“The Great Red Snapper Count”

Estimating the absolute abundance of Red Snapper in the U.S. Gulf of Mexico.

What is the problem/goal?

- Absolute abundance estimate leads to most informed mgmt.

Who was involved?

- $12M - Independent estimate
- 21 Leading Scientists from 12 Institutions (80+ Scientists Total)

How was Red Snapper abundance being estimated?

Suite of methods:

Habitat Classification
Direct Visual Counts
Hydroacoustic Surveys
Depletion Surveys
Gulf-Wide Tagging Program

Senior Principal Investigators:

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University

Sean Powers, Ph.D.
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Will Patterson, Ph.D.
University of Florida

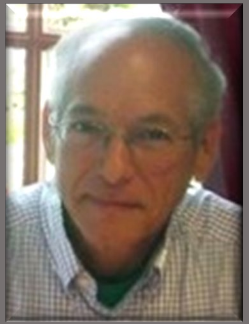
Steve Murawski, Ph.D.
University of South
Florida

Matthew Catalano, Ph.D.
Auburn University

Marcus Drymon, Ph.D.
Mississippi State University

Robert Ahrens, Ph.D.
University of Florida

Lynne Stokes, Ph.D.
Southern Methodist
University



John Hoenig, Ph.D.
Virginia Institute of
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Principal Investigators/Collaborators:

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Northeastern University

Non-Compensated Collaborators

John Walter, Ph.D.
NOAA- SEFSC

Matthew Campbell, Ph.D.
NOAA- SEFSC

Participating Institutions

Sea Grant
Mississippi-Alabama

TEXAS A&M UNIVERSITY CORPUS CHRISTI | HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES

TEXAS A&M UNIVERSITY GALVESTON CAMPUS

LSU
LOUISIANA STATE UNIVERSITY

USF
UNIVERSITY OF SOUTH FLORIDA

UF | UNIVERSITY of FLORIDA

AUBURN UNIVERSITY

USA | UNIVERSITY OF SOUTH ALABAMA

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE

SMU

MISSISSIPPI STATE UNIVERSITY

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

FIU | FLORIDA INTERNATIONAL UNIVERSITY

History – How did we arrive here?

- Planning Meetings/Workshops
- Consisted of a Two-Phase RFP Process:

Phase I - 6 Proposals ($100K ea.) to develop designs

- Coalescing of desirable aspects and design framework
- Somewhat unconventional

Phase II – Implement designs and generate abundance estimate

Phase II

Red Snapper Abundance Estimate in the U.S. Gulf of Mexico

Key Points:

- **Explicitly detailed: scope, goals, objectives, and general sampling methodologies**
- **Specified:**
  - **General statistical analyses**
  - **Target CVs**
  - **Geographic scope**
  - **Habitat types to assess**
  - **Depth ranges**
  - **Tagging study requirement**
  - **Requirement for comprehensive stakeholder engagement**
  - **No genetic-based methods and only archiving of samples**

External and SSC Review - Update

During Spring 2021 Report Reviewed by External Experts and SSC

Key Points:

- **Very valuable process. Explicit details are captured in the report and response letter.**
- **Recommendation on design and analyses greatly improved report.**
- **Team has worked diligently to reanalyze and address each of these suggestions.**
- **Specifically:**
  - **Explicitly describing a recommended stratified random sampling design;**
  - **Removal of RF design for FL (note: recently asked by SEFSC to reincorporate);**
  - **Capture as much additional variability as possible (including adding 'variance buffer');**
  - **Improving estimators, calibrations, and modification of post-strata based on suggestions;**
  - **Re-evaluating the contribution Uncharacterized Bottom;**
  - **Developed an alternate estimator of variance to capture additional uncertainty;**
  - **Developed an alternate estimator to reduce bias.**

Tagging and Exploitation Studies

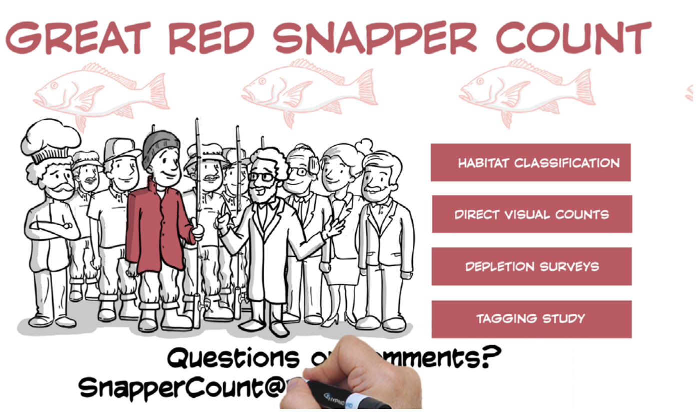
Catalano (AU)

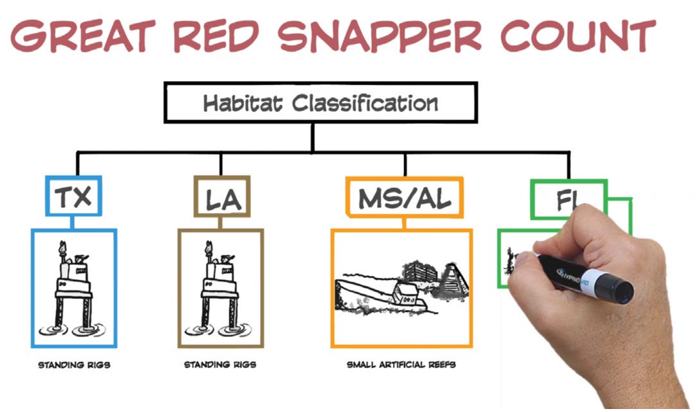
Thousands of fish tagged Gulf-wide

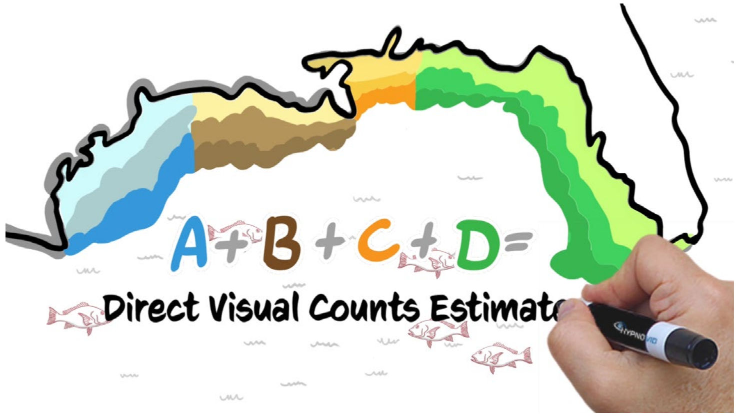
Archived genetic samples

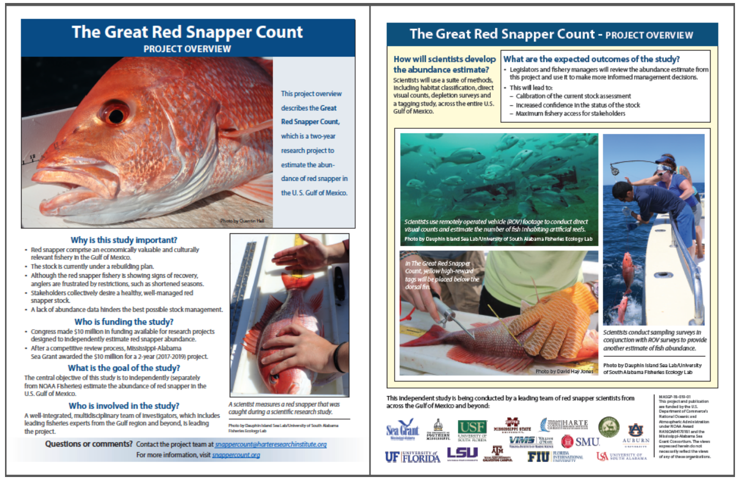
Angler Engagement

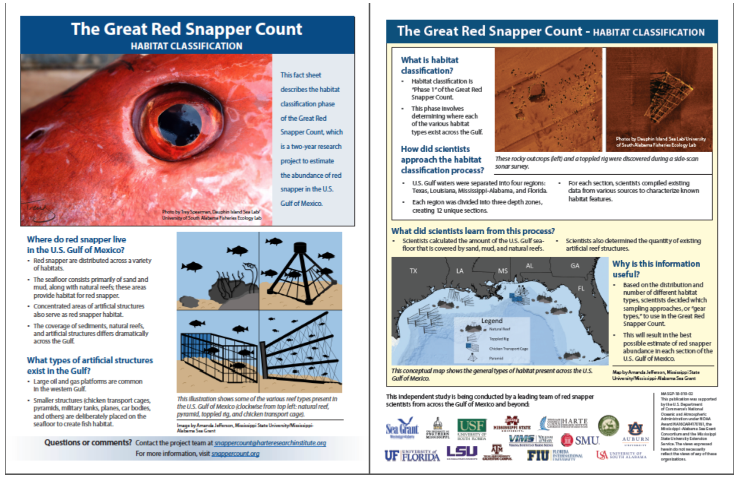
Extensive Stakeholder Engagement

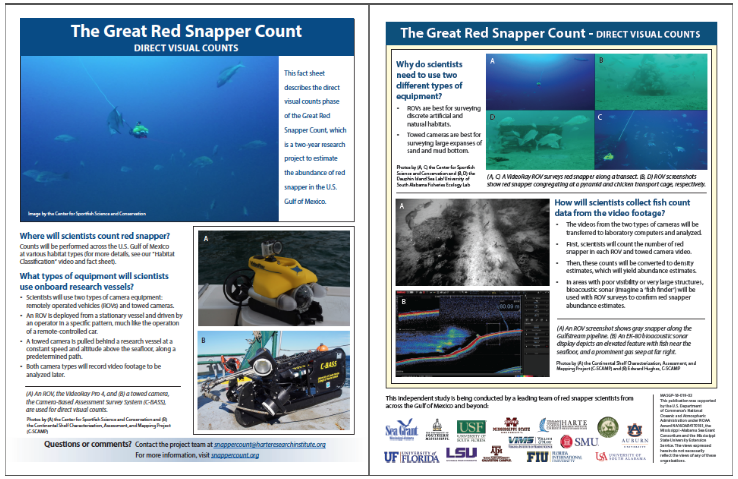






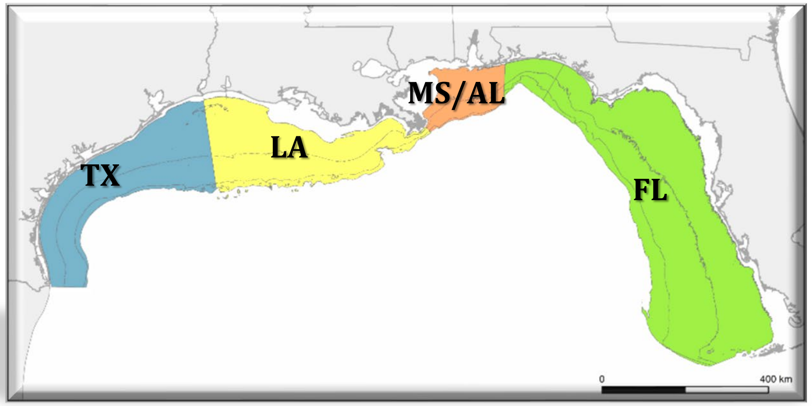




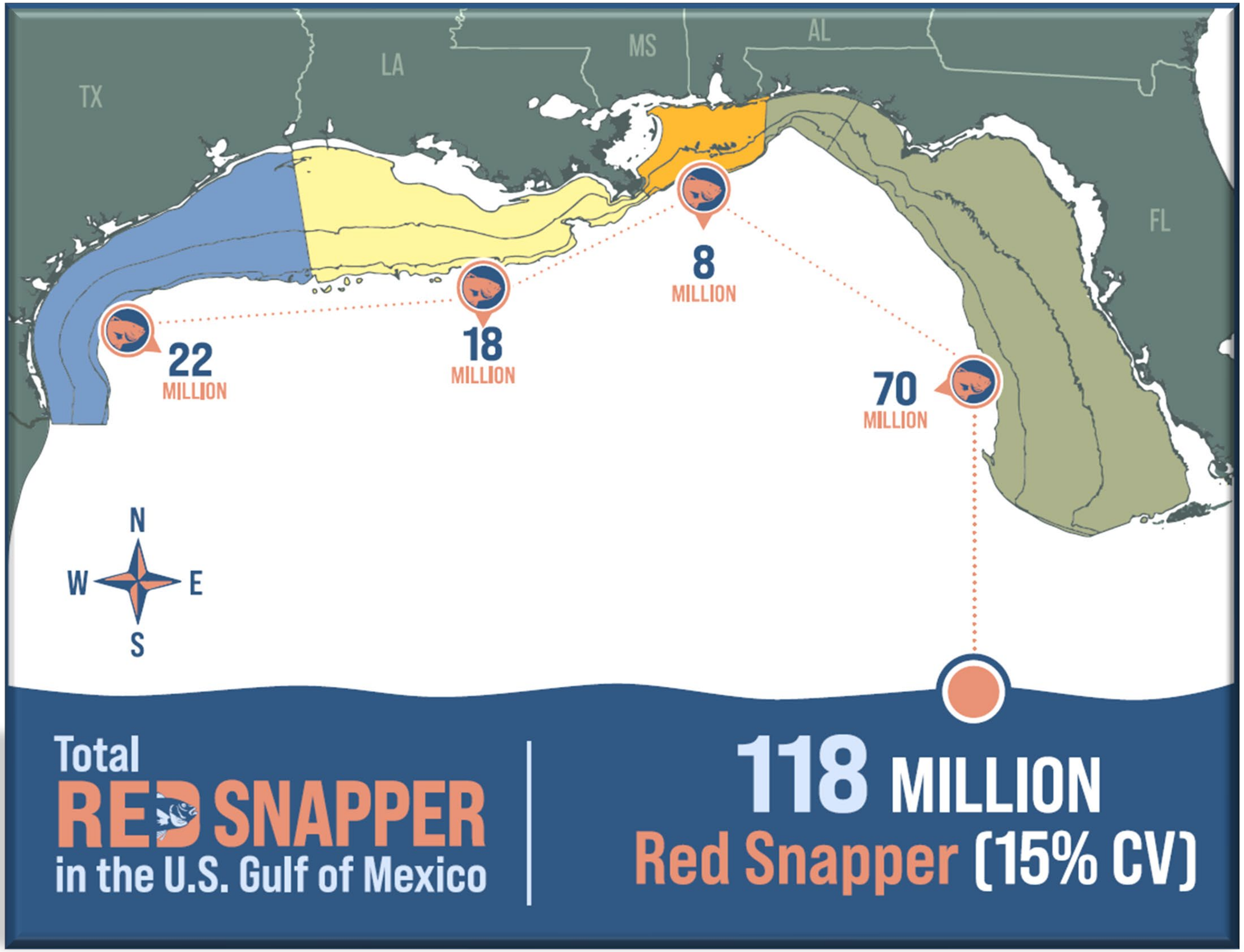


www.snappercount.org

Estimate and Analysis



- Two Independent Estimates (relatively low CVs)
- Converged with ~ 6 % difference (~ 7M Fish)



- **NOAA 2018 Stock Assessment (SEDAR 52): 36 M**
- **Report for Review – 110 M; 11% CV**

State /Region	Habitat Type	Estimated Abundance
Texas	Natural	7,000,000
	Artificial	<1,000,000
	Uncharacterized Bottom	14,000,000
	State Total	**22,000,000**
Louisiana	Natural	4,000,000
	Artificial	4,000,000
	Uncharacterized Bottom	10,000,000
	State Total	**18,000,000**
Mississippi & Alabama	Natural	4,000,000
	Artificial	1,000,000
	Uncharacterized Bottom	3,000,000
	State Total	**8,000,000**
Florida	Natural & Uncharacterized Bottom	70,000,000
	Artificial	<1,000,000
	State Total	**70,000,000**

Total RED SNAPPER in the U.S. Gulf of Mexico | **118 MILLION** (15% CV)

Table 5. Absolute abundance estimates for each state/region broken into the three habitat strata: Natural hard bottom, Artificial Reef, and Uncharacterized bottom, and pipeline estimates for the entire Gulf. Estimates of area coverage for natural and uncharacterized bottom, and number of structures for artificial reefs plus mean density per area or structure. SE = standard error; CV = coefficient of variation.

State/Region	Habitat Type	Total Area (km^2) or Structures	Number of Samples (*n*)	Area Sampled (km^2)	Mean Density ($100m^2$) or by Structure	Number	SE	CV (%)
TX	Natural	1,570	36	6.13	0.45	7,037,443	2,537,014	36
	Artificial	4,348	49			417,761	88,469	21
	Large	*941*	*45*		*362*	*340,905*	*79,287*	*23*
	Small	*3,460*	*4*		*22*	*76,855*	*39,246*	*51*
	Uncharacterized Bottom	57,535	140	6.26	0.03	14,569,830	6,663,776	46
	Total		225			22,025,035	7,130,931	32
LA	Natural	821	22	*n/a*	0.47	3,852,652	1,671,470	43
	Artificial	1,771	42		2174	3,849,325	576,234	15
	Uncharacterized Bottom	53,052	87	3.61	0.02	9,729,387	5,699,448	59
	Total		151			17,431,364	5,967,375	34
AL&MS	Natural	211	32	0.013	1.78	3,751,988	752,467	20
	Artificial	9,410	128		160	1,509,625	167,506	11
	Uncharacterized Bottom	18,500	3	0.74	0.02	3,199,472	1,625,263	51
	Total		163			8,461,085	1,798,817	21
FL	Natural & Uncharacterized	143,538	748	0.61	0.05	69,918,949	14,349,384	21
	Artificial	7,763	79		16	127,560	21,088	17
	Total		832			70,046,509	16,789,232	24
Pipelines (Gulf-wide)		26,686 linear km	27	0.49	0.02	507,661	218,961	43
Gulf of Mexico						**118,471,654**	**17,194,438**	**15**

Table 7.

State/Region	Habitat Type	Area (km^2) or Structures	Number of Samples (n)	Mean Density (100m^2) or by Structure	Number	SE	CV (%)	Conservative CV(%)	Estimator
TX	Natural	1,570	36		5,218,915	1,390,733	27	44	
	Deep	*209*	*11*	*0.09*	*178,682*	*70,111*	*39*	*65*	$\hat{t}_{y,r}$
	Mid	*953*	*22*	*0.35*	*3,381,753*	*955,545*	*28*	*47*	$\hat{t}_{y,r}$
	Shallow	*409*	*3*	*0.41*	*1,658,480*	*1,008,046*	*61*	*101*	$\hat{t}_{y,r}$
	Artificial	12,010	31		706,327	191,728	27	45	
	Pyramids	*10,902*	*13*	*11*	*125,300*	*80,777*	*64*	*107*	$\hat{t}_{y,r(pyr)}$
	Non-Pyramids	*1,108*	*18*	*524*	*581,027*	*173,881*	*30*	*50*	$\hat{t}_{y,mpu}$
	Uncharacterized Bottom	57,535	140		10,332,018	3,449,733	33	33	
	Deep	*4,034*	*4*	*0.002*	*71,460*	*38,584*	*54*	*90*	$\hat{t}_{y,r}$
	Mid-North	*8,765*	*39*	*0.015*	*747,705*	*512,361*	*69*	*93*	$\hat{t}_{y,r}$
	Mid-Central	*6,450*	*22*	*0.033*	*2,159,374*	*2,014,526*	*93*	*69*	$\hat{t}_{y,r}$
	Mid-South	*6,503*	*16*	*0.005*	*340,824*	*205,910*	*60*	*60*	$\hat{t}_{y,r}$
	Shallow- North	*17,036*	*36*	*0.014*	*2,335,968*	*1,426,726*	*61*	*65*	$\hat{t}_{y,r}$
	Shallow- Central	*8,951*	*15*	*0.038*	*3,367,881*	*2,183,282*	*65*	*61*	$\hat{t}_{y,r}$
	Shallow- South	*5,797*	*8*	*0.023*	*1,308,806*	*856,547*	*65*	*65*	$\hat{t}_{y,r}$
	Total		198		16,257,260	3,724,454	23	26	
LA	Natural	821	22		3,683,745	958,570	26	43	
	Deep	*105*	*6*	*0.14*	*151,361*	*51,731*	*34*	*57*	$\hat{t}_{y,sub}$
	Mid & Shallow	*716*	*16*	*0.49*	*3,532,384*	*957,173*	*27*	*45*	$\hat{t}_{y,sub}$
	Artificial	1,771	42		3,849,325	1,341,617	35	58	
	Deep	*93*	*7*	*710*	*66,046*	*38,272*	*58*	*96*	$\hat{t}_{y,mpu}$
	Mid	*602*	*29*	*1,399*	*842,219*	*363,261*	*43*	*72*	$\hat{t}_{y,mpu}$
	Shallow	*1,076*	*6*	*2,733*	*2,941,060*	1,290,935	*44*	*73*	$\hat{t}_{y,mpu}$
	Uncharacterized Bottom	53,052	65		11,043,973	4,024,820	36	45	
	Deep	*5,348*	*3*	*0.01*	*406,320*	*387,513*	*95*	*159*	$\hat{t}_{y,sub}$
	Mid	*19,077*	*11*	*0.02*	*3,756,598*	*2,715,533*	*72*	*120*	$\hat{t}_{y,sub}$
	Shallow	*28,627*	*51*	*0.02*	*6,881,055*	*2,945,317*	*43*	*71*	$\hat{t}_{y,sub}$
	Total		129		18,577,043	4,349,479	23	39	
AL/MS	Natural	211	32	1.78	3,751,988	752,467	20	20	
	Artificial	9,410	128	160	1,509,625	167,506	11	11	
	Uncharacterized Bottom	18,500	3	0.02	4,425,687	1,730,961	39	39	$\hat{t}_{y,r}$
	Total		163		9,687,300	1,894,859	20	20	
FL	Natural & Uncharacterized	143,538	748		66,121,747	13,296,205	20	20	
	NW Region- Deep	*1,662*	*26*	*0.01*	*92,360*	*92,214*	*100*	*100*	$\hat{t}_{y,r}$
	NW Region- Mid	*2,060*	*29*	*0.004*	*85,274*	*85,757*	*101*	*101*	$\hat{t}_{y,r}$
	NW Region- Shallow	*3,553*	*52*	*0.05*	*1,859,201*	*1,298,879*	*70*	*70*	$\hat{t}_{y,r}$
	Mid Region- Deep	*3,759*	*4*	*-*	*-*	*-*		*N/A*	$\hat{t}_{y,r}$
	Mid Region-Mid	*12,113*	*20*	*0.12*	*15,114,169*	*8,521,792*	*56*	*56*	$\hat{t}_{y,r}$
	Mid Region- Shallow	*33,977*	*425*	*0.11*	*37,891,216*	*9,203,445*	*24*	*24*	$\hat{t}_{y,r}$
	Southern Region- Deep	*12,189*	*25*	*-*	*-*	*-*		*N/A*	$\hat{t}_{y,r}$
	Southern Region- Mid	*37,043*	*37*	*0.01*	*3,510,529*	*2,532,121*	*72*	*72*	$\hat{t}_{y,r}$
	Southern Region- Shallow	*37,180*	*130*	*0.02*	*7,568,998*	*3,368,997*	*45*	*45*	$\hat{t}_{y,r}$
	Artificial	7,763	84	16	123,377	20,016	16	16	$\hat{t}_{y,mpu}$
	Total		832		66,245,124	13,296,220	20	20	
Pipelines (Gulf-wide)			27	0.02	546,988	358,761	64	64	$\hat{t}_{y,r}$
Gulf of Mexico					**111,313,716**				
TX, MS, AL, FL					92,736,673	13,942,031	15	14	
Louisiana*					18,577,043	4,349,479	23	39	

Uncharacterized bottom

Texas

- Mean and SD of fish density was calculated across random start point acoustic transects for mid and shallow depths.
- RS density was estimated as fish density times the region specific mean proportion RS.
- Variance combined uncertainty across transects as well as in the proportion.
- Mean and SD of RS density for the deep depth was calculated using transects from randomly selected locations using CBASS visual counts.

Louisiana

- Mean and SD of fish density was calculated across random start point acoustic transects for mid and shallow depths.
- RS density was estimated as fish density times the region specific mean proportion RS.
- Variance combined uncertainty across transects as well as in the proportion.
- Mean and SD of RS density for the deep depth was calculated using transects from randomly selected locations using CBASS visual counts.

Mississippi / Alabama

- Mean and SD of RS density for the all depths was calculated using transects from randomly selected locations using CBASS visual counts.

Florida

<u>Briefing Book/Review Request:</u>

- Mean and SD of RS density for 3 regions and all depths was calculated from randomly selected ROV visual transects.

<u>SEFSC Requested Re-analysis:</u>

- Mean and SD of RS density for 3 regions all depths, and random forest (RF) model classification was calculated from randomly selected ROV visual transects within each stratum.
- The RF model determined low, mid, and high probability of presence based on available fishery independent and dependent data.
- The southern region was added post hoc.

Hardbottom

Texas

- Mean and SD of RS density was calculated across random start point hydroacoustic transects with paired species composition for areas of know hardbottom.

Louisiana

- Mean and SD of RS density was calculated across random start point hydroacoustic transects with paired species composition for areas of know hardbottom.
- Data was imputed based on Texas observations.

Mississippi / Alabama

- Mean and SD of RS density was calculated across random selected features using camera MaxN counts and a fixed area surveyed.

Florida

- Not separated out given the nature of the bottom in Florida

Artificial

Texas

- Mean and SD of RS density was calculated across random hydroacoustic surveys of a structure with paired species composition for platform structures and clusters of smaller structures.

Louisiana

- Mean and SD of RS density was calculated across random hydroacoustic surveys of a structure with paired species composition for platform structures and clusters of smaller structures.
- Data was imputed based on Texas observations.

Mississippi / Alabama

- Mean and SD of RS density was calculated for each depth across random selected sites.
- To obtain total numbers per depth category, RS density was combined with stratified estimated of the total number of structures within each depth.
- Uncertainties from both estimates were combined.

Florida

- Mean and SD of RS density per structure for each depth was calculated from randomly selected ROV visual point counts.

Pipelines

Texas

- Mean and SD of RS density was calculated across transects from random selected pipeline arcs from the BOEM database.

Louisiana

- Mean and SD of RS density was calculated across transects from random selected pipeline arcs from the BOEM database.

Mississippi / Alabama

- Mean and SD of RS density was calculated across transects from random selected pipeline arcs from the BOEM database.

Florida

- Mean and SD of RS density was calculated across transects from random selected pipeline arcs from the BOEM database.

State/Region	Habitat Type	Total Area (km^2) or Structures	Number of Samples (*n*)	Area Sampled (km^2)	Mean Density ($100m^2$) or by Structure	Number	SE	CV (%)
TX	Natural	1,570	36	6.13	0.45	7,037,443	2,537,014	36
	Artificial	4,348	49			417,761	88,469	21
	Large	*941*	*45*		*362*	*340,905*	*79,287*	*23*
	Small	*3,460*	*4*		*22*	*76,855*	*39,246*	*51*
	Uncharacterized Bottom	57,535	140	6.26	0.03	14,569,830	6,663,776	46
	Total		225			22,025,035	7,130,931	32
LA	Natural	821	22	*n/a*	0.47	3,852,652	1,671,470	43
	Artificial	1,771	42		2174	3,849,325	576,234	15
	Uncharacterized Bottom	53,052	87	3.61	0.02	9,729,387	5,699,448	59
	Total		151			17,431,364	5,967,375	34
AL&MS	Natural	211	32	0.013	1.78	3,751,988	752,467	20
	Artificial	9,410	128		160	1,509,625	167,506	11
	Uncharacterized Bottom	18,500	3	0.74	0.02	3,199,472	1,625,263	51
	Total		163			8,461,085	1,798,817	21
FL	Natural & Uncharacterized	143,538	748	0.61	0.03	48,124,414	10,437,839	22
	Artificial	7,763	79		16	127,560	21,088	17
	Total		832			48,251,974	10,437,861	22
Pipelines (Gulf-wide)		26,686 linear km	27	0.49	0.019	507,661	218,961	43
Gulf of Mexico						**96,677,119**	**13,969,084**	**14**

Revised estimation – Dr. Lynne Stokes

- In the secondary analysis, revisions were made in each state estimate:
  - MS/AL: variance was adjusted to account for estimation of AR population size
  - TX: Variance estimate was increased to include variance component due to calibration in UCB stratum; post-strata were added to UCB due to separate calibration factors; error in identifying transects was corrected, resulting in fewer transects in UCB.
  - LA: TX changes affected LA estimate, since much of LA data was imputed.
- Some changes increased estimate/SE and some decreased them.
- Total abundance was reduced and CV was nearly unchanged.

Calibration variance component for UCB in TX

- For TX UCB, Mid & Shallow, calibration factors for C, N, and S were estimated from independent experimental data (say $\hat{p}_h, h = C, N, S$), where *p* represents the proportion of fish (u) that are RS (*y*).
  - Estimate of calibration factor is sample mean: $\hat{p}_h = \frac{\sum_{j=1}^{r} \hat{p}_{hj}}{r}$
- Then $\hat{t}_{h,y} = t_{h,x} \times \frac{\sum_{i=1}^{n_h} \hat{p}_h u_{hi}}{\sum_{i=1}^{n} x_{hi}} = t_{h,x} \frac{\sum_{i=1}^{n_h} u_{hi}}{\sum_{i=1}^{n} x_{hi}} \times \hat{p}_h = \hat{t}_{hu,r} \times \hat{p}_h$
- An unbiased estimate of the variance of a product of two independent random variables has a closed form (Goodman 1962). This estimator was used for the variance for all Mid&Shallow UCB strata.

Other TX strata using calibration

- Natural bottom also used a calibration method, but the data on which the calibration was based was not readily available to me.
- To compensate, I used a “worst case scenario” approach to examine the effect.
  - I calculated the multiplicative increase in variance of RS abundance estimate (efficiency) due to calibration for each of the six post-strata of the UCB in Texas.
  - They ranged from 1.01 to 2.77.
  - I applied the maximum value to remaining post-strata using calibration in TX and LA.
  - This increased the variances as shown in Table 7 of report.

State/Region	Habitat Type	Area (km^2) or Structures	Number of Samples (n)	Area Sampled (km^2)	Mean Density (100m^2) or by Structure	Number	SE	CV (%)	Conservative CV(%)	Estimator
TX	Natural	1,570	36	6.13		5,218,915	1,390,733	27	44	
	Deep	*209*	*11*		*0.09*	*178,682*	*70,111*	*39*	*65*	$\hat{t}_{y,r}$
	Mid	*953*	*22*		*0.35*	*3,381,753*	*955,545*	*28*	*47*	$\hat{t}_{y,r}$
	Shallow	*409*	*3*		*0.41*	*1,658,480*	*1,008,046*	*61*	*101*	$\hat{t}_{y,r}$
	Artificial	12,010	31			706,327	191,728	27	45	
	Pyramids	*10,902*	*13*		*11*	*125,300*	*80,777*	*64*	*107*	$\hat{t}_{y,r(pyr)}$
	Non-Pyramids	*1,108*	*18*		*524*	*581,027*	*173,881*	*30*	*50*	$\hat{t}_{y,mpu}$
	Uncharacterized Bottom	57,535	140	6.22		10,332,018	3,449,733	33	33	
	Deep	*4,034*	*4*	*1.35*	*0.002*	*71,460*	*38,584*	*54*	*90*	$\hat{t}_{y,r}$
	Mid-North	*8,765*	*39*	*1.75*	*0.015*	*747,705*	*512,361*	*69*	*N/A*	$\hat{t}_{y,r}$
	Mid-Central	*6,450*	*22*	*1.05*	*0.033*	*2,159,374*	*2,014,526*	*93*	*N/A*	$\hat{t}_{y,r}$
	Mid-South	*6,503*	*16*	*0.92*	*0.005*	*340,824*	*205,910*	*60*	*N/A*	$\hat{t}_{y,r}$
	Shallow- North	*17,036*	*36*	*0.51*	*0.014*	*2,335,968*	*1,426,726*	*61*	*N/A*	$\hat{t}_{y,r}$
	Shallow- Central	*8,951*	*15*	*0.38*	*0.038*	*3,367,881*	*2,183,282*	*65*	*N/A*	$\hat{t}_{y,r}$
	Shallow- South	*5,797*	*8*	*0.25*	*0.023*	*1,308,806*	*856,547*	*65*	*N/A*	$\hat{t}_{y,r}$
	Total		198			16,257,260	3,724,454	23	26	
LA	Natural	821	22	N/A		3,683,745	958,570	26	43	
	Deep	*105*	*6*		*0.14*	*151,361*	*51,731*	*34*	*57*	$\hat{t}_{y,sub}$
	Mid & Shallow	*716*	*16*		*0.49*	*3,532,384*	*957,173*	*27*	*45*	$\hat{t}_{y,sub}$
	Artificial	1,771	42			3,849,325	1,341,617	35	58	
	Deep	*93*	*7*		*710*	*66,046*	*38,272*	*58*	*96*	$\hat{t}_{y,mpu}$
	Mid	*602*	*29*		*1,399*	*842,219*	*363,261*	*43*	*72*	$\hat{t}_{y,mpu}$
	Shallow	*1,076*	*6*		*2,733*	*2,941,060*	1,290,935	*44*	*73*	$\hat{t}_{y,mpu}$
	Uncharacterized Bottom	53,052	65	2.42		11,043,973	4,024,820	36	61	
	Deep	*5,348*	*3*	*0.68*	*0.01*	*406,320*	*387,513*	*95*	*159*	$\hat{t}_{y,sub}$
	Mid	*19,077*	*11*	*0.85*	*0.02*	*3,756,598*	*2,715,533*	*72*	*120*	$\hat{t}_{y,sub}$
	Shallow	*28,627*	*51*	*0.89*	*0.02*	*6,881,055*	*2,945,317*	*43*	*71*	$\hat{t}_{y,sub}$
	Total		129			18,577,043	4,349,479	23	39	
AL/MS	Natural	211	32	0.01	1.78	3,751,988	752,467	20	N/A	
	Artificial	9,410	128		160	1,509,625	167,506	11	N/A	
	Uncharacterized Bottom	18,500	3	0.74	0.02	4,425,687	1,730,961	39	N/A	$\hat{t}_{y,r}$
	Total		163			9,687,300	1,894,859	20	N/A	
FL	Natural & Uncharacterized	143,538	748	0.61		46,921,038	10,300,890	37	N/A	
	Red Snapper unlikely	*92,616*				*14,653,325*	*5,462,227*		N/A	
	NW Region- Deep	*1,557*	*13*	*0.009*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	NW Region- Mid	*1,148*	*17*	*0.014*	*0.007*	*81,238*	*82,058*	*101%*	*N/A*	$\hat{t}_{y,r}$
	NW Region- Shallow	*2,009*	*23*	*0.024*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	Mid Region- Deep	*3,295*	*2*	*0.001*	*0.000*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Mid Region-Mid	*3,013*	*0*	*-*	*-*	*0*			*N/A*	$\hat{t}_{y,r}$
	Mid Region- Shallow	*19,460*	*77*	*0.052*	*0.271*	*5,265,679*	*2,616,464*	*50%*	*N/A*	$\hat{t}_{y,r}$
	Southern Region- Deep	*9,871*	*15*	*0.010*	*0.000*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Southern Region- Mid	*18,358*	*13*	*0.013*	*0.315*	*5,786,192*	*3,859,150*	*67%*	*N/A*	$\hat{t}_{y,r}$
	Southern Region- Shallow	*33,905*	*53*	*0.048*	*0.104*	*3,520,216*	*2,844,339*	*81%*	*N/A*	$\hat{t}_{y,r}$
	Red Snapper likely	*28,065*				*15,454,698*	*5,838,704*		N/A	
	NW Region- Deep	*98*	*7*	*0.005*	*0.211*	*20,614*	*20,410*	*99%*	*N/A*	$\hat{t}_{y,r}$
	NW Region- Mid	*693*	*7*	*0.006*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	NW Region- Shallow	*1,145*	*11*	*0.008*	*1.847*	*2,115,089*	*2,118,505*	*100%*	*N/A*	$\hat{t}_{y,r}$
	Mid Region- Deep	*419*	*2*	*0.001*	*0.000*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Mid Region-Mid	*4,026*	*10*	*0.009*	*1.057*	*4,256,027*	*3,042,427*	*71%*	*N/A*	$\hat{t}_{y,r}$
	Mid Region- Shallow	*8,030*	*138*	*0.107*	*1.021*	*8,199,695*	*4,479,071*	*55%*	*N/A*	$\hat{t}_{y,r}$
	Southern Region- Deep	*1,928*	*6*	*0.004*	*0.000*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Southern Region- Mid	*9,383*	*10*	*0.016*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	Southern Region- Shallow	*2,343*	*49*	*0.038*	*0.368*	*863,273*	*532,486*	*62%*	*N/A*	$\hat{t}_{y,r}$
	Red Snapper highly likely	*22,858*				*16,813,015*	*6,494,764*		N/A	
	NW Region- Deep	*8*	*6*	*0.004*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	NW Region- Mid	*220*	*5*	*0.004*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	NW Region- Shallow	*399*	*18*	*0.016*	*0.635*	*253,470*	*227,876*	*90%*	*N/A*	$\hat{t}_{y,r}$
	Mid Region- Deep	*45*	*0*	*-*	*-*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Mid Region-Mid	*5,074*	*10*	*0.011*	*1.418*	*7,195,848*	*5,984,849*		*N/A*	$\hat{t}_{y,r}$
	Mid Region- Shallow	*6,487*	*210*	*0.174*	*1.424*	*9,236,065*	*2,510,522*	*27%*	*N/A*	$\hat{t}_{y,r}$
	Southern Region- Deep	*390*	*4*	*0.003*	*0.000*	*0*	*0*		*N/A*	$\hat{t}_{y,r}$
	Southern Region- Mid	*9,301*	*14*	*0.014*	*0.000*	*0*			*N/A*	$\hat{t}_{y,r}$
	Southern Region- Shallow	*932*	*28*	*0.022*	*0.137*	*127,631*	*94,323*	*74%*	*N/A*	$\hat{t}_{y,r}$
	Artificial	7,763	84		16	123,377	20,125	16	N/A	$\hat{t}_{y,mpu}$
	Total		832			47,044,415	10,300,910	22	N/A	
Pipelines (Gulf-wide)		26,686 linear km	27	0.49	0.021	546,988	358,761	64	N/A	$\hat{t}_{y,r}$
Gulf of Mexico						**92,113,006**				
TX, MS, AL, FL						73,535,963	13,942,031	15	15	
Louisiana*						18,577,043	4,349,479	23	39	

47 Million

Key Takeaways:

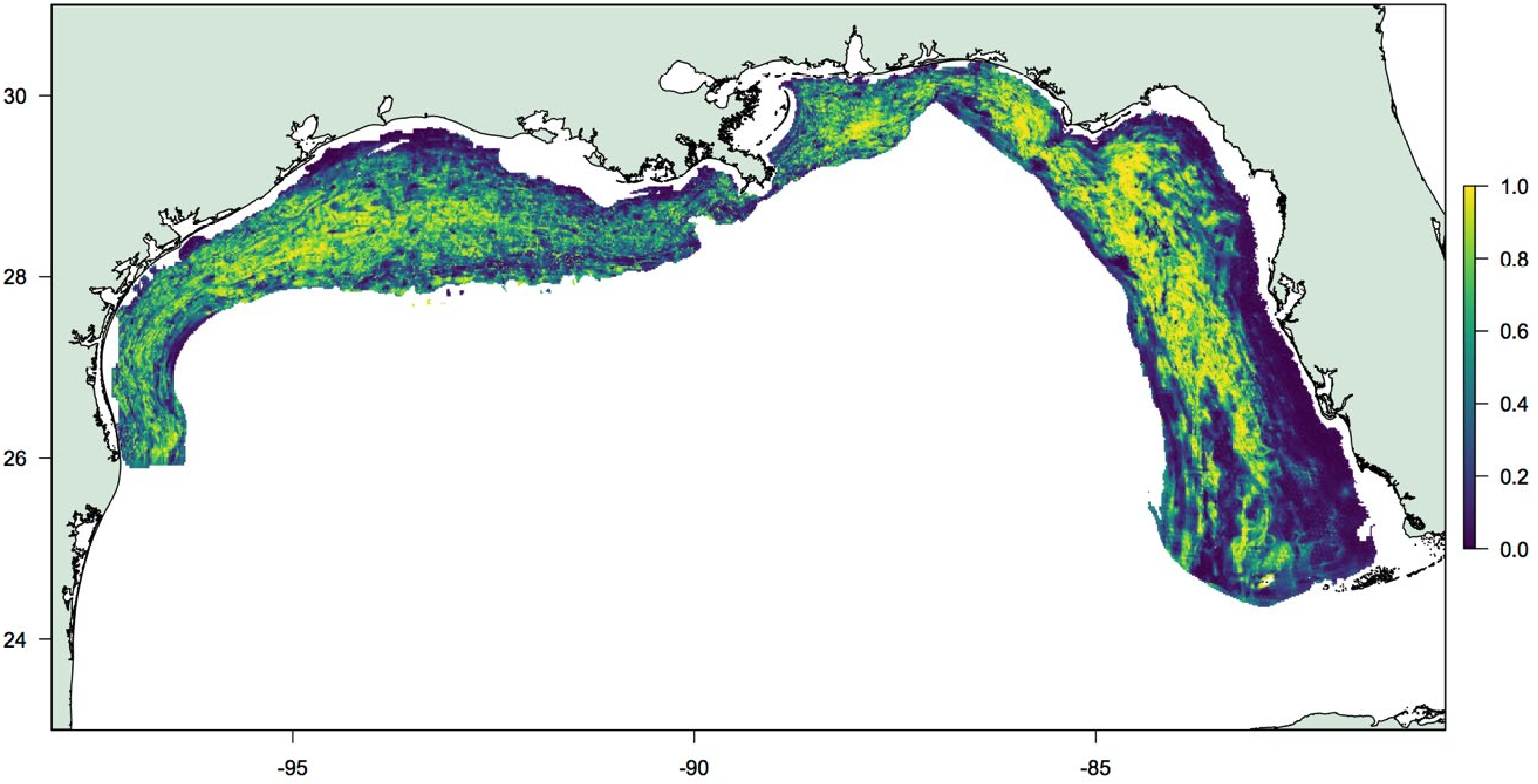
- Report had undergone an exceptionally rigorous peer-review.
- Fully met the concerns of the external review team and SSC.
- Estimate is conservative and likely underestimates abundance.
- Visual/detectability constraints generally lead to underestimate.
- Habitat types are not known with certainty – improved mapping.
- Known populations occur outside of defined study area.

Acknowledgements

- Steering Committee
- Dr. LaDon Swann

External Reviewers:

- Mary Christman
- Steve Cadrin
- David Eggleston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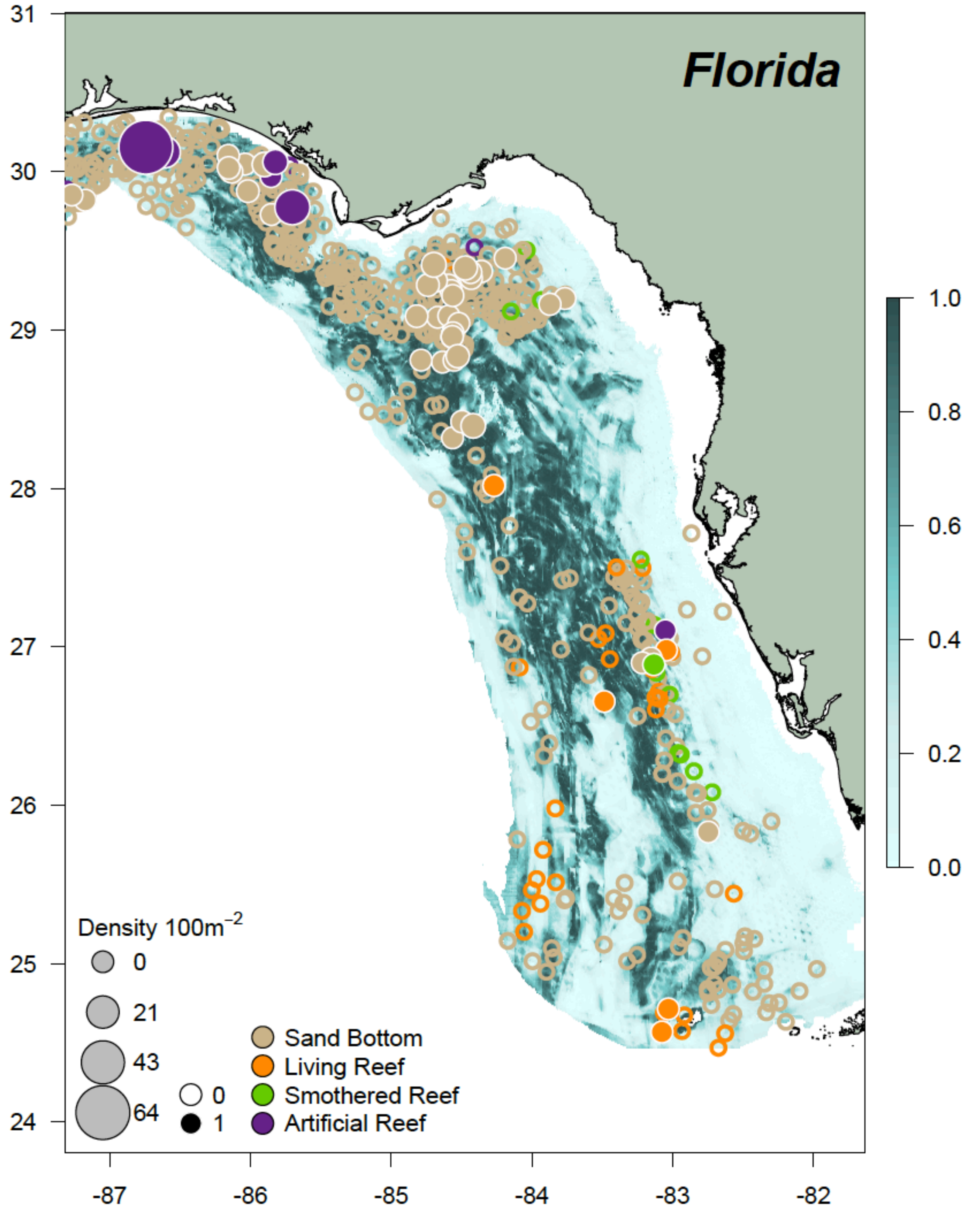
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43
64
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1
Sand Bottom
Living Reef
Smothered Reef
Artificial Reef