Data Collection and Findings in Spawning Special Management Zones

Prepared by:
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Dr. Lewis Naisbett-Jones

Presented at:
System Management Plan
Workgroup Meeting
November 15, 2023

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Acknowledgements

•South Atlantic Fisheries Management Council esp. Chip Collier, John Carmichael, Gregg Waugh
•SC DNR MARMAP, esp. Tracy Smart
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•Gulf and South Atlantic Fisheries Foundation
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•NOAA Saltonstall Kennedy Program
•Commercial fishermen including Jack Cox, Mark Marhefka, Andy McGraw, Tim Cook, Zach Bowen, Chris Conklin, James Holden, Bo Von Harten, Robert Schemell, Sam Manning
•Mapping: Chris Taylor, Stacy Harter, Nick Farmer

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Outline

1. Background and overview of SSMZs
2. Definitions, sampling methods and timing
3. Historic sampling efforts at SSMZs
4. Georgetown Hole 2023 sampling
5. Forthcoming data collection

Key definitions pertaining to fish spawning

- Spawning – egg release
  - (could be pairs, small group or large aggregation)
- Spawning aggregation -
  - Conspecific fish that have migrated and grouped together for the purpose of reproduction, in densities 3x normal (Domeier et al. 1997)
- Fish aggregation –
  - Group of fish (could be for feeding, breeding, or simply normal schooling behavior, i.e. jacks)


Spawning mutton snapper

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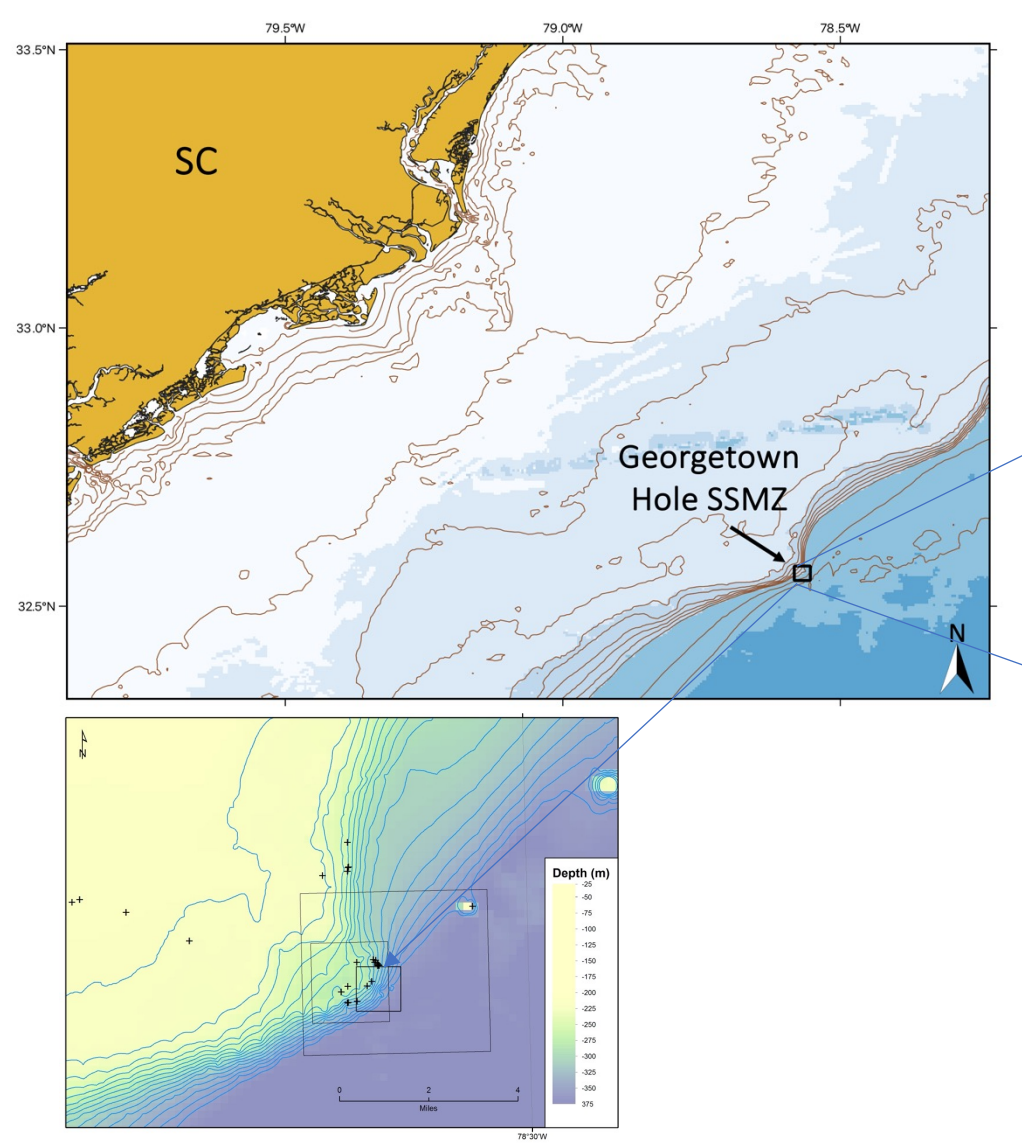
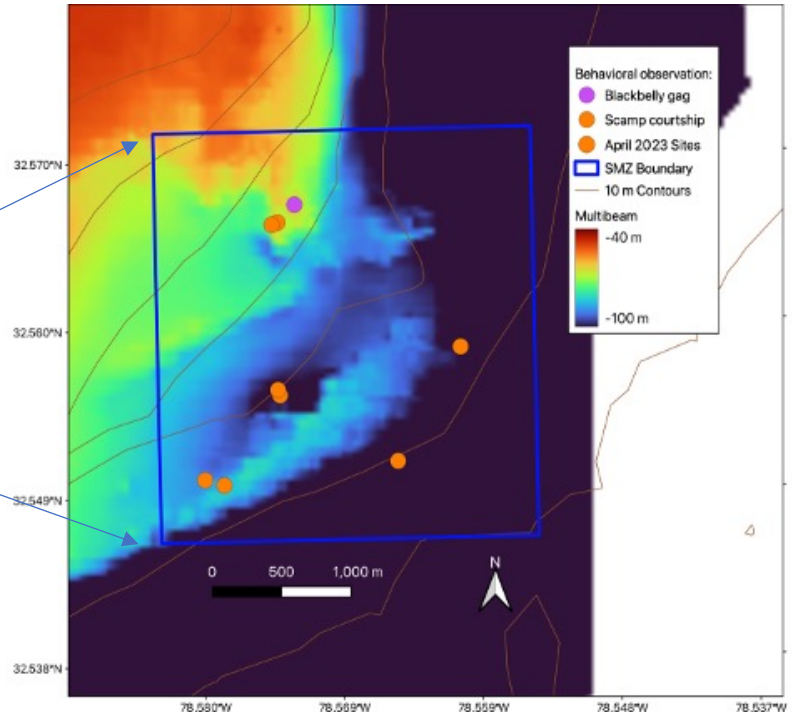
Many reef fish species spawn at promontories or “elbows”



Georgetown Hole is a reef edge promontory or “elbow” that juts into deep water



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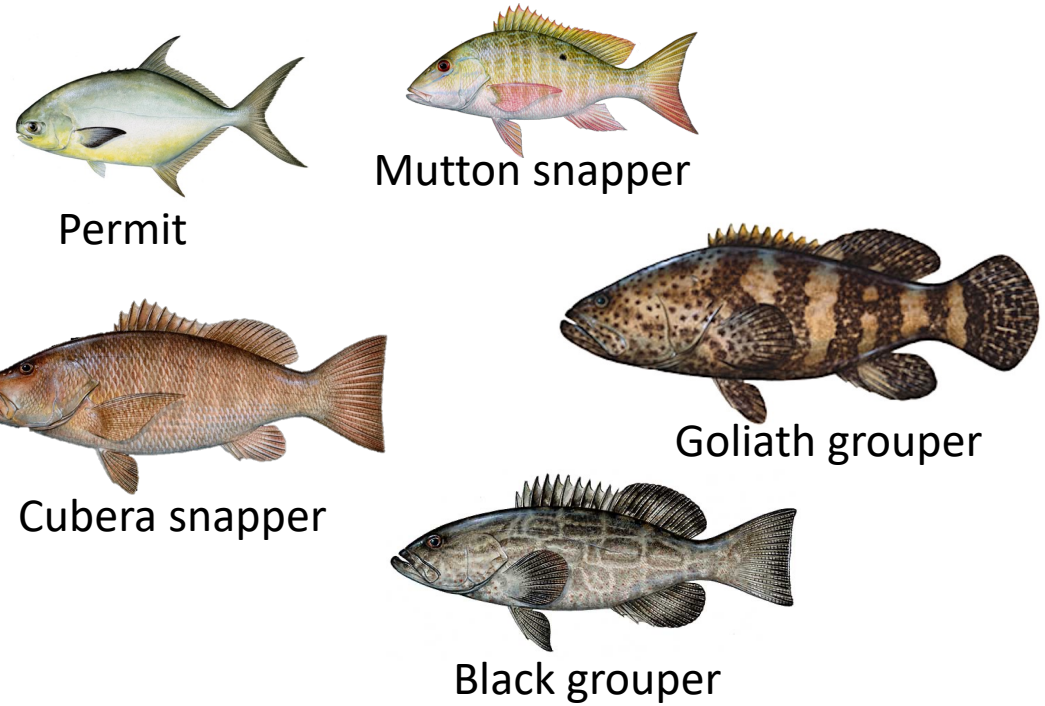
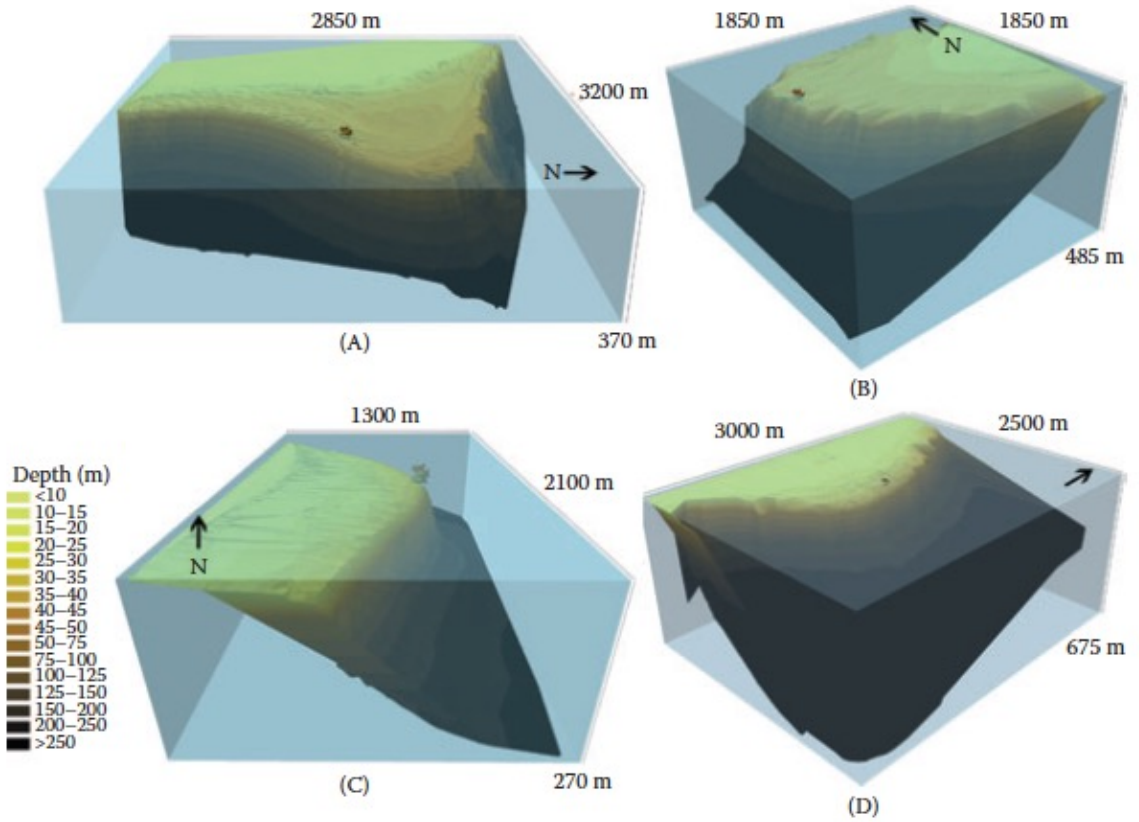
Many reef fish species spawn at promontories or “elbows”

BIOGEOGRAPHY OF TRANSIENT REEF-FISH SPAWNING AGGREGATIONS IN THE CARIBBEAN: A SYNTHESIS FOR FUTURE RESEARCH AND MANAGEMENT

SHINICHI KOBARA[1], WILLIAM D. HEYMAN[2], SIMON J. PITTMAN[3,5] & RICHARD S. NEMETH[4]





Oceanography and Marine Biology: An Annual Review, 2013, **51**, 281-326

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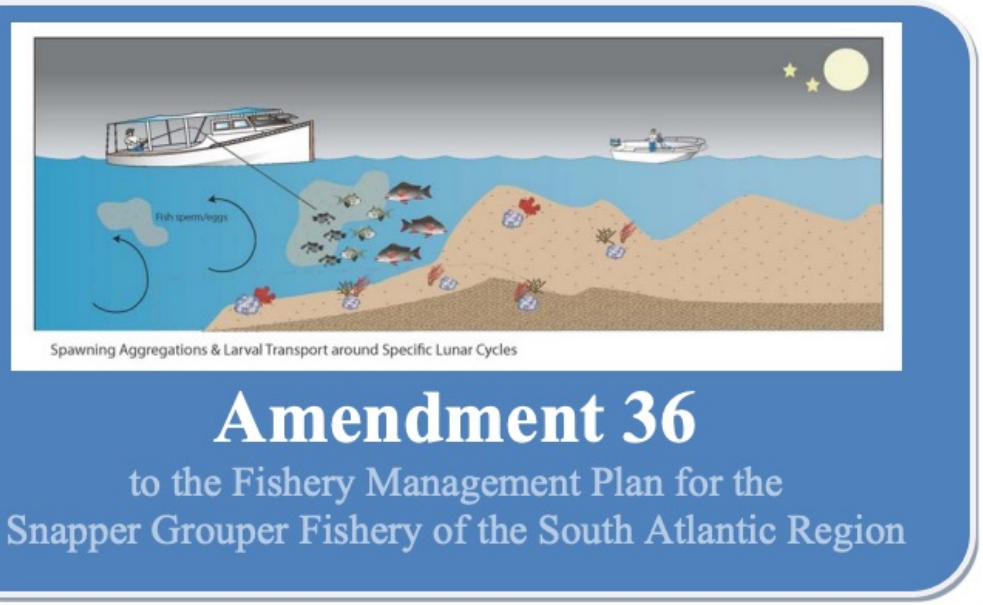
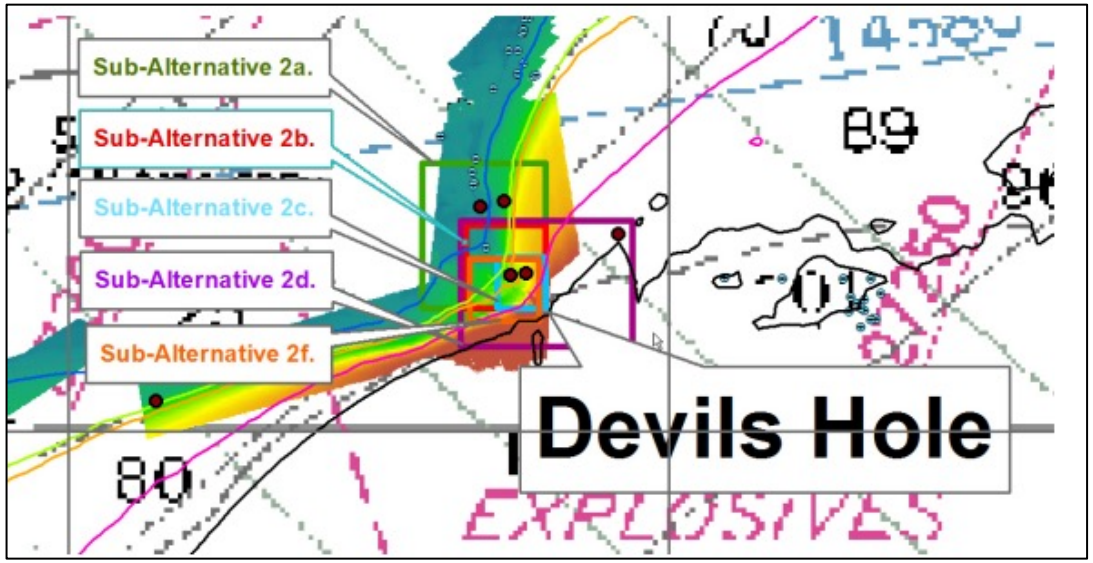
History of Spawning SMZs



Goal: Protect spawning fish to support fisheries



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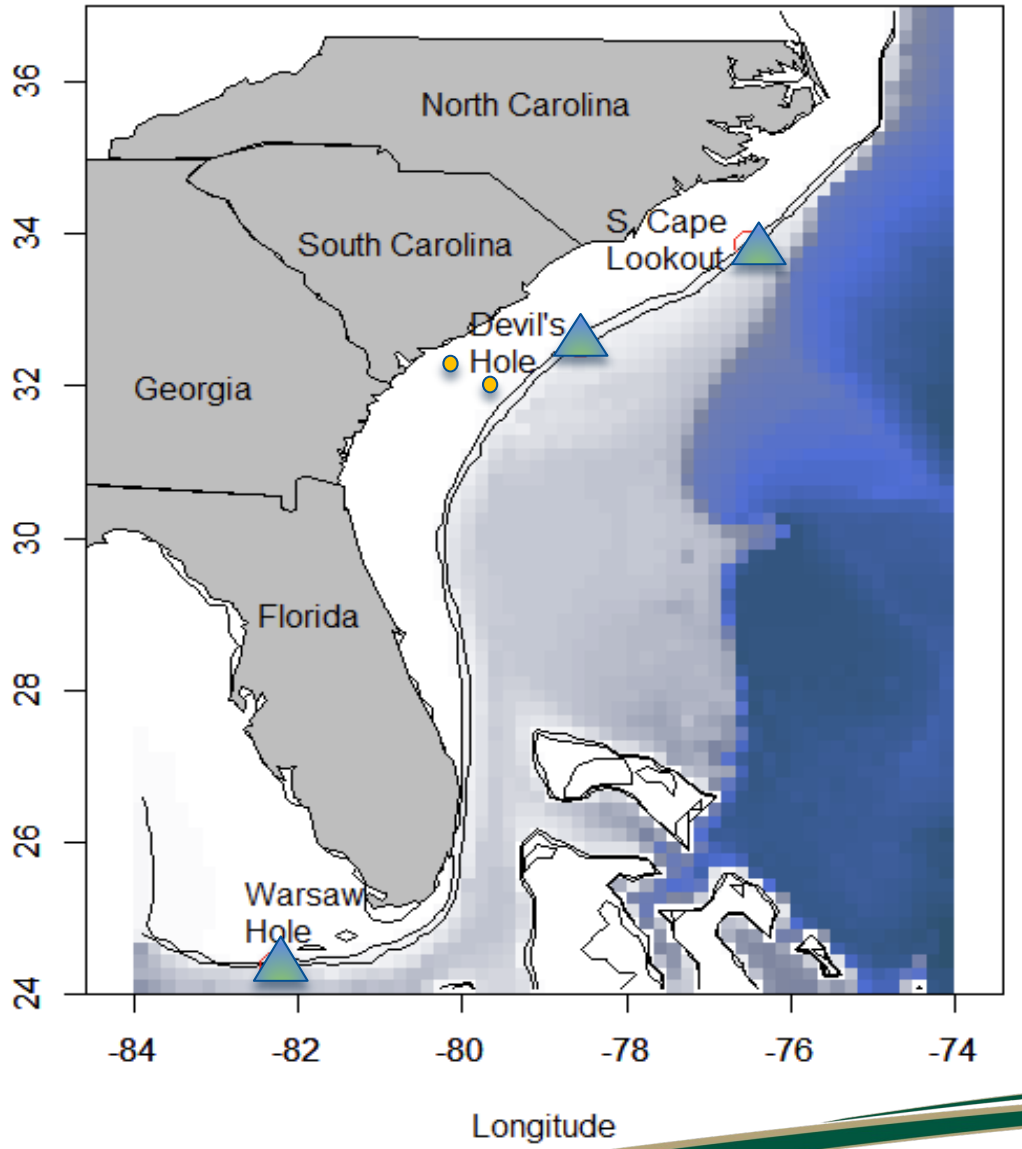
History of Spawning SMZs

- 5 sites established through Amendment 36 (2017) to the South Atlantic Snapper Grouper FMP:
  - S. Cape Lookout (5.10 sq miles)
  - Georgetown/Devil's Hole (3.03 sq miles)
  - Warsaw Hole (3.60 sq miles)
- Site protection will sunset in **2027** in natural reefs, unless sufficient evidence of spawning is documented



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SMZ Sampling Methods

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Predicting Spawning Time & Location to Guide Sampling

- Fisher Knowledge
- Geomorphology
- Fishery-dependent and Independent data

PLOS ONE

RESEARCH ARTICLE

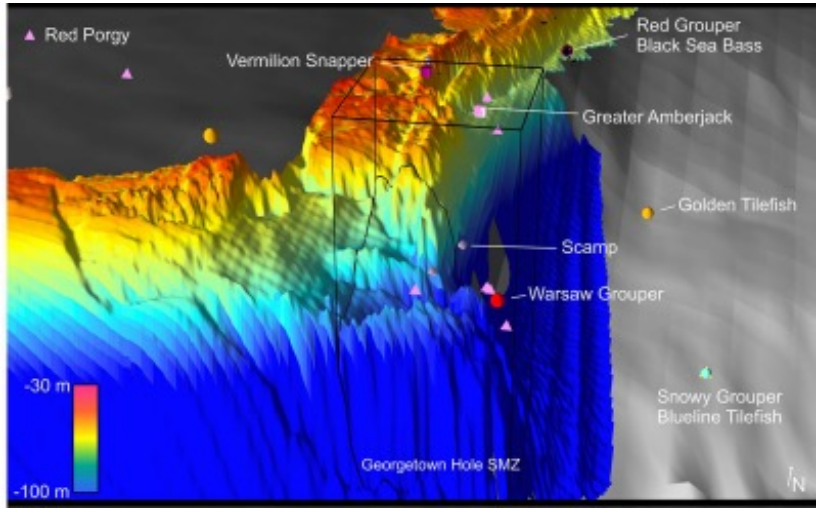
Timing and locations of reef fish spawning off the southeastern United States

Nicholas A. Farmer[1]*, William D. Heyman[2], Mandy Karnauskas[3], Shinichi Kobara[4], Tracey I. Smart[5], Joseph C. Ballenger[5], Marcel J. M. Reichert[5], David M. Wyanski[5], Michelle S. Tishler[6], Kenyon C. Lindeman[7], Susan K. Lowerre-Barbieri[8], Theodore S. Switzer[8], Justin J. Solomon[9], Kyle McCain[2], Mark Marhefka[10], George R. Sedberry[11]

Table 6. Timing of spawning (gray shading) and peak spawning (black shading) for exploited Atlantic Ocean reef fish stocks off the southeastern United States. Months in bold denote core SERFS core fishery-independent sampling months. See S1 Table for references.

Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Citation
Gray triggerfish													[10]
Greater amberjack													[7]
White grunt													[14, 17]
Cubera Snapper													WDH, pers. comm.
Red snapper													[17, 18]
Vermilion snapper													[2, 17]
Blueline tilefish													[6]
Tilefish													[4, 17]
Black sea bass													[15, 17]
Gag													[13, 17]
Red grouper													[1]
Scamp (NC)													[12]
Scamp (FL)													[5]
Scamp (29.95–32.95 °N)													[8, 17]
Snowy grouper													[16, 19]
Speckled hind													[20]
Warsaw Grouper													[11, 17]
Red porgy													[3, 17]

doi:10.1371/journal.pone.0172968.t006



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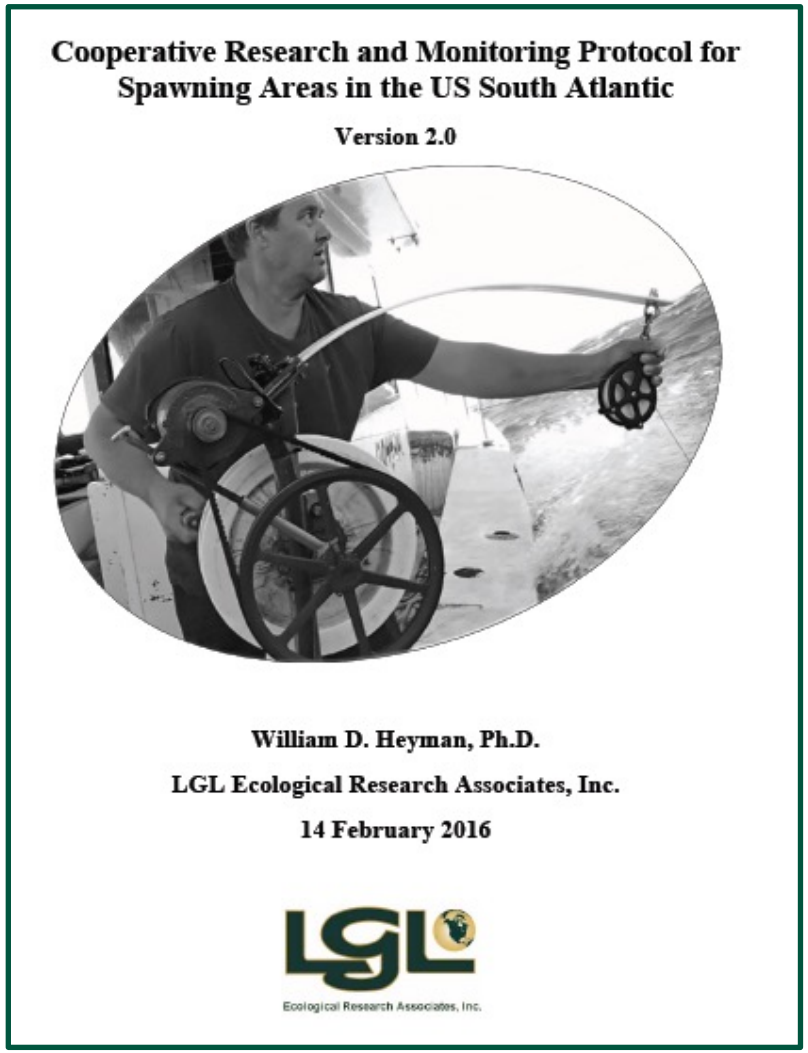
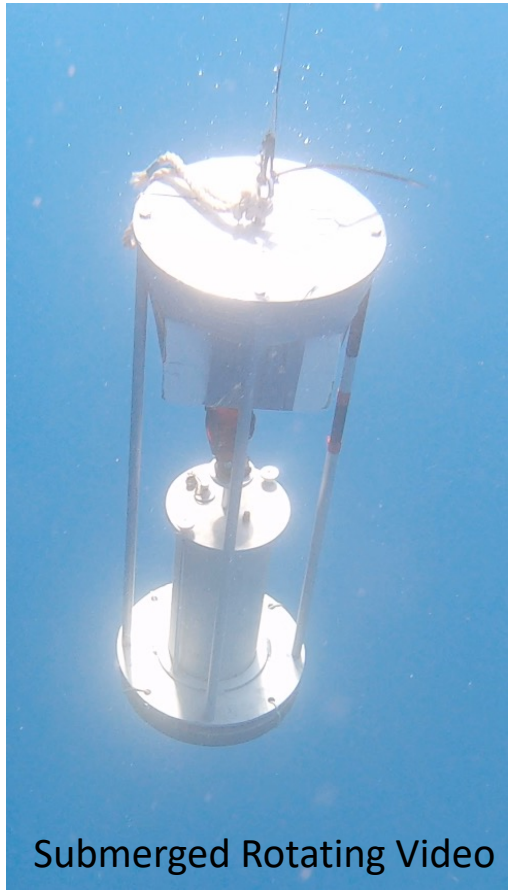
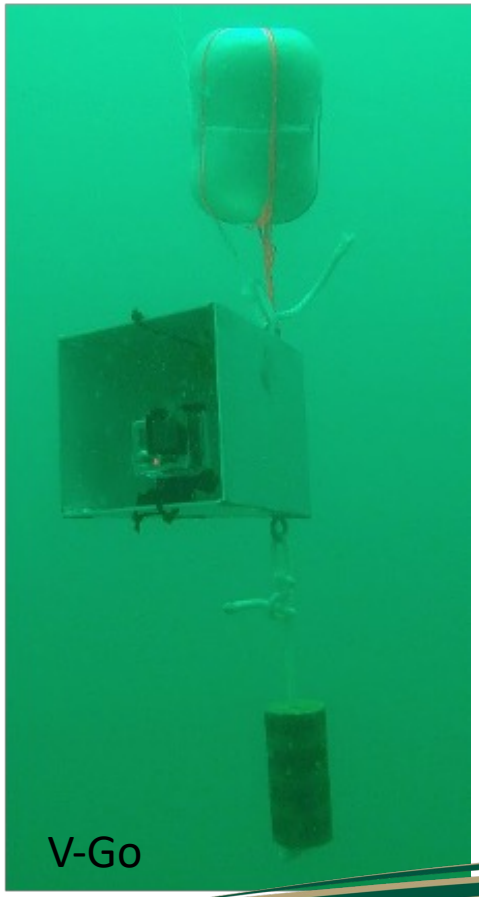
Sampling Methods – Cooperative Research

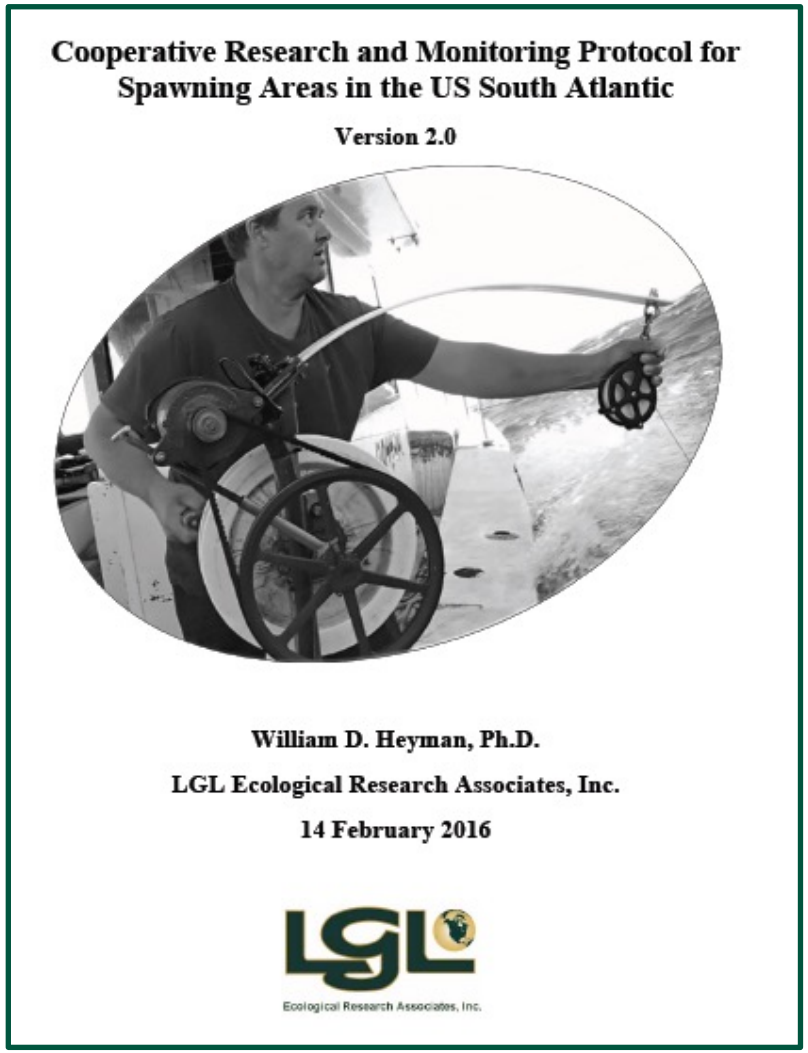


- Underwater Video Surveys


Submerged Rotating Video


V-Go

Sampling Methods – Cooperative Research


Cooperative Research and Monitoring Protocol for Spawning Areas in the US South Atlantic

Version 2.0

William D. Heyman, Ph.D.

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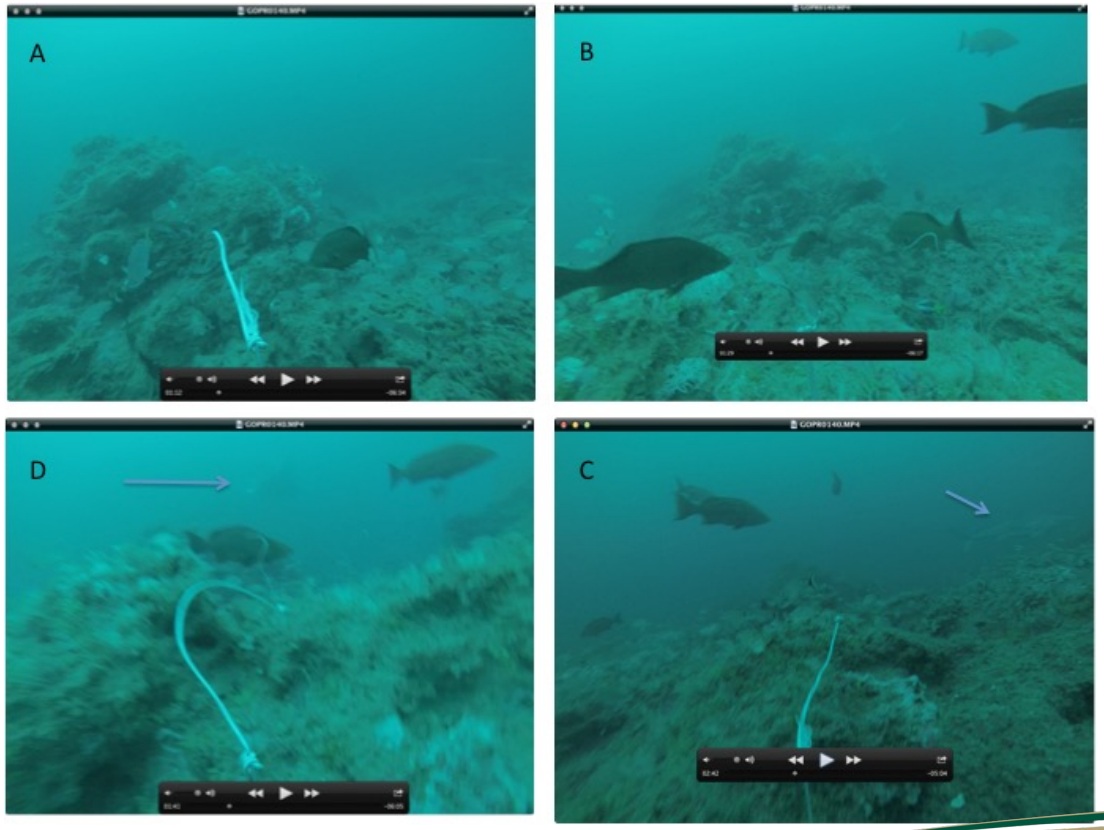
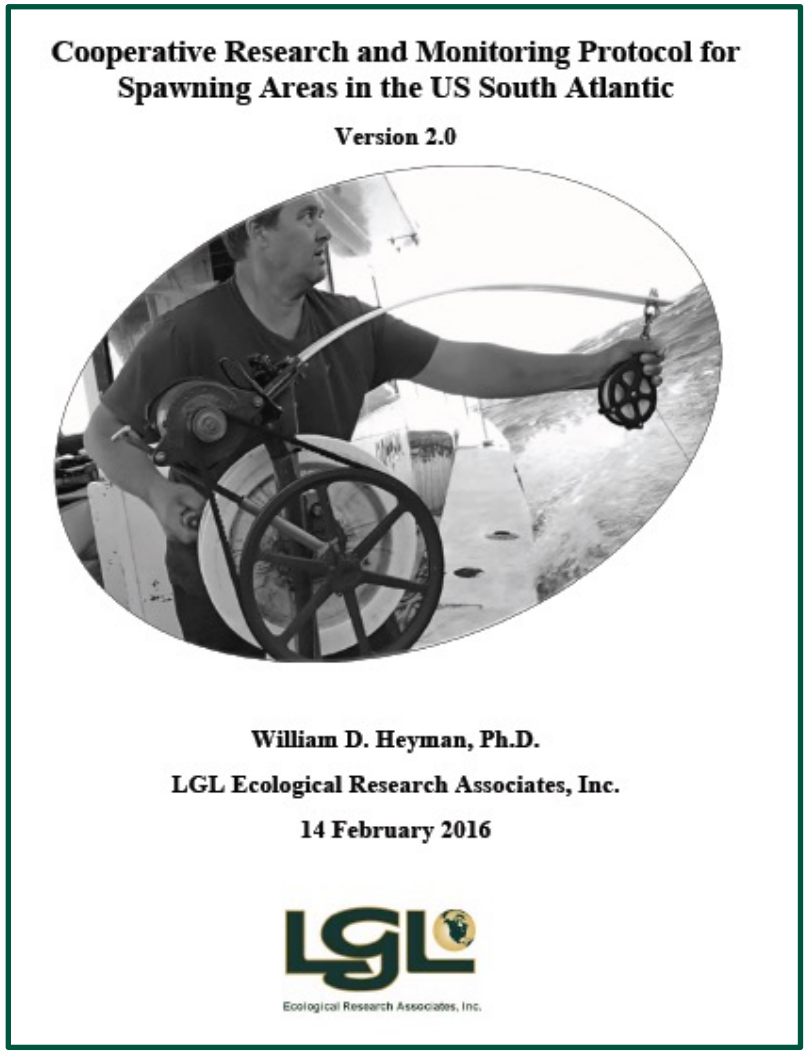
14 February 2016

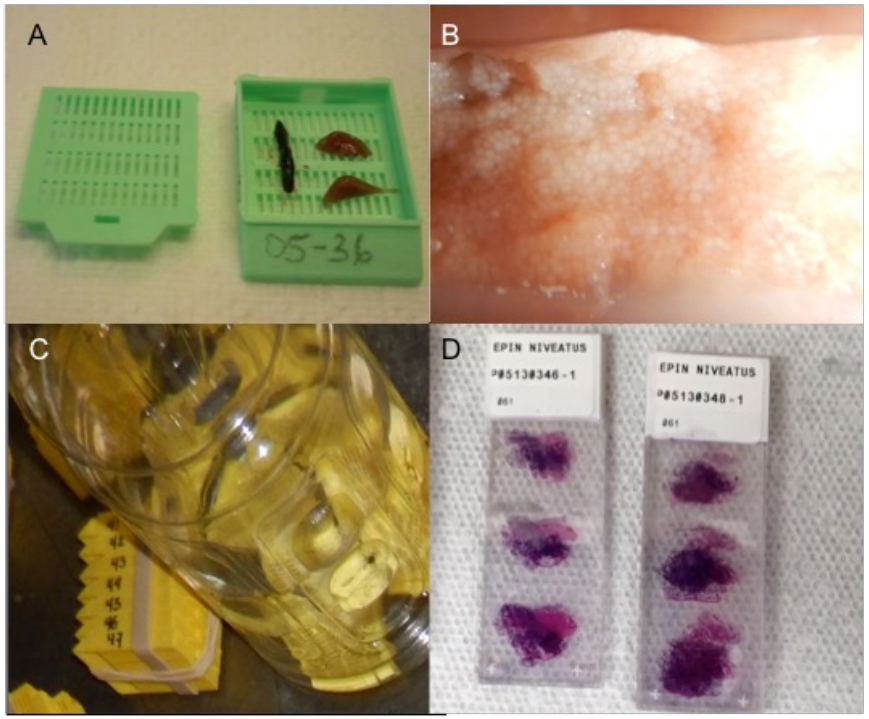
- Underwater video analysis for courtship, spawning and aggregation

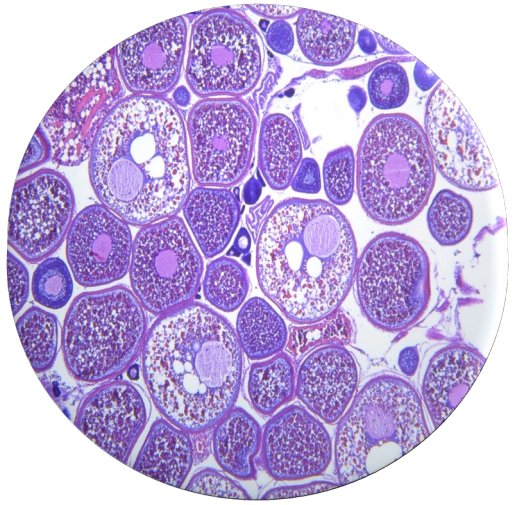


Sampling Methods – Cooperative Research

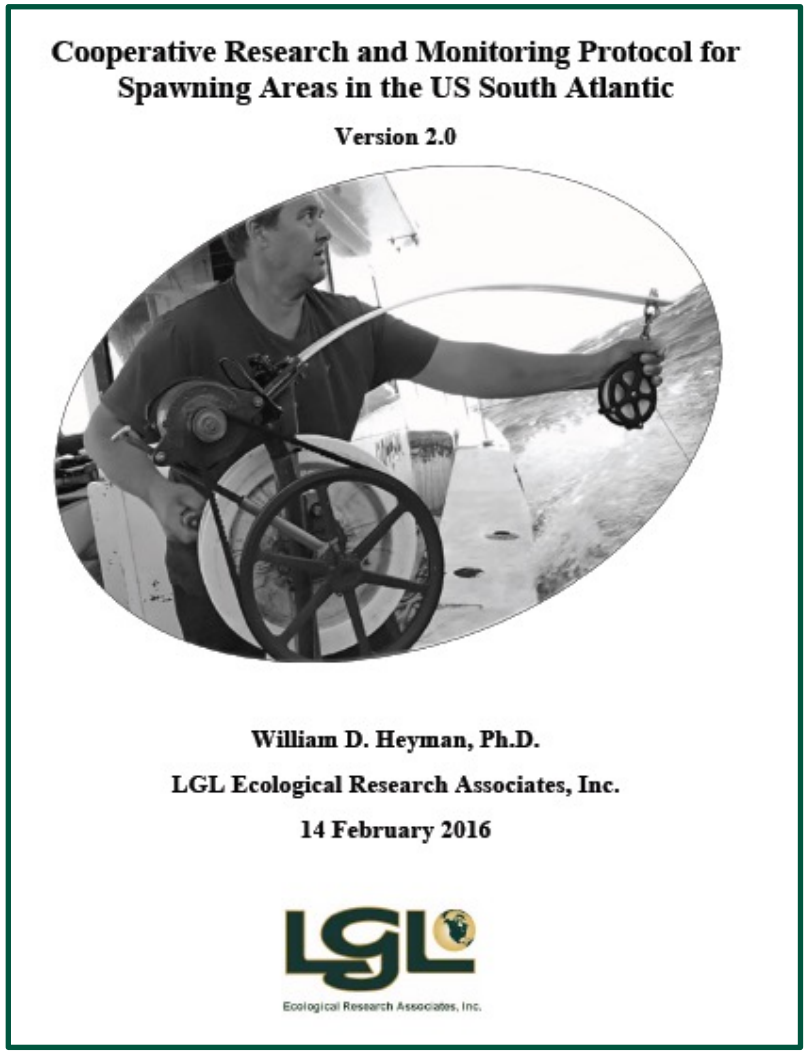


- Biological sampling (histology)





Sampling Methods – Cooperative Research


Cooperative Research and Monitoring Protocol for Spawning Areas in the US South Atlantic

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- Morphometric and age data

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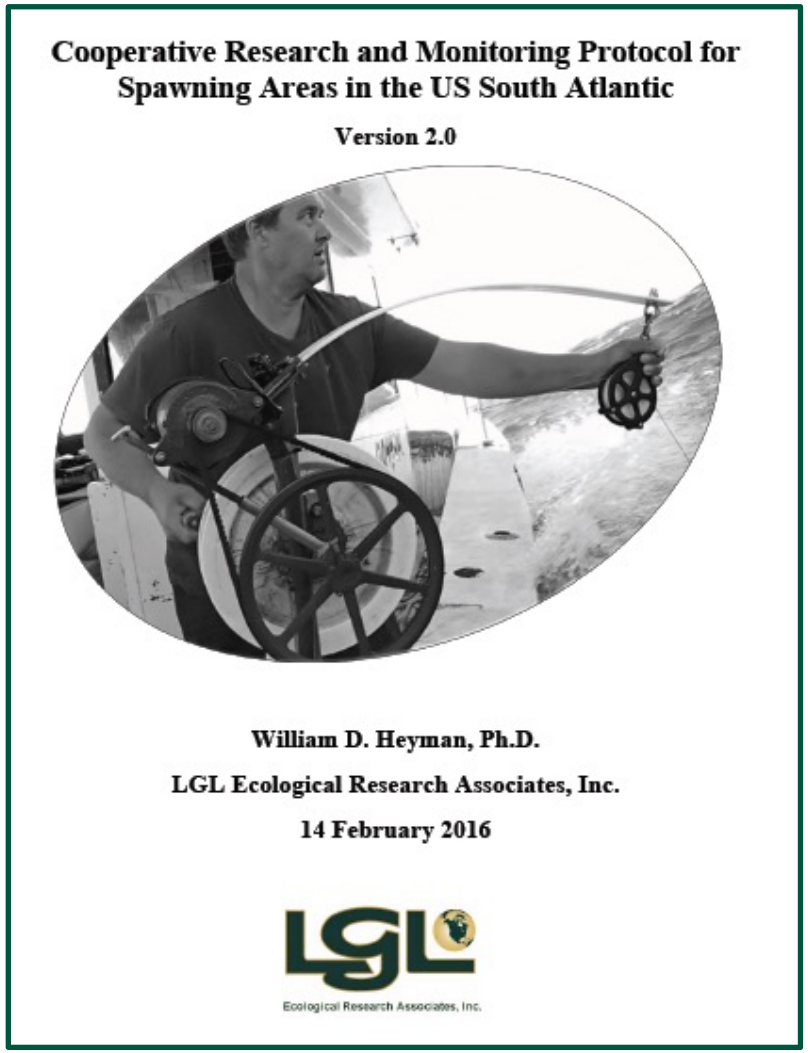
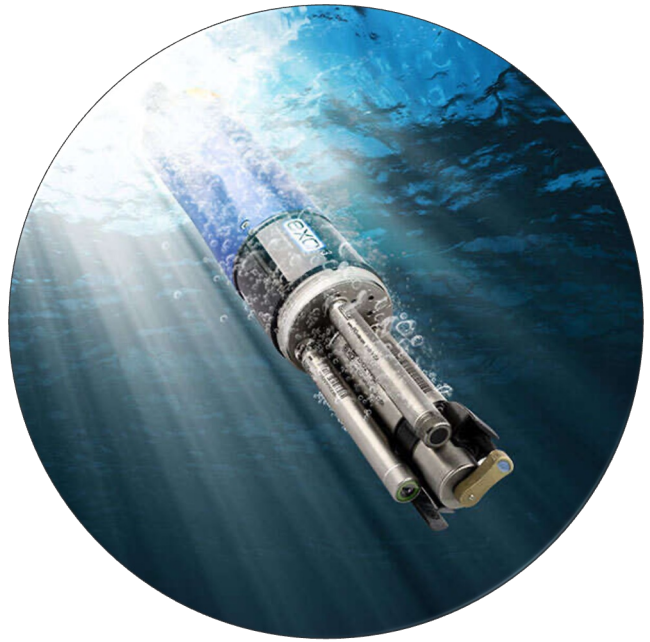
Sampling Methods – Cooperative Research



- Physiochemical monitoring



Evidence for spawning: DIRECT

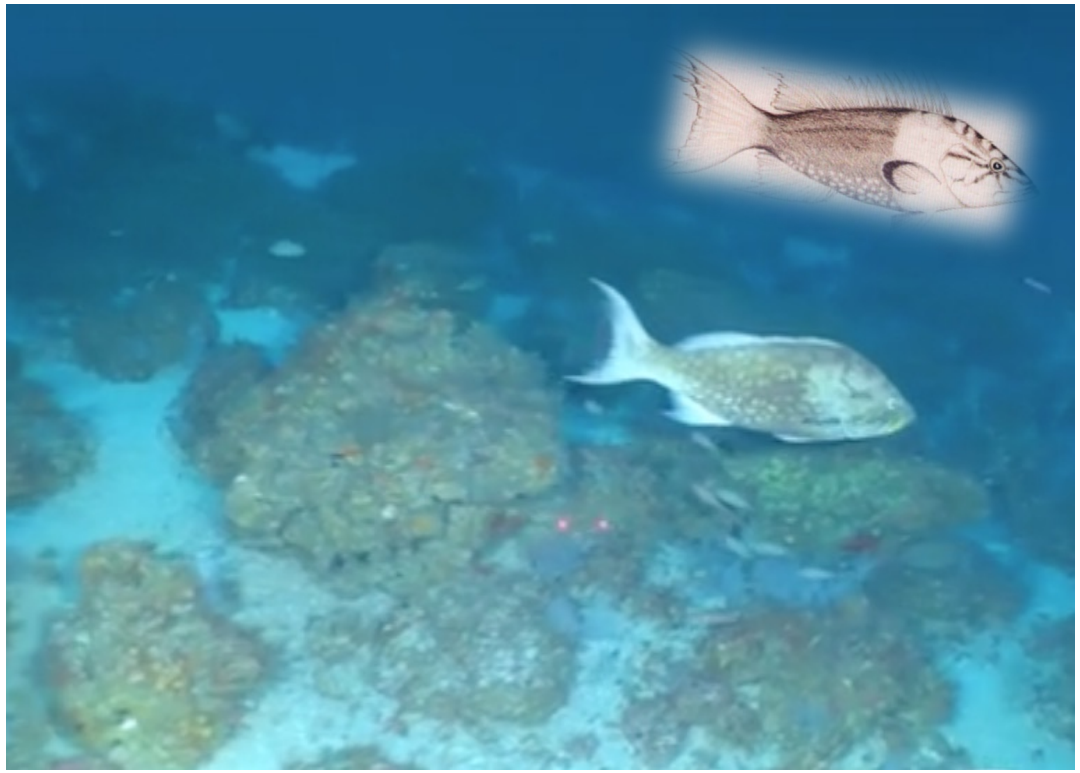
Direct Evidence

- Photo/video documentation of spawning (gamete release)
- Hydrated oocytes in gonads of female fish
- Post ovulatory follicles in female gonads


Gamete release


Hydrated oocytes

Evidence for spawning: INDIRECT



Indirect Evidence

- Underwater observations and photo/video documentation of courtship behavior and coloration
- High percentage of female fish caught have late development stage gonads
- Anecdotal information

Summary of Sampling Effort to date

Sampling Effort within SAFMC SSMZs

SSMZ Site	Funding	Month	Year	Captain	Team lead/contact	Techniques biological	video	physical	Notes
Georgetown Hole	Pew Charitable Trust	February	2014	Mark Marhefke	Will Heyman	x	x	x	Report available
Georgetown Hole	Pew Charitable Trust	April	2014	Mark Marhefke	Will Heyman	x	x	x	Report available
Georgetown Hole	SAFMC	July	2014	Mark Marhefke	Will Heyman	x	x	x	Report available
Georgetown Hole	Pew Charitable Trust	July	2015	Zach Bowen	David Westfall	x	x	x	Report available
Georgetown Hole	Pew Charitable Trust	August	2016	Zach Bowen	David Westfall	x	x	x	Report available
Warsaw Hole	SAFMC/Mote	June	2018	Robert Schemmel	Chip Collier/Jim Loscasio	x	x	x	data available
South Cape Lookout	Pew Charitable Trust	May	2016	James Holden	Kyle McCain/Will Heyman	x	x	x	Report available
Georgetown Hole	MARFIN	Summer	2020	Sam Manning	Tracy Smart	x	X	x	Report available
Georgetown Hole	MARFIN	Summer	2021	Harten/Manning	Tracy Smart	x	X	x	Report pending
Georgetown Hole	MARFIN	June	2022	Bo Von Harten	Tracy Smart	x	x	x	Report pending
Georgetown Hole	The Nature Conservancy	April	2023	Andy McGraw	Heyman/Conklin	x	x	x	Report pending
Georgetown Hole adjacent to SMZ	NOAA	July	2013		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	July	2013		Stacey Harter		x	x	data available
Georgetown Hole adjacent to SMZ	NOAA	June	2014		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	July	2017		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	July	2017		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	July	2017		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	June	2019		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	June	2019		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	June	2019		Stacey Harter		x	x	data available
Georgetown Hole adjacent to SMZ	NOAA	June	2021		Stacey Harter		x	x	data available
Georgetown Hole adjacent to SMZ	NOAA	June	2021		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	June	2021		Stacey Harter		x	x	data available
Georgetown Hole	NOAA	June	2021		Stacey Harter		x	x	data available
Georgetown Hole adjacent to SMZ	NOAA	June	2021		Stacey Harter		x	x	data available

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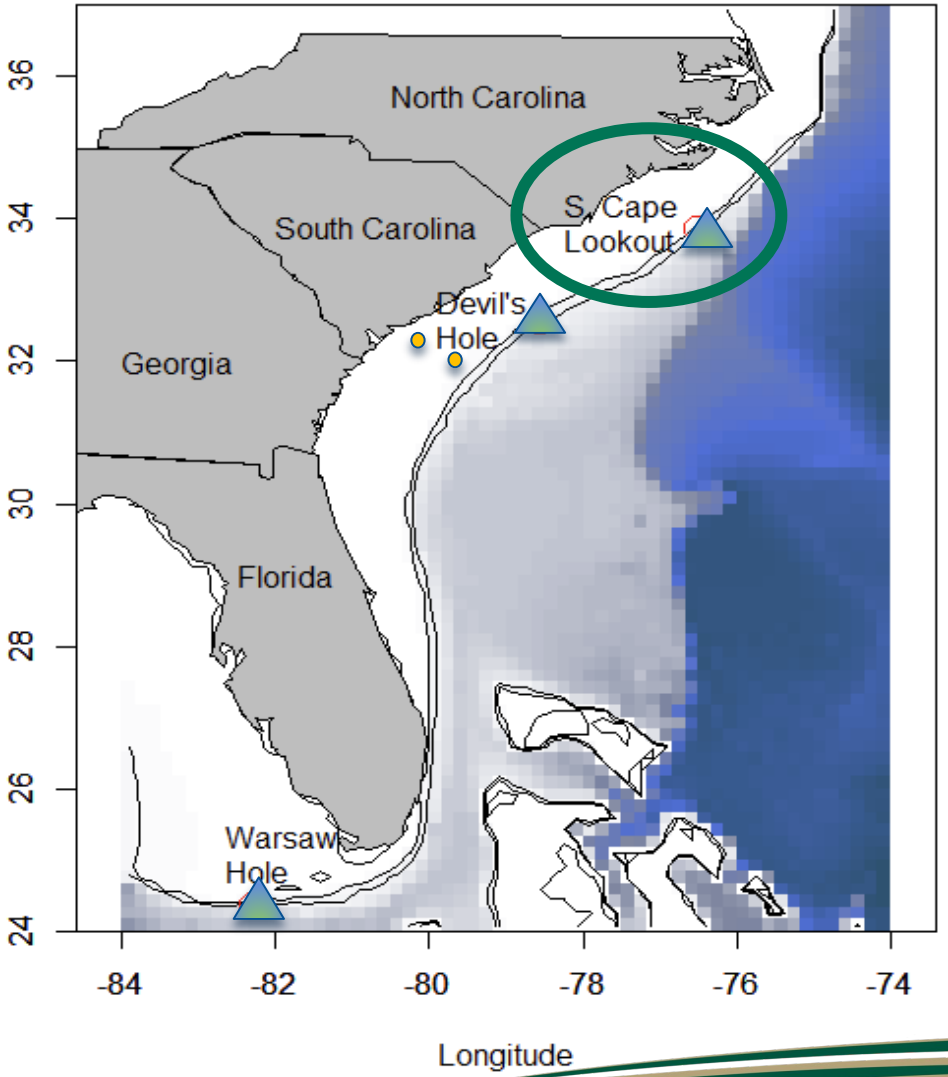
South Cape Lookout



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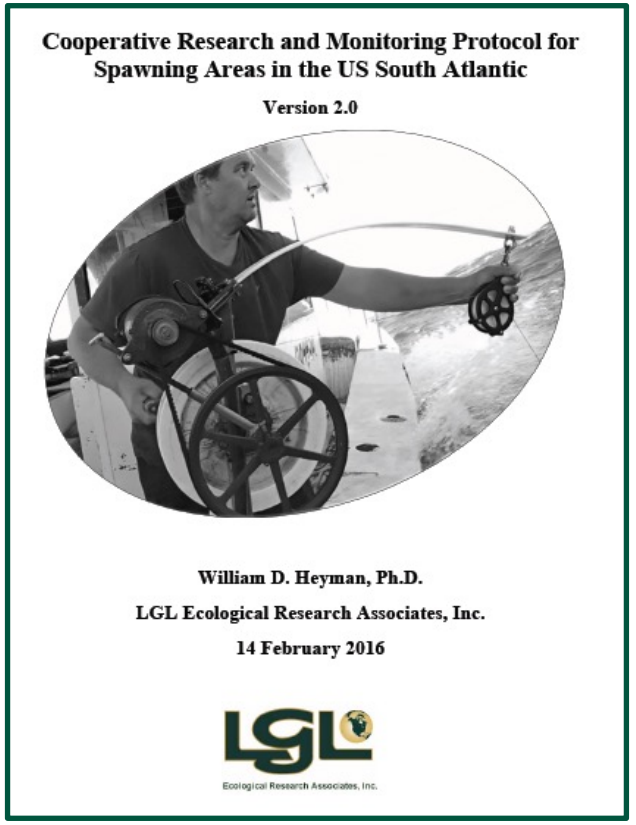
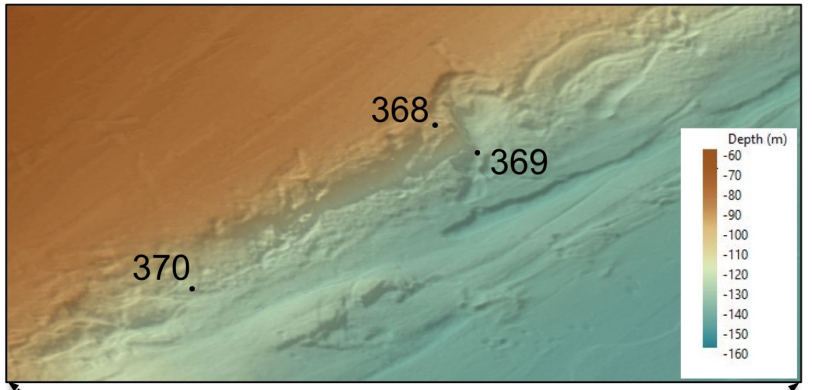
South Cape Lookout Sampling May 2016

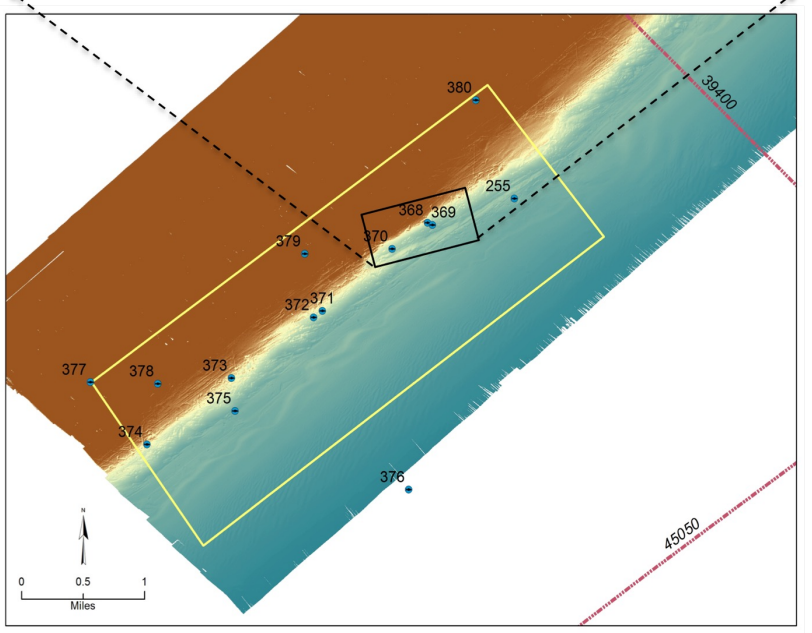
Captains Jack Cox, James Holden



South Cape Lookout: May 2016

Site No.	Date	Area	Tag No.	Species	TL (mm)	Whole fish wt (kg)	Gonad wt (g)	GSI	Sex	MARMAP maturity state	Gonad visual assessment**
368	11-May-16	S. Cape Lookout	61	Almaco	927	8.64	345.0	3.99	M	Running Ripe	LD
368	11-May-16	S. Cape Lookout	62	Almaco	710	3.79	38.0	1.00	F	Early Developing	LD
369	12-May-16	S. Cape Lookout	63	Scamp	610	2.51*	60.0	2.39	F	**Running Ripe**	LD
369	12-May-16	S. Cape Lookout	64	Silk Snapper	545	2.64			I		I
369	12-May-16	S. Cape Lookout	66	Gag	768	4.66	25.0	0.54	I		I
369	12-May-16	S. Cape Lookout	67	Rock Hind	403	1.24	66.0	5.32	F	**Running Ripe**	HYD
369	12-May-16	S. Cape Lookout	68	Vermilion Snapper	492	1.45	28.0	1.93	F	Developing; Vitellogenesis	LD
371	12-May-16	S. Cape Lookout	69	Red Grouper	782	8.46	33.0	0.39	M	Developing	S
371	12-May-16	S. Cape Lookout	70	Speckled Hind	741	8.00			I		I
374	12-May-16	S. Cape Lookout	71	Red Snapper	625	3.00	42.0	1.40	F	Developing; Vitellogenesis	LD
374	12-May-16	S. Cape Lookout	72	Almaco	697	3.14	14.0	0.45	M	Running Ripe	LD
375	12-May-16	S. Cape Lookout	73	Almaco	846	5.97	48.0	0.80	M	Running Ripe	LD
375	12-May-16	S. Cape Lookout	74	Snowy	453	1.44			I		I
376	12-May-16	S. Cape Lookout	75	Snowy	417	1.23	1.0	0.08	I	Immature	I
379	12-May-16	S. Cape Lookout	65	Almaco	1004	10.28	328.0	3.19	M	Running Ripe	LD





Direct evidence for spawning scamp and rock hind at rocky outcrop

Heyman WD and KA McCain. 2017. Characterizing the South Cape Lookout Spawning Special Management Zone Using Cooperative Research. LGL Ecological Research Associates, Inc., Bryan, TX. 39 p.

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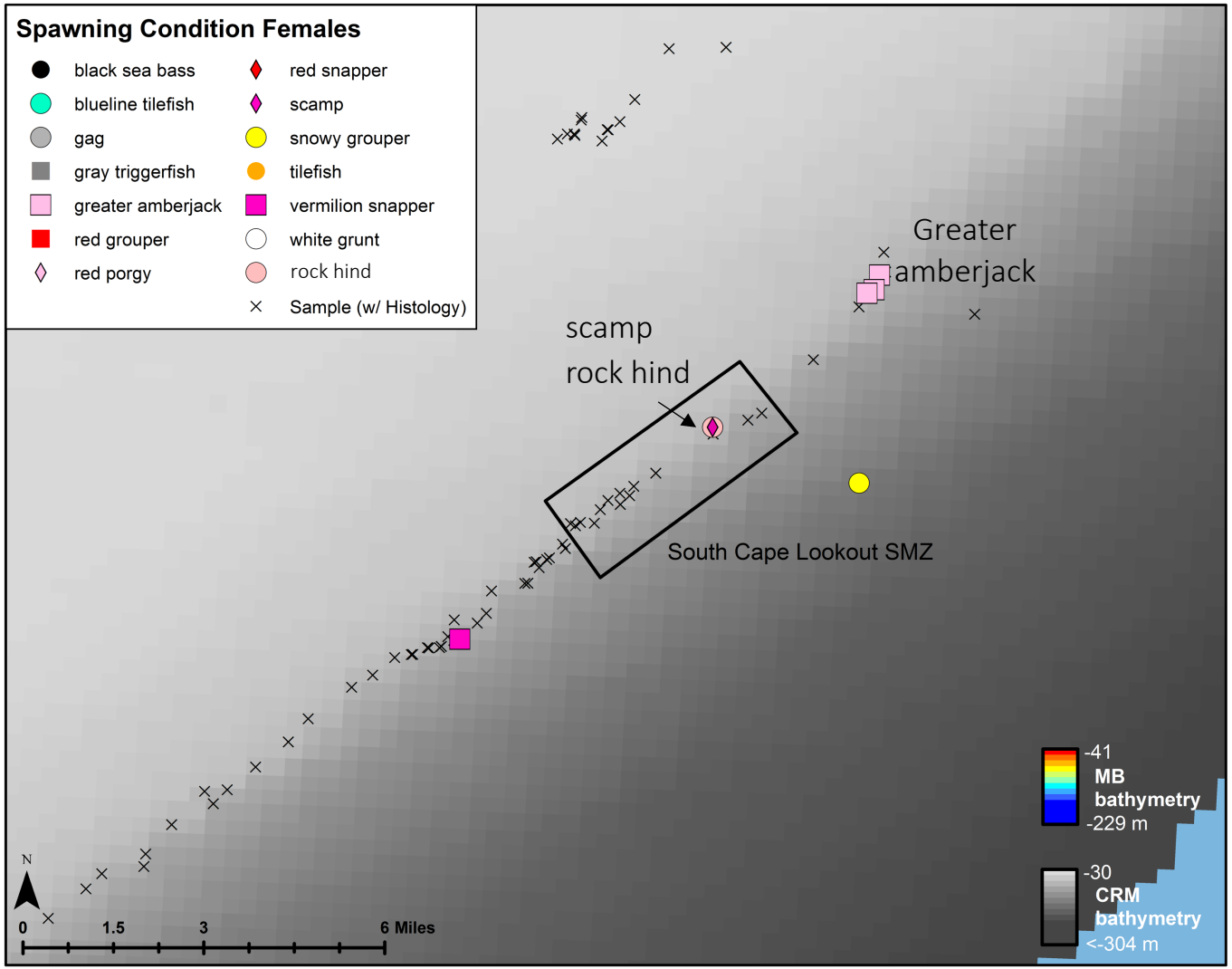
South Cape Lookout, May 2016



- Most of the SSMZ is hard mud or sediment, and gentle shelf break
- Most likely red grouper spawning habitat
- Future sampling to target red grouper

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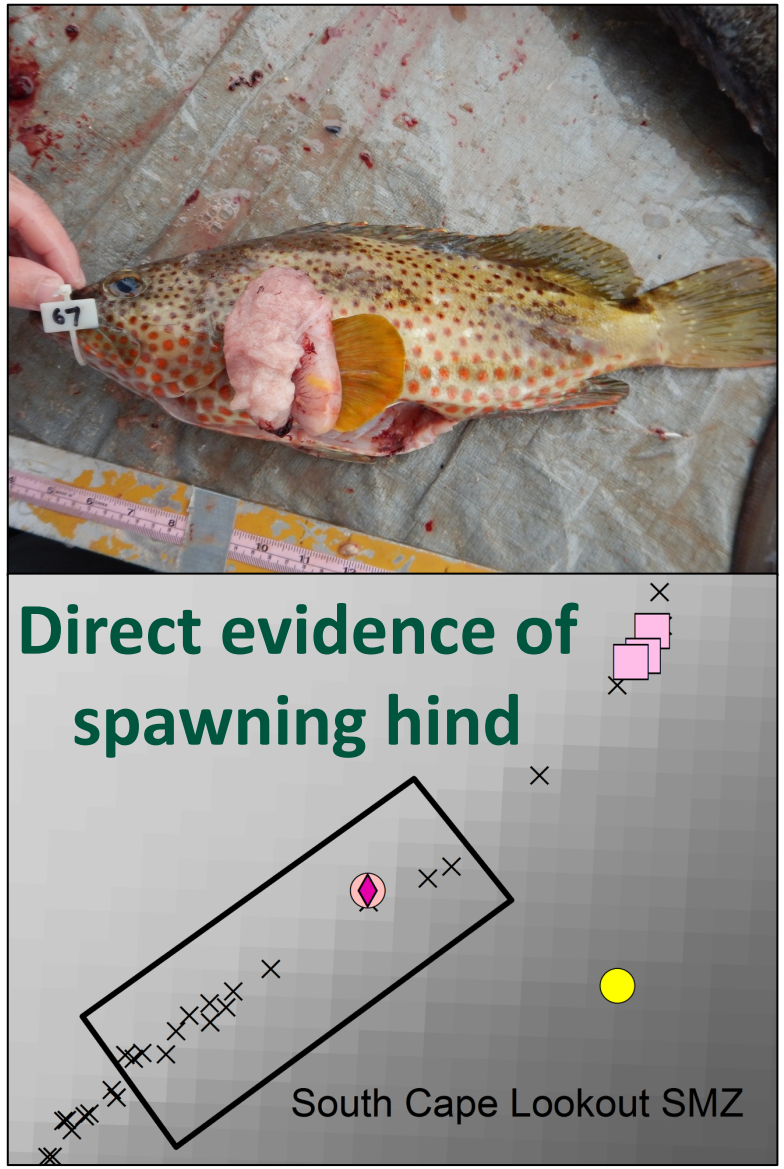
South Cape Lookout, May 2016



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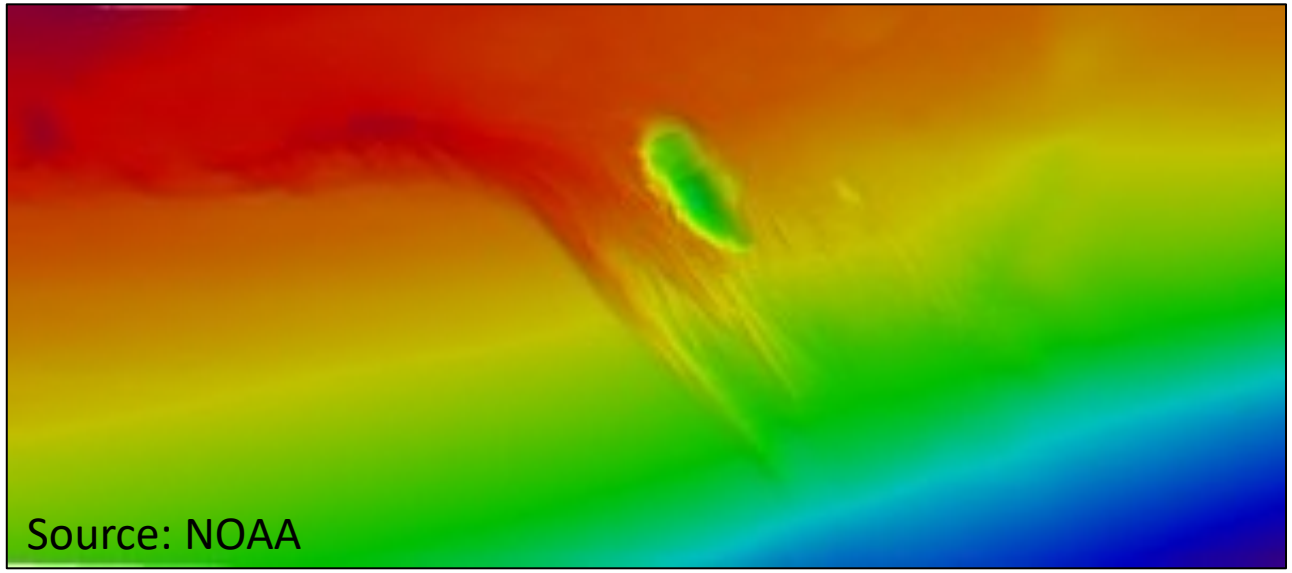
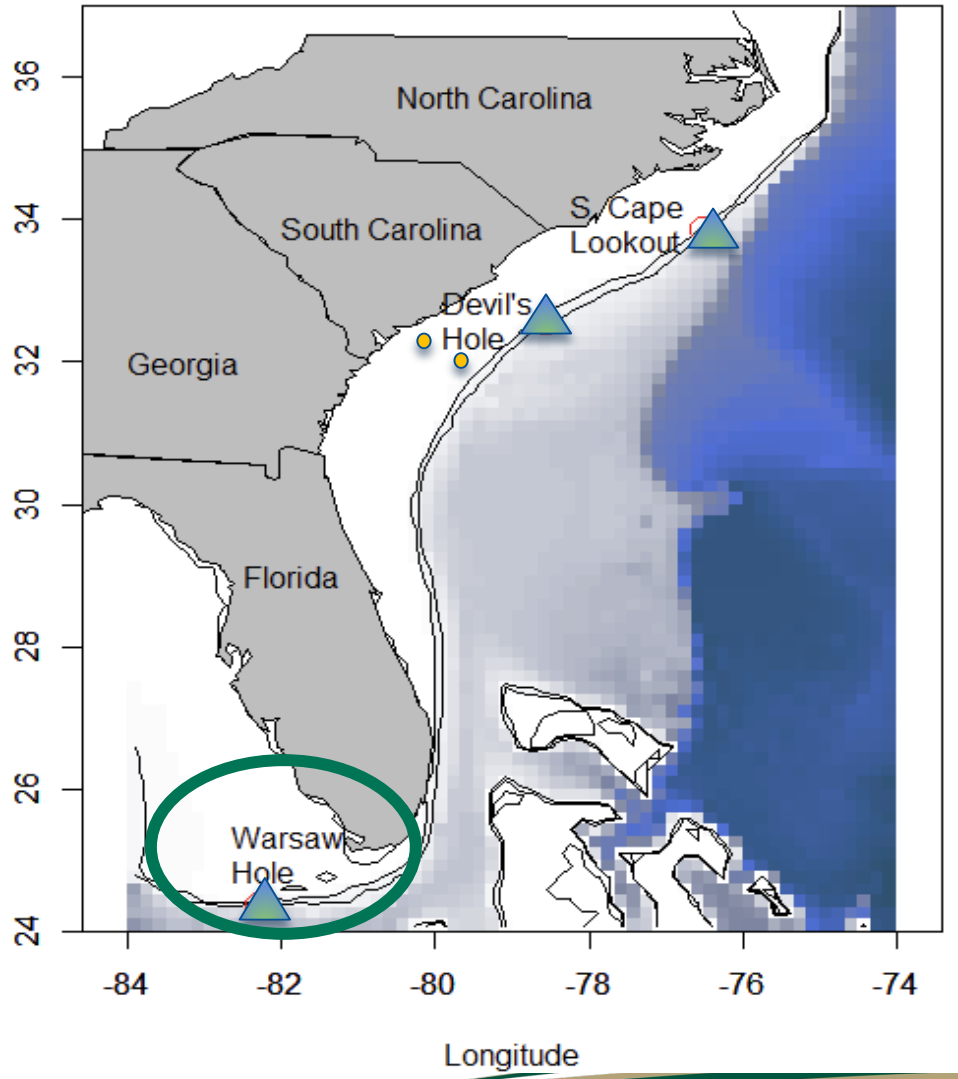
Warsaw Hole





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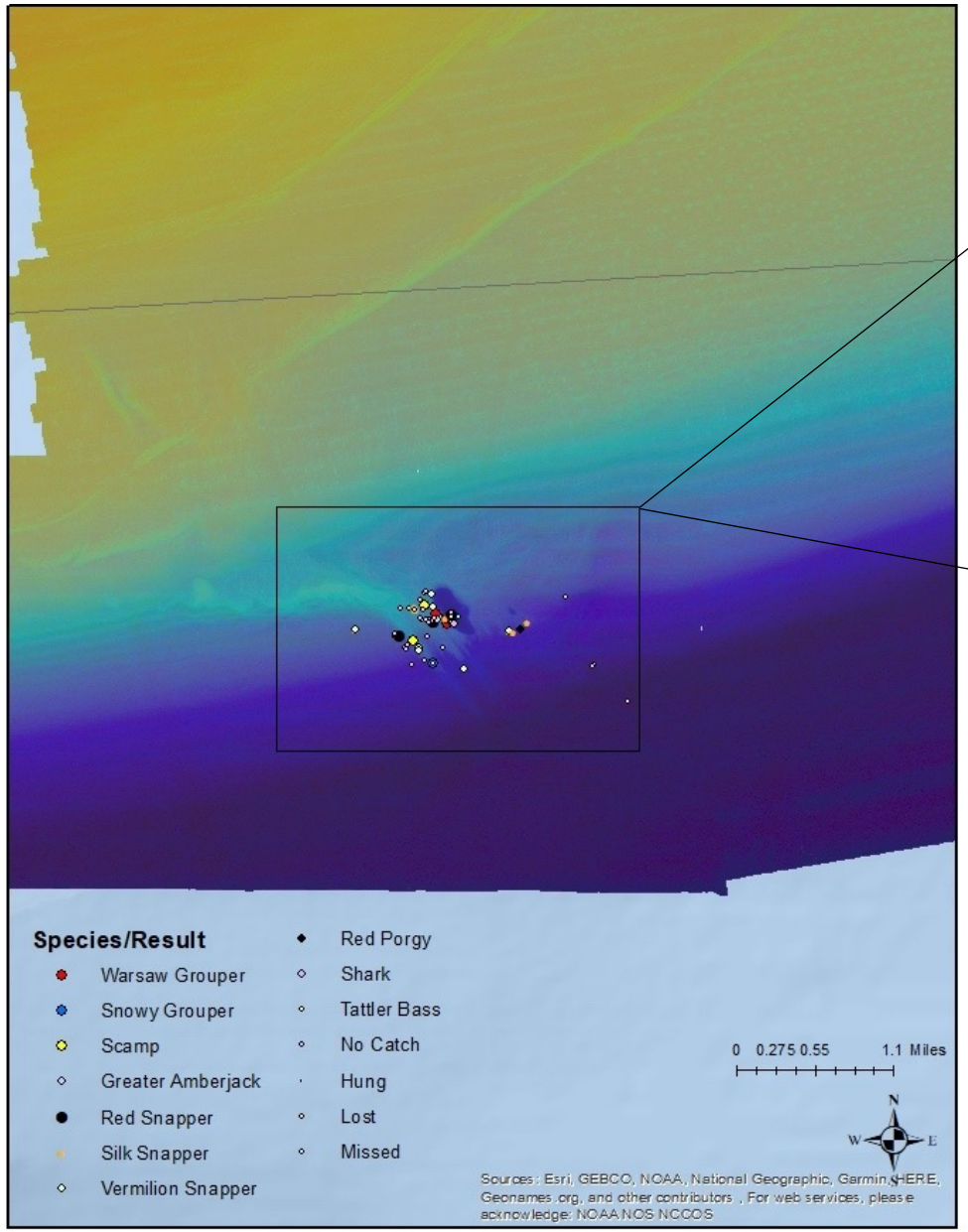
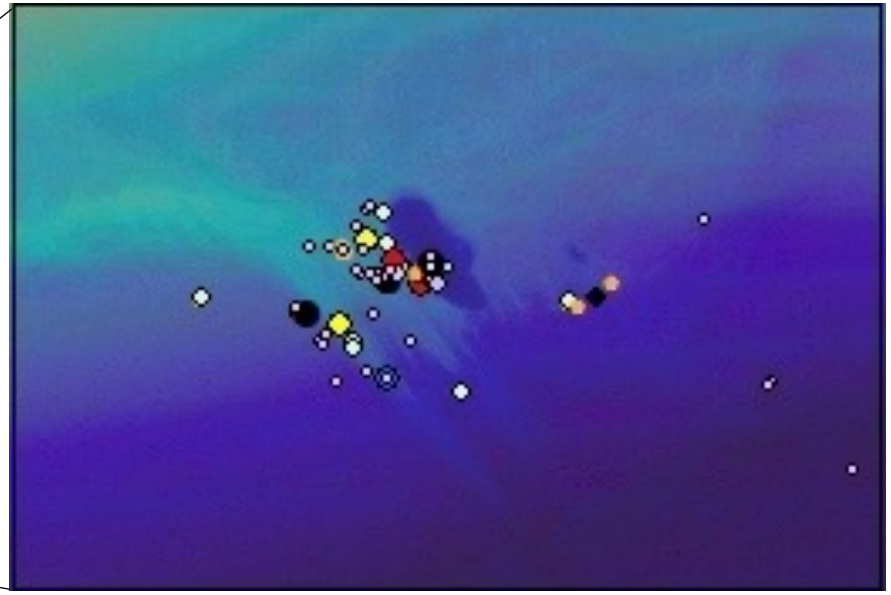
Warsaw Hole Sampling Locations – June 2018





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Warsaw Hole Sampling June 2018

ID	Last Name	Trip ID	Nearest City	ssel Nar	Latitude	Longitude	Species	Status	Caught At	Length (In)	Length Type	Weight (Lbs)	Depth (Ft)
959	Collier	581	Key West	sea ya	24.36123	-82.3225	Snapper, Red	Kept	6/29/18 14:57	0		0	301-500
958	Collier	581	Key West	sea ya	24.36063	-82.3149	Snapper, Silk	Kept	6/29/18 9:26	14	TL	0	
957	Collier	581	Key West	sea ya	24.36223	-82.3253	Grouper, Scamp	Kept	6/29/18 9:57	16	FL	0	151-300
956	Collier	581	Key West	sea ya	24.36208	-82.3244	Snapper, Vermilion	Kept	6/29/18 10:04	12.7	TL	0.36	
955	Collier	581	Key West	sea ya	24.36108	-82.3232	Snapper, Silk	Kept	6/29/18 10:32	14.4	TL	0	301-500
954	Collier	581	Key West	sea ya	24.36088	-82.324	Amberjack, Greater	Kept	6/29/18 11:26	0		0	301-500
953	Collier	581	Key West	sea ya	24.3581	-82.3258	Snapper, Vermilion	Kept	6/29/18 11:41	13.8	TL	0	
952	Collier	581	Key West	sea ya	24.35933	-82.3278	Snapper, Red	Kept	6/29/18 11:54	0		0	301-500
951	Collier	581	Key West	sea ya	24.36207	-82.3263	Snapper, Silk	Kept	6/29/18 13:41	14	TL	0	
950	Collier	581	Key West	sea ya	24.36187	-82.3261	Snapper, Silk	Kept	6/29/18 13:44	11.7	TL	0	
949	Collier	581	Key West	sea ya	24.36178	-82.3262	Snapper, Silk	Kept	6/29/18 13:51	0		0	
948	Collier	581	Key West	sea ya	24.36123	-82.3225	Shark, Sandbar	Released	6/29/18 14:57	0		0	301-500
947	Collier	580	Key West	seaua	24.36115	-82.324	Snapper, Vermilion	Kept	6/28/18 9:09	12.7	FL	0	301-500
946	Collier	580	Key West	seaua	24.36115	-82.324	Snapper, Vermilion	Kept	6/28/18 9:09	10.7	FL	0	301-500
945	Collier	580	Key West	seaua	24.36052	-82.323	Grouper, Warsaw	Kept	6/28/18 10:00	0	TL	60	301-500
944	Collier	580	Key West	seaua	24.36068	-82.3224	Snapper, Vermilion	Kept	6/28/18 10:52	13	TL	0	301-500
943	Collier	580	Key West	seaua	24.361917	-82.3268	Snapper, Silk	Kept	6/28/18 11:43	13.3	TL	0	
942	Collier	580	Key West	seaua	24.361917	-82.3268	Snapper, Silk	Kept	6/28/18 11:43	13	TL	0	
941	Collier	580	Key West	seaua	24.35683	-82.3245	Grouper, Snowy	Kept	6/28/18 12:21	14.8	TL	0	301-500
940	Collier	580	Key West	seaua	24.35637	-82.3213	Snapper, Vermilion	Kept	6/28/18 12:43	9.8	TL	0	301-500
939	Collier	580	Key West	seaua	24.353825	-82.3258	Snapper, Vermilion	Kept	6/28/18 12:59	12.6	TL	0	301-500
938	Collier	580	Key West	seaua	24.35892	-82.3264	Grouper, Scamp	Kept	6/28/18 14:14	20.5	FL	0	301-500
937	Collier	580	Key West	seaua	24.36148	-82.3241	Grouper, Warsaw	Kept	6/28/18 14:59	40.9	TL	40	301-500
936	Collier	580	Key West	seaua	24.36327	-82.3246	Snapper, Vermilion	Kept	6/28/18 16:28	14.3	TL	0	301-500
926	Collier	575	Key West	seaya	24.386	-82.316	Alewife	Released	6/27/18 8:54	0		0	
925	Collier	575	Key West	seaya			Alewife	Released	6/27/18 11:40	0		0	
924	Collier	575	Key West	seaya			Alewife	Released	6/27/18 11:46	165	FL	0	301-500
923	Collier	575	Key West	seaya	24.35993	-82.3327	Porgy, Red	Kept	6/27/18 11:58	0		0	151-300
922	Collier	575	Key West	seaya	24.35993	-82.3327	Snapper, Silk	Kept	6/27/18 12:03	0		0	301-500
921	Collier	575	Key West	seaya	24.35992	-82.3323	Snapper, Vermilion	Kept	6/27/18 12:11	0		0	301-500
920	Collier	575	Key West	seaya	24.3598	-82.3163	Snapper, Silk	Kept	6/27/18 12:25	0	TL	0	301-500
919	Collier	575	Key West	seaya	24.35992	-82.3167	Porgy, Red	Kept	6/27/18 12:32	0		0	
918	Collier	575	Key West	seaya	24.35992	-82.3167	Porgy, Red	Kept	6/27/18 12:32	0		0	
917	Collier	575	Key West	seaya	24.35992	-82.3167	Snapper, Silk	Kept	6/27/18 12:40	0	TL	0	
916	Collier	575	Key West	seaya	24.35992	-82.3167	Porgy, Red	Kept	6/27/18 12:42	0	TL	0	301-500
915	Collier	575	Key West	seaya	24.35992	-82.3167	Snapper, Vermilion	Kept	6/27/18 12:48	0	TL	0	301-500
914	Collier	575	Key West	seaya	24.36112	-82.3248	Grouper, Scamp	Kept	6/27/18 13:37	0	TL	0	301-500
913	Collier	575	Key West	seaya	24.3606	-82.3244	Snapper, Red	Kept	6/27/18 15:25	0	TL	0	151-300
912	Collier	575	Key West	seaya	24.3606	-82.3244	Snapper, Red	Kept	6/27/18 15:38	0	TL	8	
911	Collier	575	Key West	seaya	24.3606	-82.3244	Snapper, Red	Kept	6/27/18 15:46	0		0	
910	Collier	575	Key West	seaya	24.36067	-82.3244	Snapper, Silk	Kept	6/27/18 15:57	0	TL	0	151-300

F/V Sea Ya, Key West
Science Lead: Chip Collier

Ecological Research Associates, Inc.

Warsaw Hole Sampling, Collier et al. on F/V Sea Ya, June 2018

28 June 2018

1. Warsaw Grouper, 40 lb
2. Warsaw grouper 60 lb (SL 976 mm) “spawning capable”, with fully yolked vitellogenic oocytes

Indirect evidence for spawning Warsaw grouper

Future sampling planned for 2024

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Warsaw Hole Sampling, Collier et al. on F/V Sea Ya, June 2018

28 June 2018

1. Warsaw Grouper, 40 lb
2. Warsaw grouper 60 lb (SL 976 mm) “spawning capable”, with fully yolked vitellogenic oocytes

Indirect evidence for spawning Warsaw grouper

Future sampling to target Greater amberjack spawning during April or May 2024

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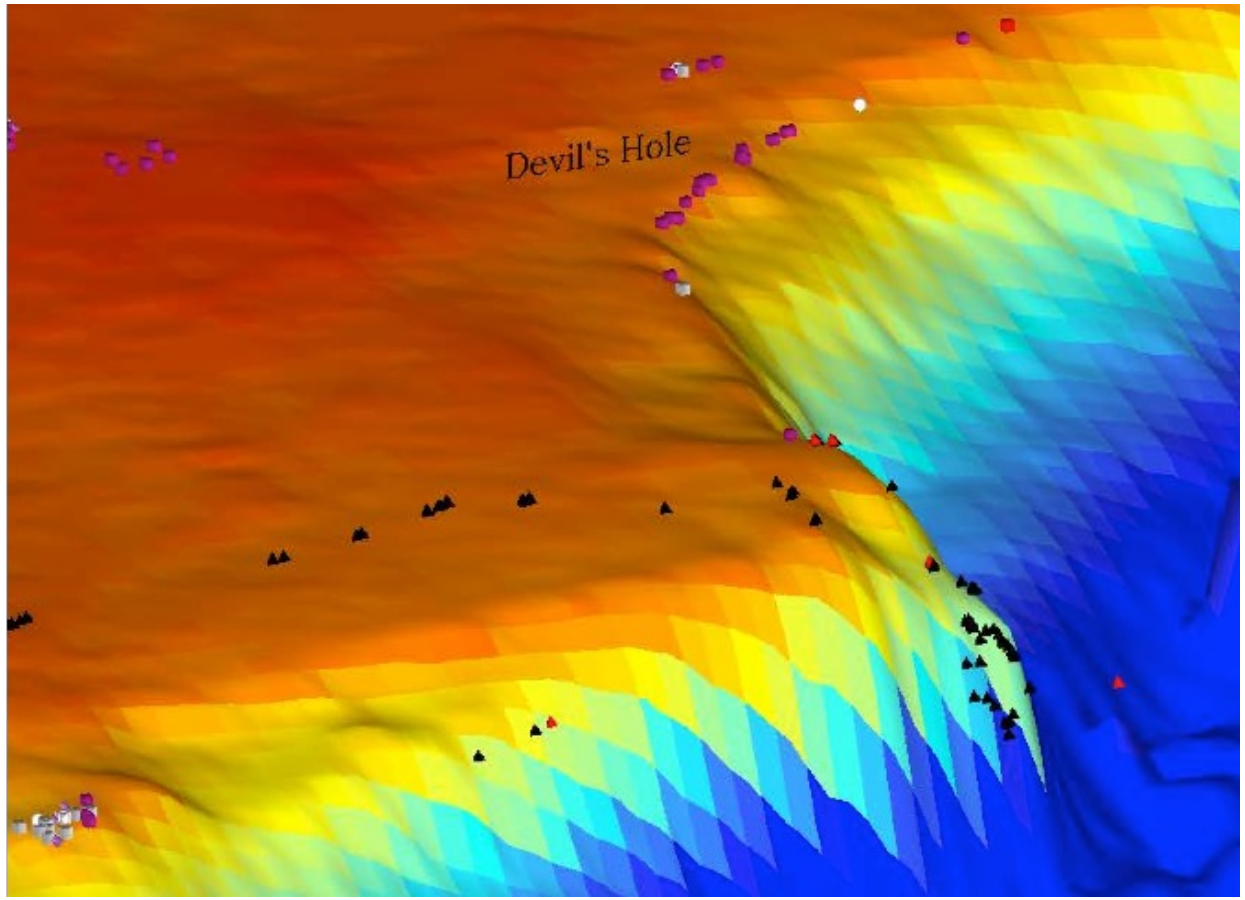
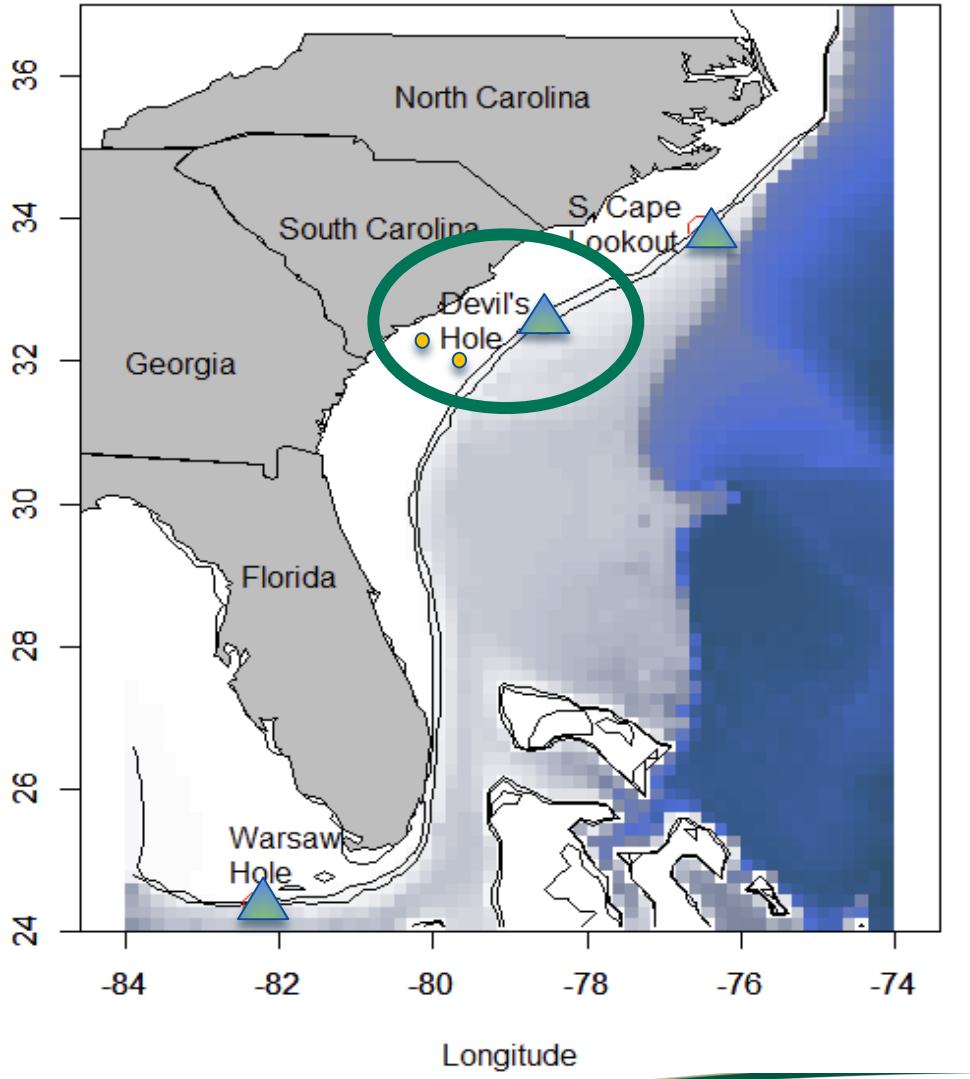
Georgetown Hole





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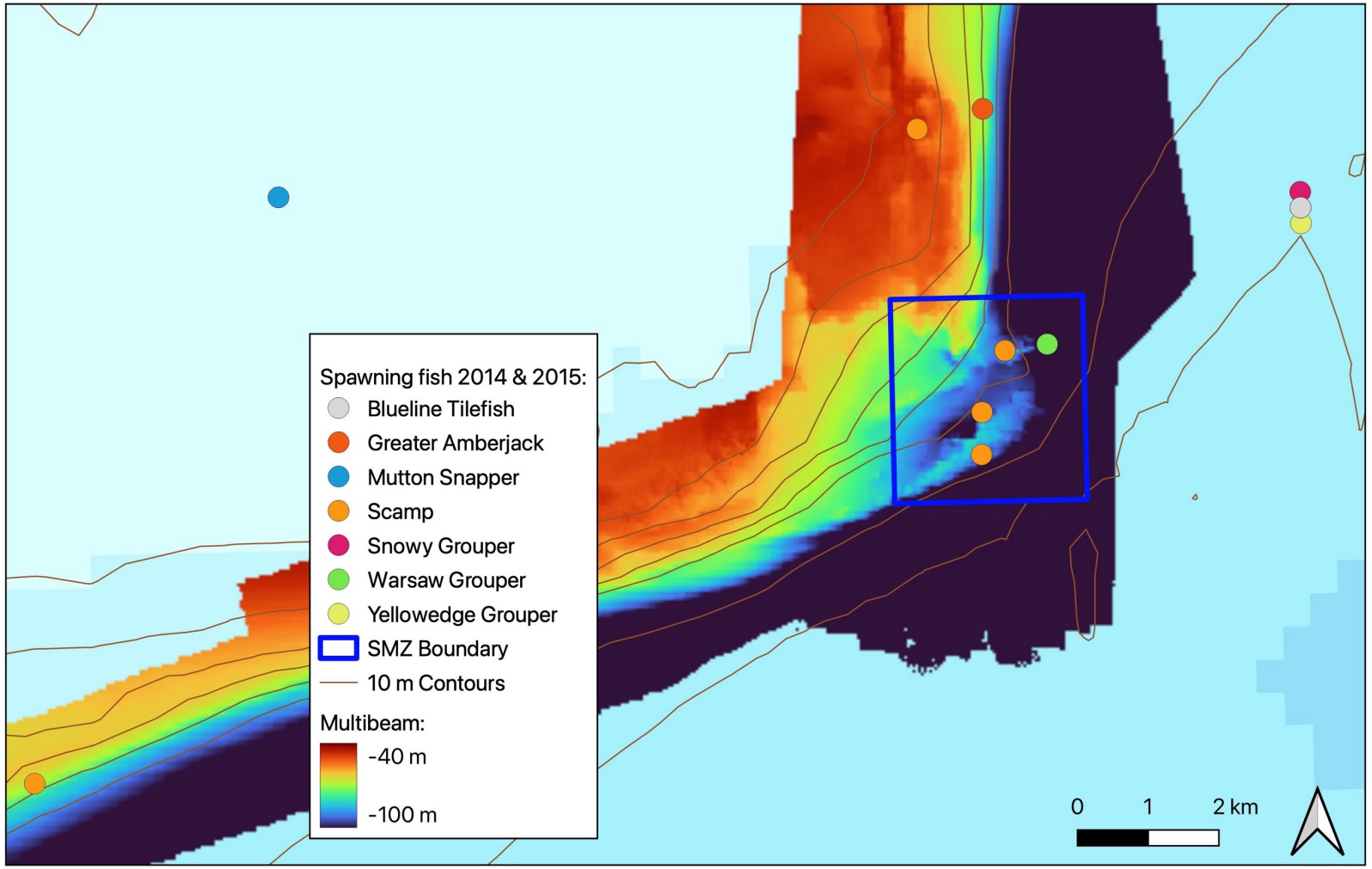
Georgetown Hole April-July, 2014-2015

Captain: Mark Marhefka
F/V Amy Marie

Ecological Research Associates, Inc.

Georgetown Hole Spawning Females: April-July, 2014-2015



Direct evidence of spawning Warsaw grouper, scamp, snowy, AJ

Suggest more sampling outside of the existing SSMZ boundary

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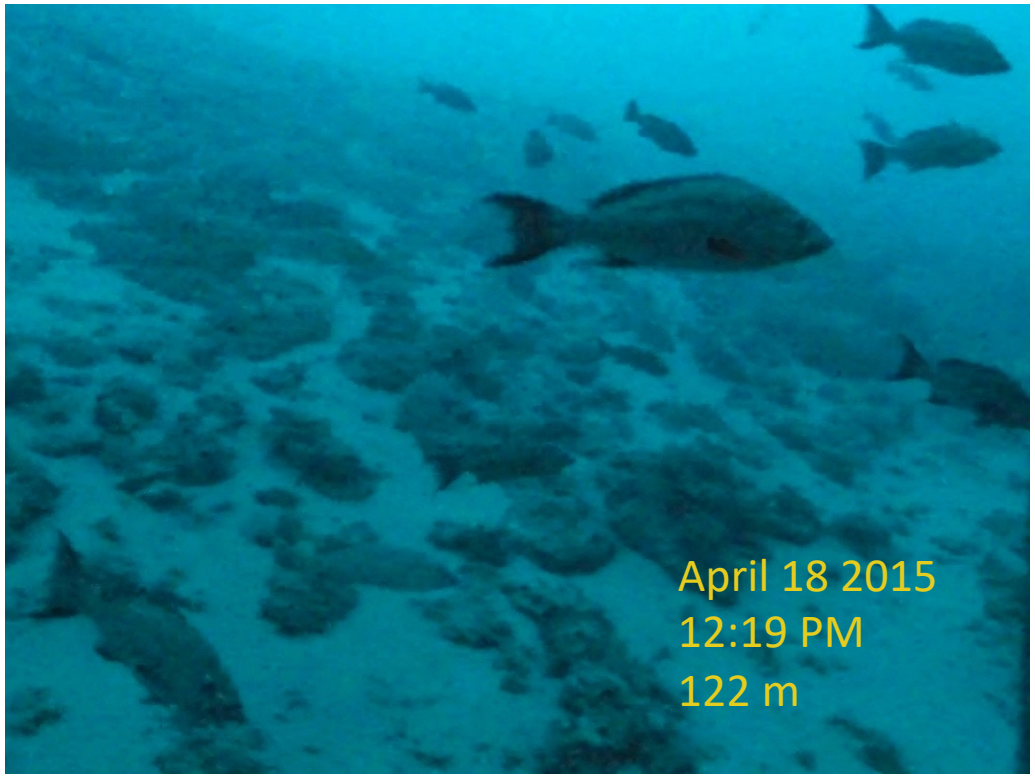
Georgetown Hole Video surveys: April-July, 2014-2015

Scamp aggregation



Scamp courtship coloration and behavior

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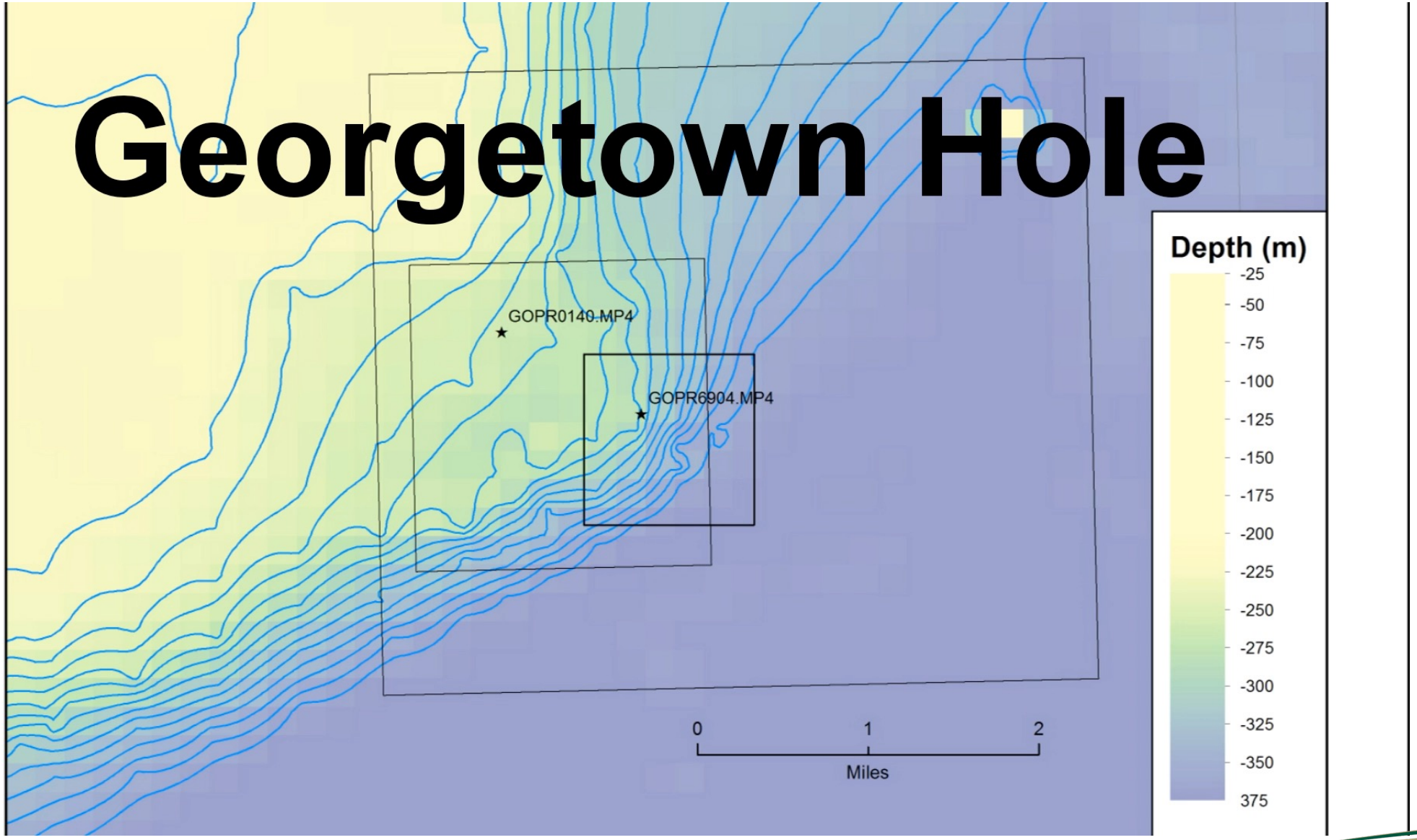
Georgetown Hole Scamp Aggregation



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Georgetown Hole Sampling April 2023

Captain Andy McGraw and mate Tim Cook

Sampling Sites April 18-22nd, 2023

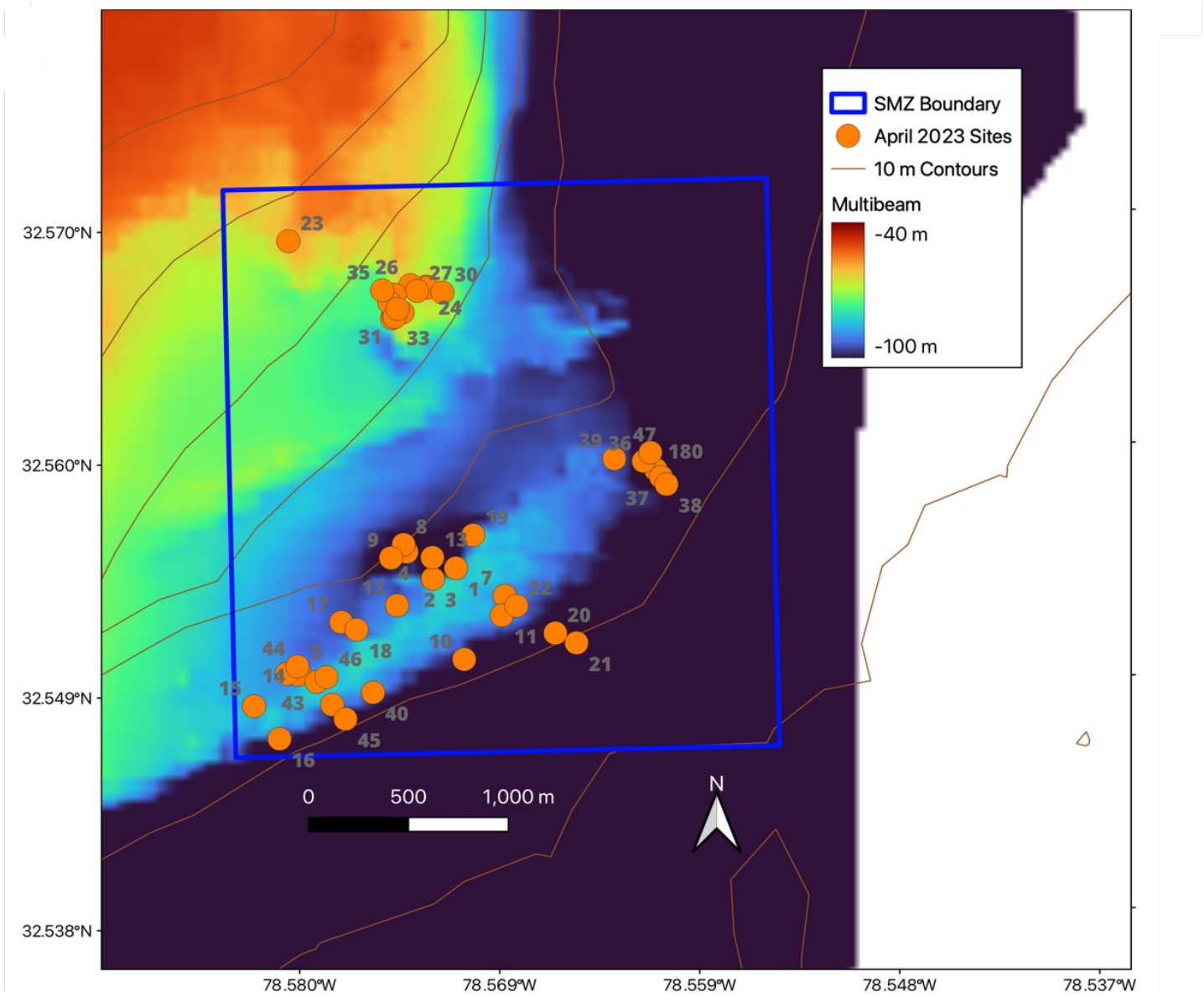

Figure 1. Sites (n = 53) sampled (orange dots) within Georgetown Hole SMZ (blue square) during April 2023.

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Species Sampled April 18-22nd, 2023

Common Name	Sample Size
Blackfin snapper	22
Gag grouper	2
Red snapper	1
Scamp grouper	13
Snowy grouper	10
Speckled hind	4
Yellowedge grouper	1
Blueline tilefish	2

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Georgetown Hole Histological Analysis, April 2023

100% of female scamp grouper sampled (n = 7) were in spawning condition

The mean Gonadosomatic Index ((gonad weight/gonad-free fish weight)*100) for female scamp grouper collected in April 2023 was **3.6%.** The highest calculated GSI for female scamp was **5.2%**

57% of female blackfin snapper sampled (n = 7) were in spawning condition →

The mean Gonadosomatic Index for female blackfin snapper collected in April 2023 was **1.93%** (Stdev:1.3). The highest calculated GSI for blackfin snapper was **4.1%**

Direct evidence of spawning scamp and blackfin snapper

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Georgetown Hole Video Surveys, April 2023

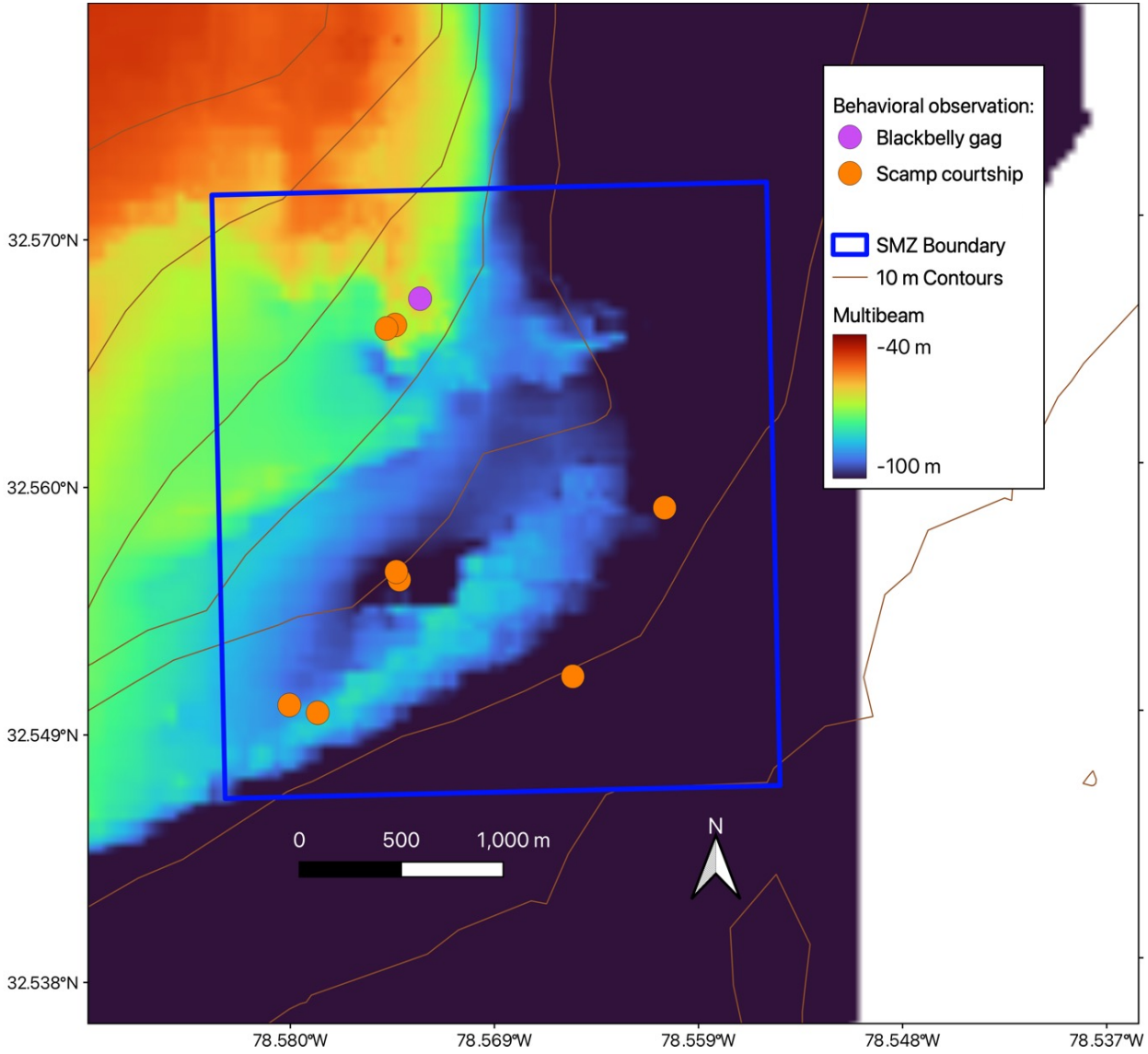

Figure 2. Locations within Georgetown Hole where scamp courtship behavior or blackbelly gag were observed on video surveys.

Indirect evidence of spawning scamp and gag

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Georgetown Hole Age Data, April 2023

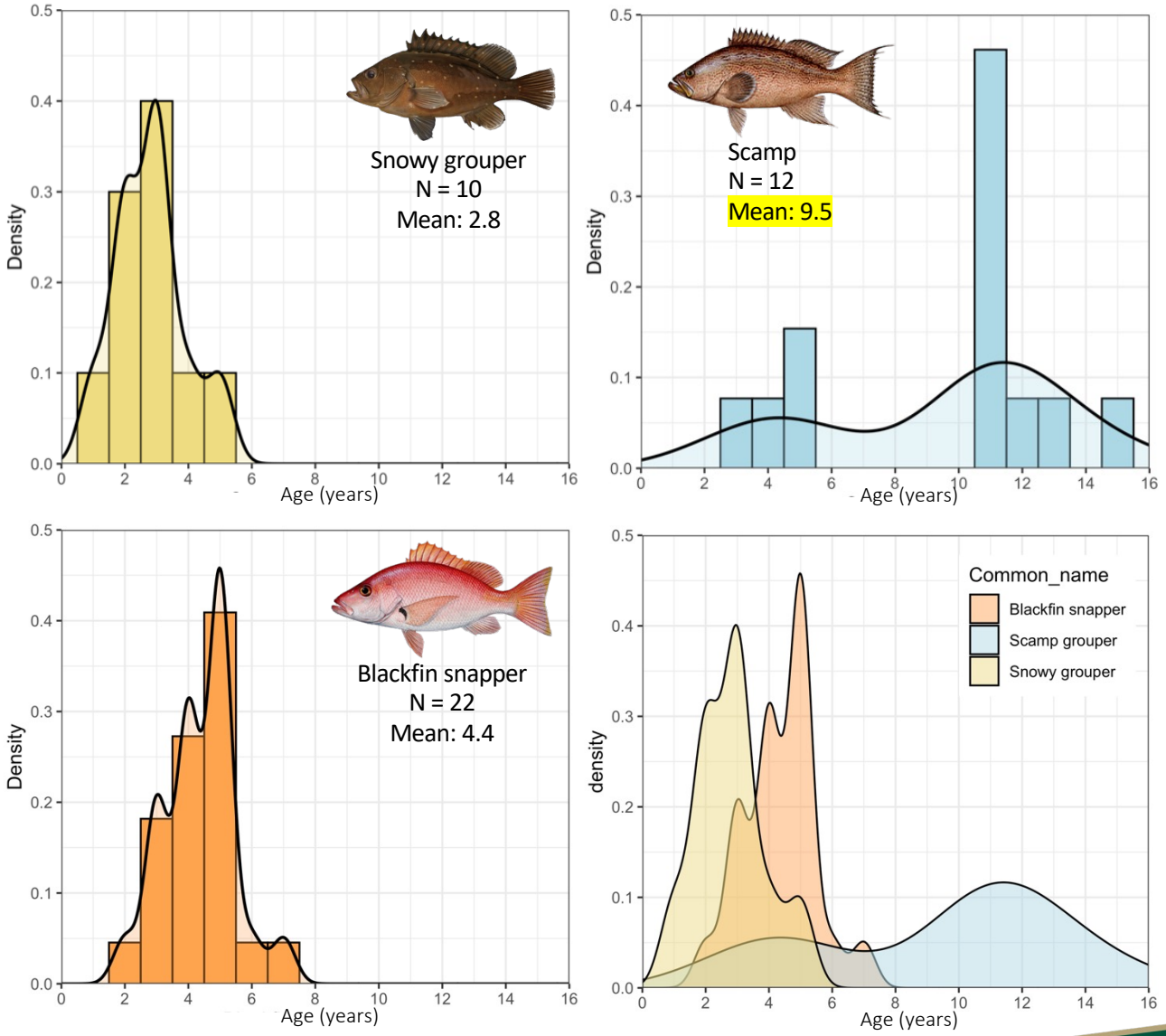

Figure 3. Age-density distribution for snowy grouper, scamp, and blackfin snapper collected in Georgetown Hole, April 2023.

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Georgetown Hole Age Data, April 2023 Comparison to SEDAR, 2021

Table 1. Summary of age data per species collected in Georgetown Hole SSMZ, April 2023.

Common Name	Max Age	Min Age	Mean Age	Median Age	Sample Size
Blackfin snapper	7	2	4.3	4.5	22
Gag	15	8	11.5	11.5	2
Red snapper	11	11	11	11	1
Scamp	15	3	9.5	11	13
Snowy grouper	5	1	2.8	3	10

Scamp in Georgetown Hole are relatively old

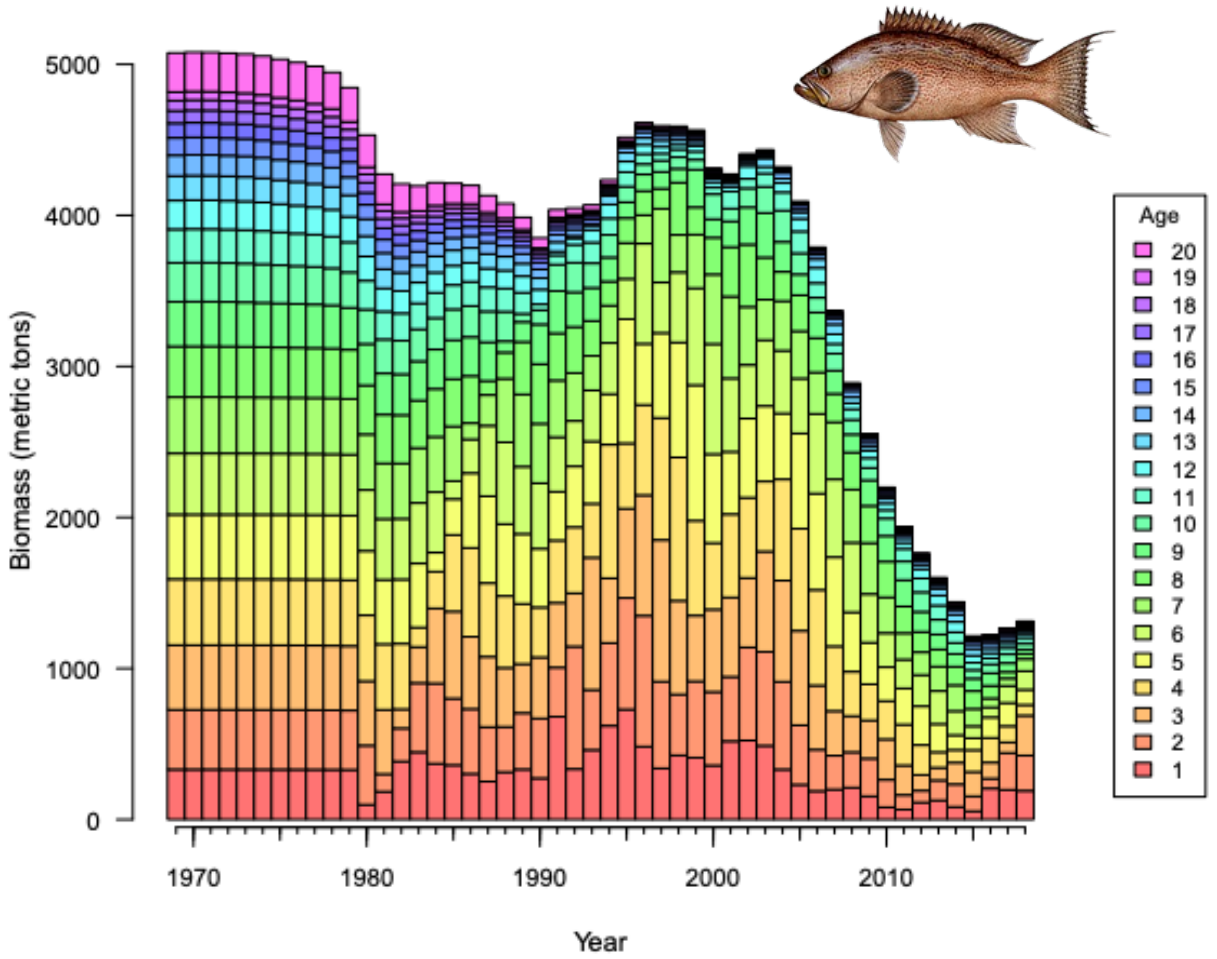

Figure 4. Estimated scamp biomass per age over time based on catch data in southeastern U.S. waters from the Florida Keys to the North Carolina-Virginia border (SEDAR, 2021).

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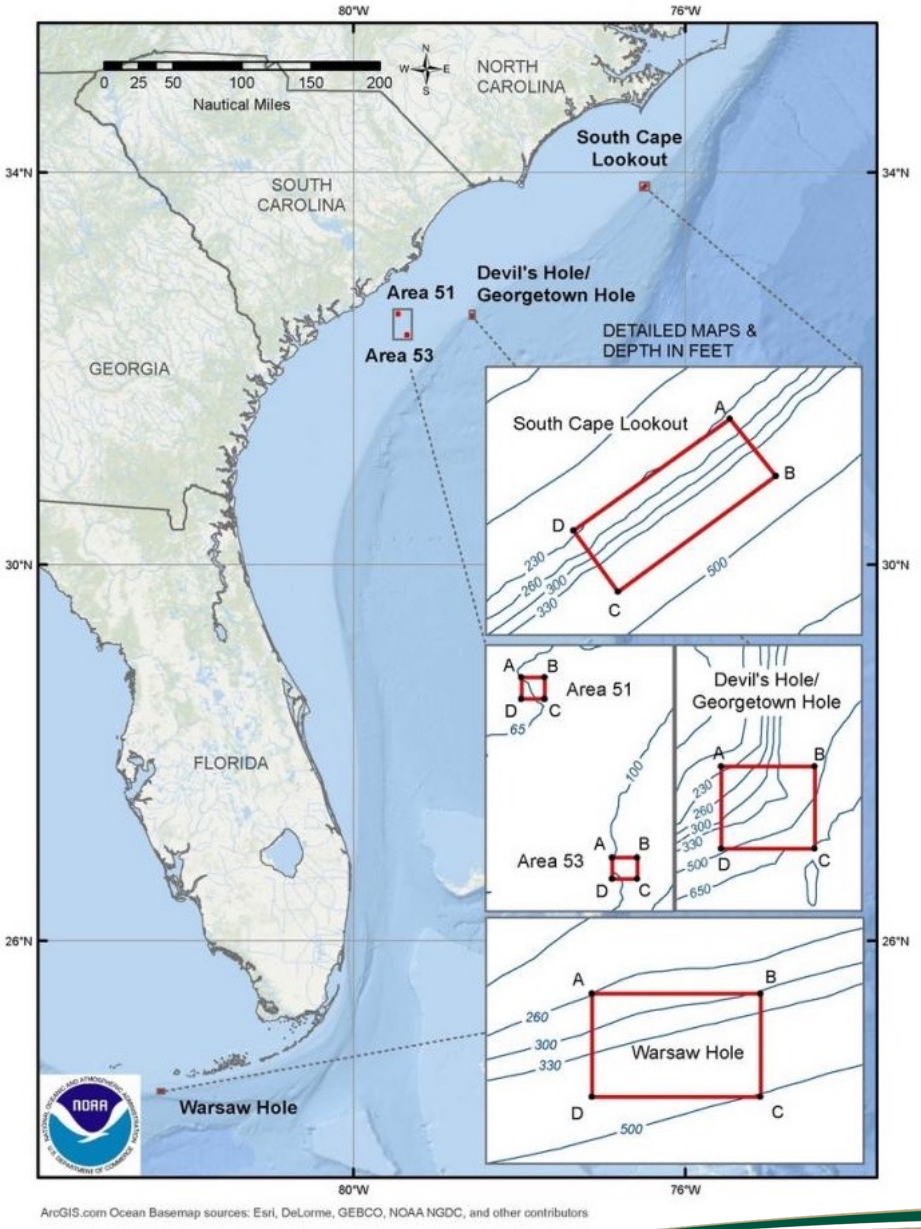
Upcoming sampling

Sampling:

- Sampling trips to Georgetown Hole planned in 2024. Funded by The Nature Conservancy
- Sampling trip to Warsaw Hole planned for 2024. Funded by SAFMC

Goal:

- Provide data to inform council/working group decisions regarding 2027 sunset clause.



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Possible Future add-ons

- Conventional, acoustic (Vemco), and satellite tagging to evaluate site fidelity, connectivity and movement in relation to reserve boundaries
- Non-destructive sampling for gonads using canulation
- Passive hydroacoustic monitoring for sounds of spawning fish and fishing activity
- Evaluate enforcement needs and concerns
- Cooperative monitoring training for additional fishermen
- Establish Sentinel Sites

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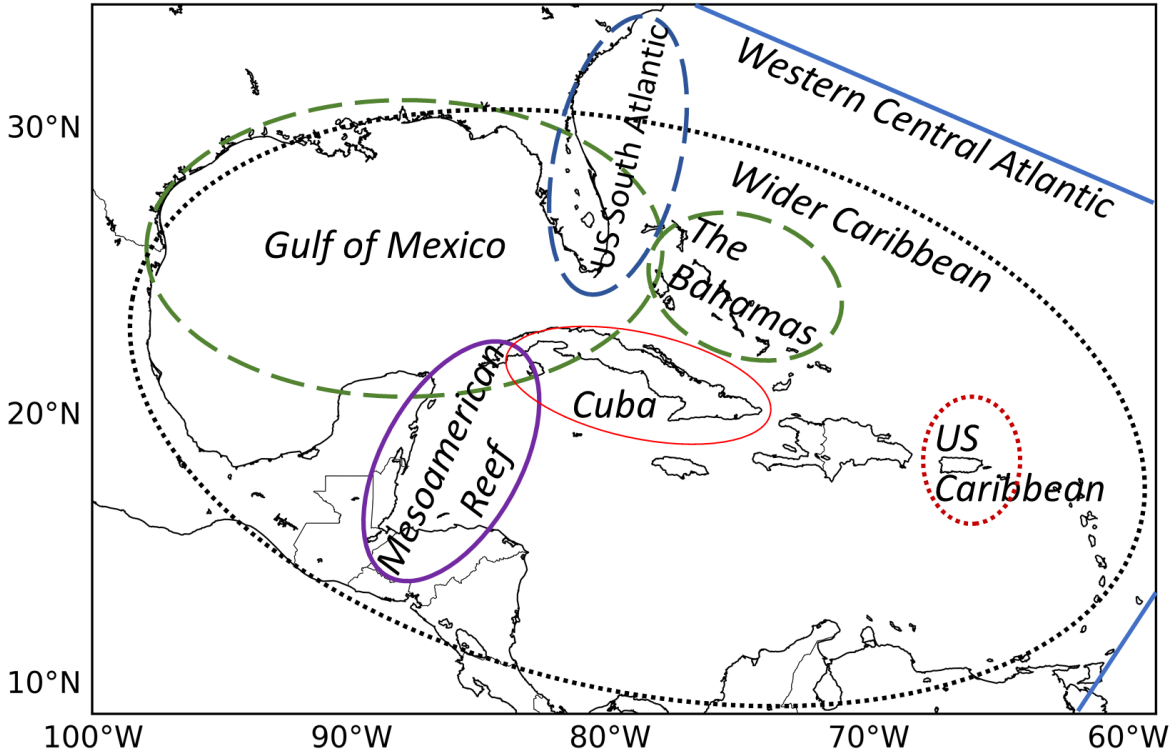
Linking with other Regions and the Big Fish Initiative

Belize SPAGs Working Group

GCOOS FSAs in the Gulf of Mexico



Big Fish Initiative YouTube

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Acknowledgements

- South Atlantic Fisheries Management Council
- SC DNR MARMAP
- The Nature Conservancy, Mary Conley, Liz Fly
- Gulf and South Atlantic Fisheries Foundation
- Pew Charitable Trusts
- Summit and Oak Foundations
- NOAA Saltonstall Kennedy Program
- Commercial fishermen including Jack Cox, James Holden, Mark Marhefka, Andy McGraw, Tim Cook, Chris Conklin,