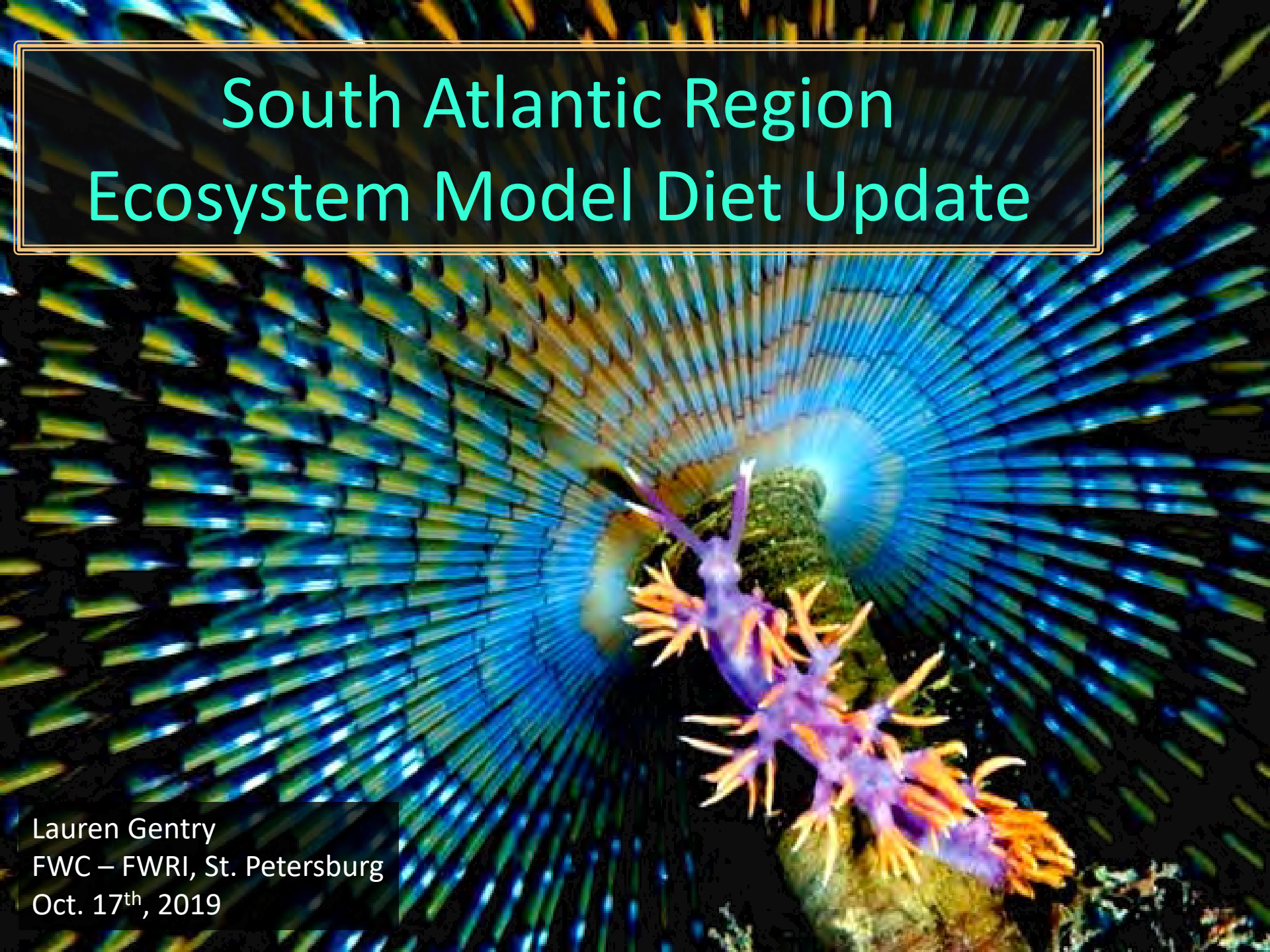
South Atlantic Region Ecosystem Model Diet Update



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Oct. 17th, 2019

April vs Now

April

Diets for approx. 60 species representing 40 groups

Species proxies for 30 groups

West Florida Shelf model data for 50 groups

Best guess data for 20 groups

Now

Diets for 223 species representing 112 groups

~~Species proxies~~

West Florida Shelf model data for 17 groups (invertebrates)

~~Best guess data~~

670 species

140 groups

6
Photosynthetic groups

Seagrass
Benthic macroalgae
Pelagic macroalgae
Marsh vegetation
Phytoplankton
Microphytobenthos

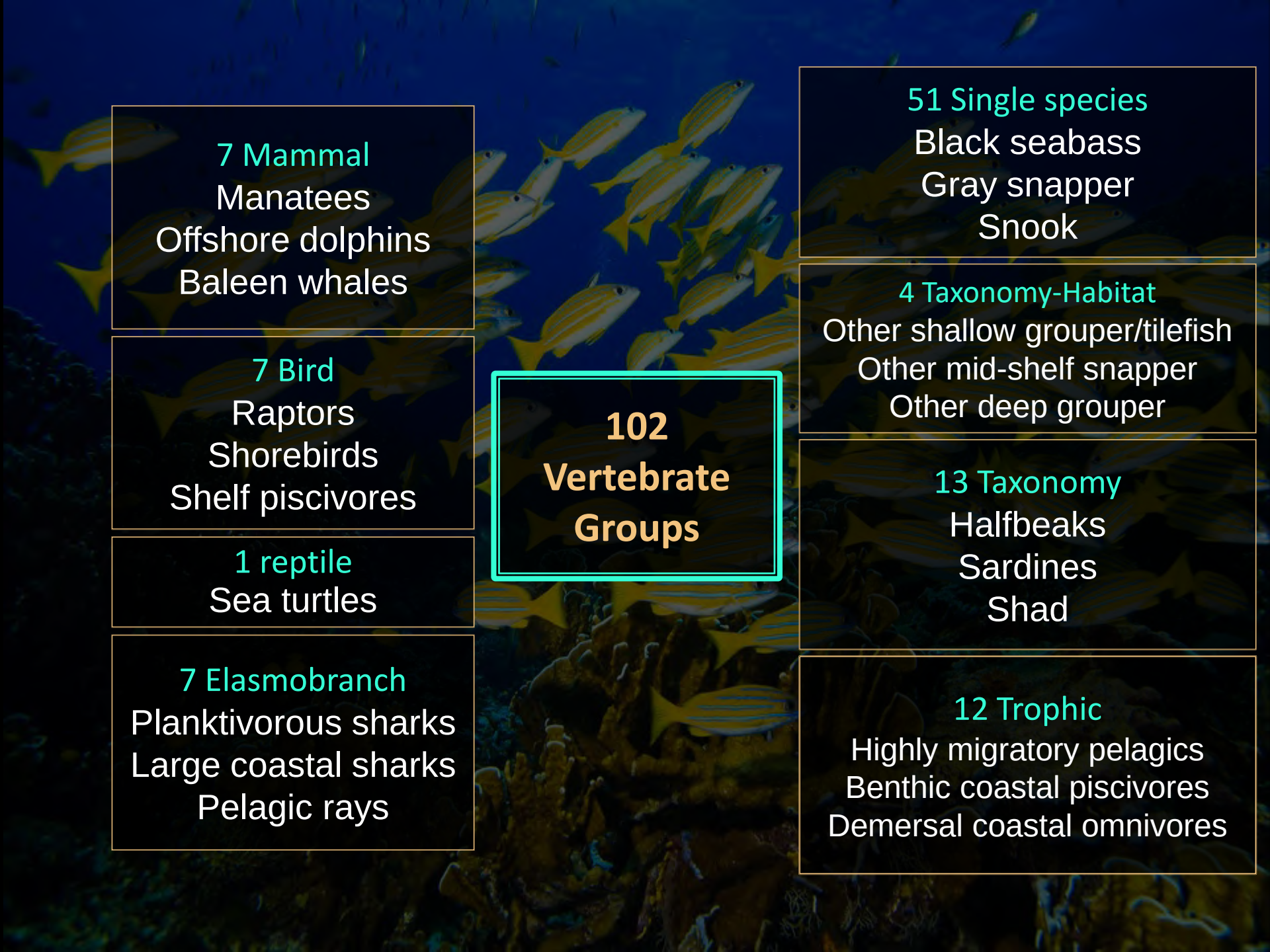
28
Invertebrate groups

Blue crabs
Spiny lobster
Offshore polychaetes
Squids
Mega-invert predators
…

102
Vertebrate groups

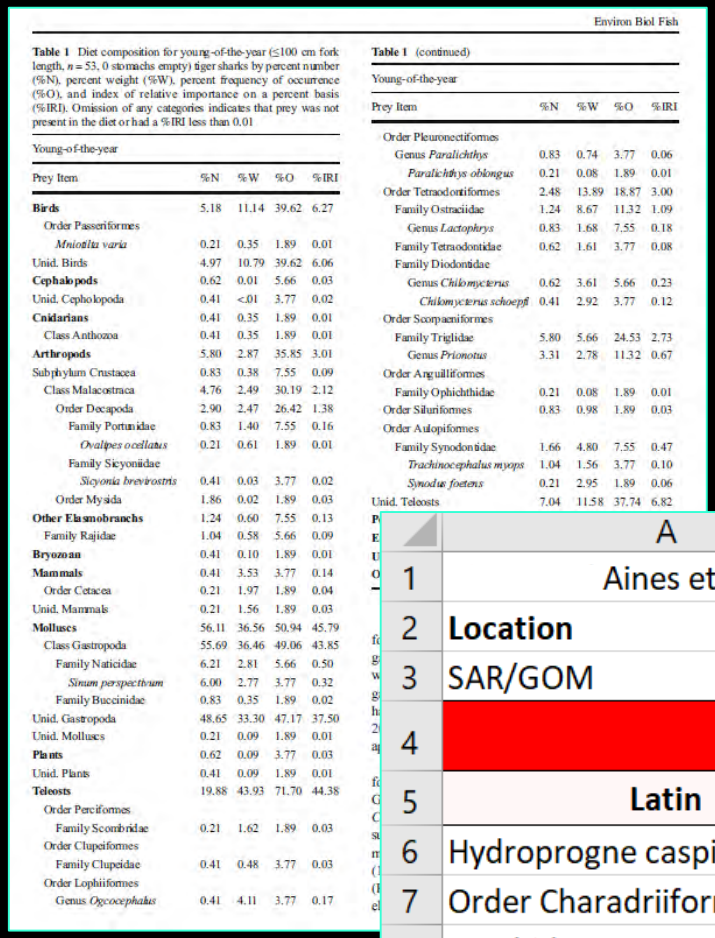
Pilot whales
Birds – raptors
Sea turtles
Dogfish sharks
Black seabass
Other deep grouper
Syngnathids
Pelagic planktivores
…

3 detritus groups, 1 dead carcass


7 Mammal
Manatees
Offshore dolphins
Baleen whales
7 Bird
Raptors
Shorebirds
Shelf piscivores
1 reptile
Sea turtles
7 Elasmobranch
Planktivorous sharks
Large coastal sharks
Pelagic rays
102 Vertebrate Groups
51 Single species
Black seabass
Gray snapper
Snook
4 Taxonomy-Habitat
Other shallow grouper/tilefish
Other mid-shelf snapper
Other deep grouper
13 Taxonomy
Halfbeaks
Sardines
Shad
12 Trophic
Highly migratory pelagics
Benthic coastal piscivores
Demersal coastal omnivores

Method

Published stomach contents - %W



Environ Biol Fish

Table 1 Diet composition for young-of-the-year (≤100 cm fork length, $n = 53$, 0 stomachs empty) tiger sharks by percent number (%N), percent weight (%W), percent frequency of occurrence (%O), and index of relative importance on a percent basis (%IRI). Omission of any categories indicates that prey was not present in the diet or had a %IRI less than 0.01

Young-of-the-year

Prey Item	%N	%W	%O	%IRI
Birds	5.18	11.14	39.62	6.27
Order Passeriformes				
Mniotilta varia	0.21	0.35	1.89	0.01
Unid. Birds	4.97	10.79	39.62	6.06
Cephalopods	0.62	0.01	5.66	0.03
Unid. Cepholopoda	0.41	<.01	3.77	0.02
Cnidarians	0.41	0.35	1.89	0.01
Class Anthozoa	0.41	0.35	1.89	0.01
Arthropods	5.80	2.87	35.85	3.01
Subphylum Crustacea	0.83	0.38	7.55	0.09
Class Malacostraca	4.76	2.49	30.19	2.12
Order Decapoda	2.90	2.47	26.42	1.38
Family Portunidae	0.83	1.40	7.55	0.16
Ovalipes ocellatus	0.21	0.61	1.89	0.01
Family Sicyoniidae				
Sicyonia brevirostris	0.41	0.03	3.77	0.02
Order Mysida	1.86	0.02	1.89	0.03
Other Elasmobranchs	1.24	0.60	7.55	0.13
Family Rajidae	1.04	0.58	5.66	0.09
Bryozoan	0.41	0.10	1.89	0.01
Mammals	0.41	3.53	3.77	0.14
Order Cetacea	0.21	1.97	1.89	0.04
Unid. Mammals	0.21	1.56	1.89	0.03
Molluscs	56.11	36.56	50.94	45.79
Class Gastropoda	55.69	36.46	49.06	43.85
Family Naticidae	6.21	2.81	5.66	0.50
Sinum perspectivum	6.00	2.77	3.77	0.32
Family Buccinidae	0.83	0.35	1.89	0.02
Unid. Gastropoda	48.65	33.30	47.17	37.50
Unid. Molluscs	0.21	0.09	1.89	0.01
Plants	0.62	0.09	3.77	0.03
Unid. Plants	0.41	0.09	1.89	0.01
Teleosts	19.88	43.93	71.70	44.38
Order Perciformes				
Family Scombridae	0.21	1.62	1.89	0.03
Order Clupeiformes				
Family Clupeidae	0.41	0.48	3.77	0.03
Order Lophiiformes				
Genus *Ogcocephalus*	0.41	4.11	3.77	0.17

Table 1 (continued)

Young-of-the-year

Prey Item	%N	%W	%O	%IRI
Order Pleuronectiformes				
Genus *Paralichthys*	0.83	0.74	3.77	0.06
Paralichthys oblongus	0.21	0.08	1.89	0.01
Order Tetraodontiformes	2.48	13.89	18.87	3.00
Family Ostraciidae	1.24	8.67	11.32	1.09
Genus *Lactophrys*	0.83	1.68	7.55	0.18
Family Tetraodontidae	0.62	1.61	3.77	0.08
Family Diodontidae				
Genus *Chilomycterus*	0.62	3.61	5.66	0.23
Chilomycterus schoepfi	0.41	2.92	3.77	0.12
Order Scorpaeniformes				
Family Triglidae	5.80	5.66	24.53	2.73
Genus *Prionotus*	3.31	2.78	11.32	0.67
Order Anguilliformes				
Family Ophichthidae	0.21	0.08	1.89	0.01
Order Siluriformes	0.83	0.98	1.89	0.03
Order Aulopiformes				
Family Synodontidae	1.66	4.80	7.55	0.47
Trachinocephalus myops	1.04	1.56	3.77	0.10
Synodus foetens	0.21	2.95	1.89	0.06
Unid. Teleosts	7.04	11.58	37.74	6.82

	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	

Method

Example of final diet list

Functional Groups	Proportion of Diet
Highly migratory pelagics	0.144299
Sea turtles	0.1217
Demersal coastal omnivores	0.1072
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
Auxis mackerels	0.0129
Pelagic rays	0.0115
Bluefish	0.0113
Birds - Shorebirds	0.0075
Other sciaenids	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

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

Analyses – Metadata scores

<10 individuals sampled

Anchovies
Nassau grouper
Ocean triggerfish

<10 prey groups in diet

Anchovies
Shad
Hogfish

>60% stomach contents unknown

Planktivorous sharks
Manatees
Shad

<25% species finished in group

Shad
Dogfish sharks
Mullets

Data older than 1975

Atlantic spadefish
Bar jack
Blue runner

No location or other ocean

Auxis mackerels
Golden tilefish
Sunfish

Lowest Pedigree Totals

Pelagic rays
Planktivorous sharks
Shad

Analyses – Metadata scores

Species occurring in at least 3 of 7 data-deficient rankings

5

Planktivorous sharks

3

Ocean triggerfish
Shad
Anchovies

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 mid-shelf snappers
Other shallow grouper/tile
Blueline tilefish
Atlantic mackerel

Pelagic sharks
Small coastal sharks
Large coastal sharks
Demersal rays/skates

Red drum
Demersal coastal invertivores

Birds
Inverts

Analyses – Sensitivity

Isolated largest single adjustments to a predator/prey pair

Increasing predator diets on high biomass prey

Other mid-shelf snapper --- Squids

Syngnathids --- Small mobile epifauna

Decreasing predator reliance on single prey

Halfbeaks --- Seagrass

Coastal bottlenose dolphin --- Weakfish

Hogfish --- Echinoderms and gastropods

Red snapper --- Other grunts

July Meeting

Analyses presented to Modeling Workgroup - changes made

1. **Species for which no diets will be found added to larger groups**
2. **Experts for difficult-to-find species contacted**
3. **Herring placed into own group for accuracy and importance**
4. **Queen triggerfish added to model**

Value in the process

Use of diet matrix in other applications

-NOAA Climate Change Vulnerability Assessment
-Ecospecies Database
-Comprehensive prey lists in the future

Identifying data gaps

-Deep water grouper diets
-Tarpon predators?

Identifying interesting/valuable interactions

-Shortfin makos consume 80% bluefish?
-Blue marlin consume 80% Auxis mackerels?
-Do red snapper eat that much black seabass?

Next Steps

Fill in more gaps in the diets - ongoing
QAQC estimates (biomass, production, etc)
-Wraps up Ecopath

Determine predator/prey vulnerabilities
QAQC time series
-Wraps up Ecosim

Add spatial data (Luke McEachron)
Determine major habitat constraints
-Ecospace

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Roger Pugliese, SAFMC
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Kathleen Okeife, FWRI
Kevin Thompson, FWRI
SAFMC


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			

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

Pelagics
Bar jack
Shad
Scads
Anchovies
Halfbeaks
Almaco jack

Tetradoniformes
Puffers
Filefish

Pelagic planktivores
Pearlsides
Lanternfishes
Codlets

Pelagic oceanic piscivores
Flyingfish
Needlefish

Could use improved data

Sharks
White shark
Oceanic whitetip
Smooth hammerhead
Longfin Mako
Lemon shark

Deep dogfish sharks
Flathead cat shark
Kitefin shark
Sharpnose sevengill
Lined lanternshark

Cetaceans
Dolphins
Beaked whales
Baleen whales

Invasive – never enough data
Lionfish