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Spatial distribution of commercial and recreational red snapper catch to provide options for determining fraction of 'fishable' biomass revised 4.2.2021 (updated 12/28/2021)

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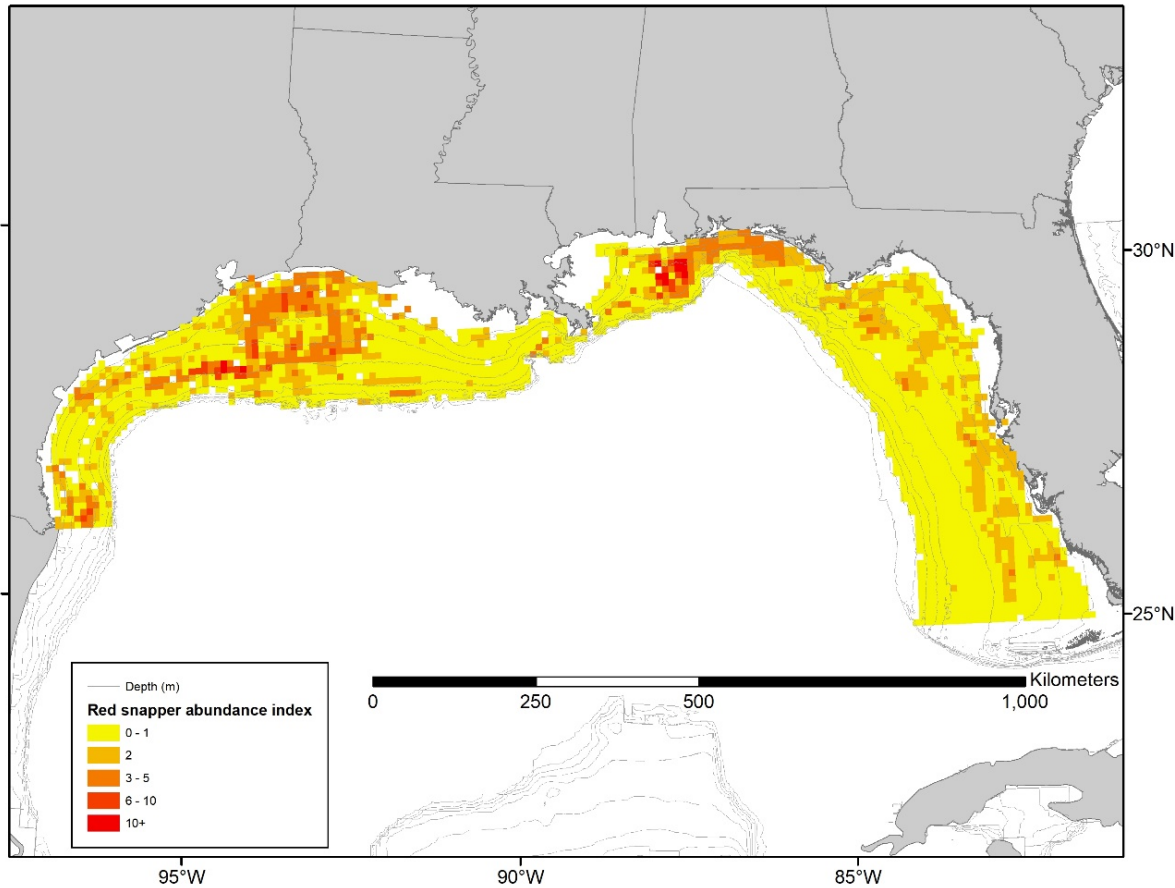
12/28/2021

Gulf of Mexico SSC meeting

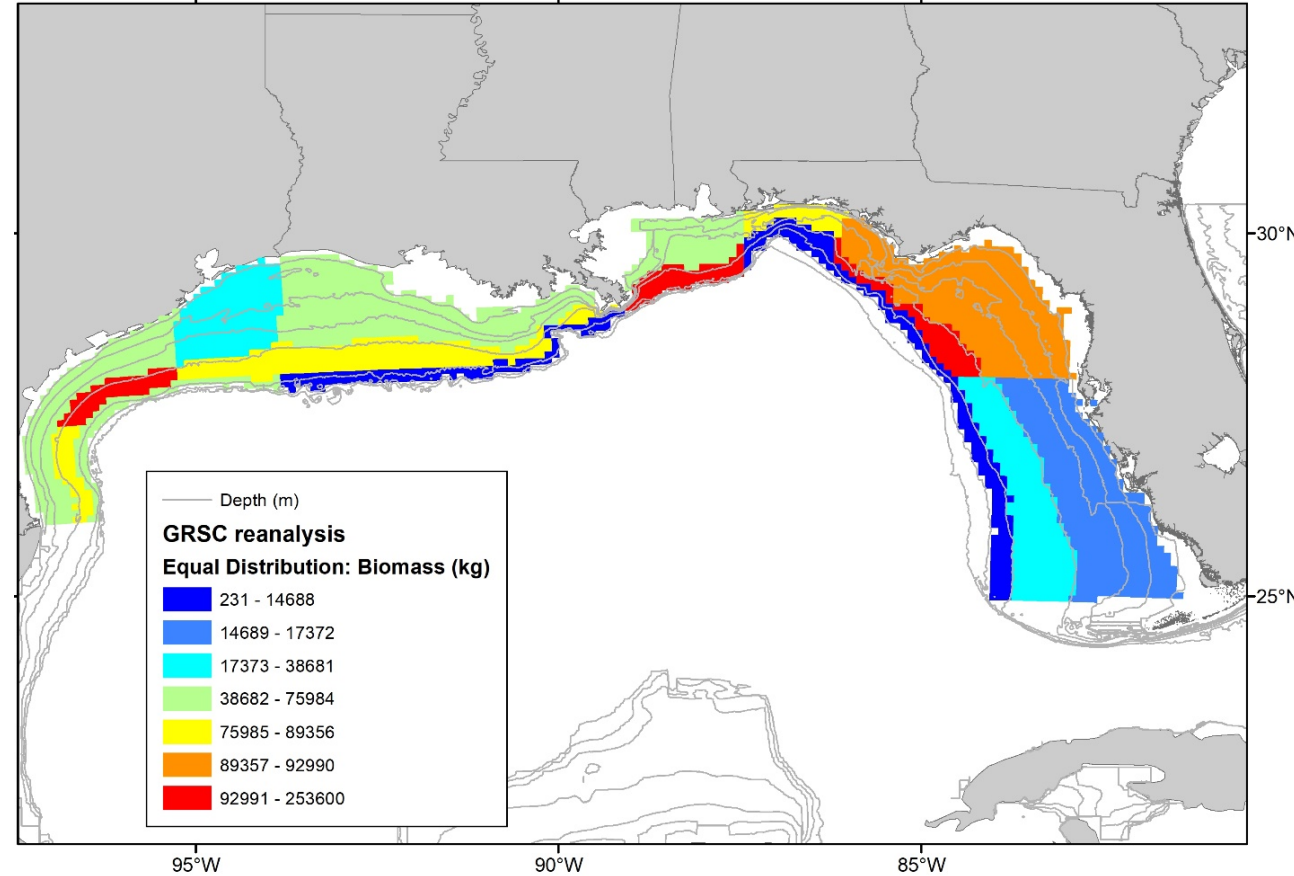
Three objectives

1. Distribution of biomass
2. Distribution of catch and effort
3. Identifying extent of 'fished' biomass on UCB

Karnauskas et al spatial mapping



GRSC spatial mapping



Mandy Karnauskas, John F. Walter III, Matthew D. Campbell, Adam G. Pollack, J. Marcus Drymon & Sean Powers (2017) Red Snapper Distribution on Natural Habitats and Artificial Structures in the Northern Gulf of Mexico, *Marine and Coastal Fisheries*, 9:1, 50-67.

Objectives

Map commercial catch and effort using reef fish vertical line VMS matched to landings.

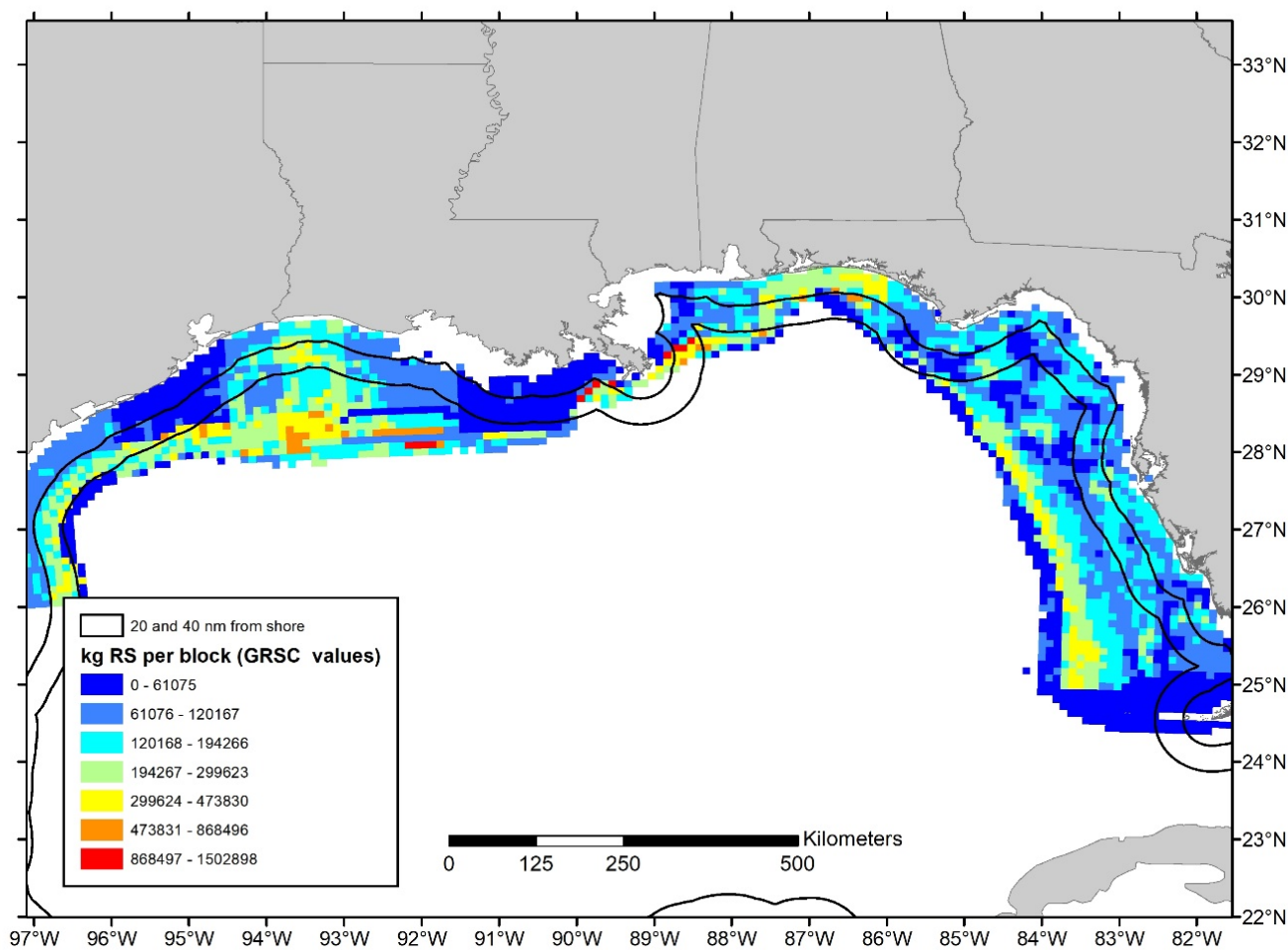
Map recreational catch and effort using FWRI and state data

Overlay with 'best' spatial map of red snapper relative abundance, raised to GRSC numbers (92 million)

Identify the fraction of 'fished' biomass, defined as having estimated exploitation rate $> 0.01\%$

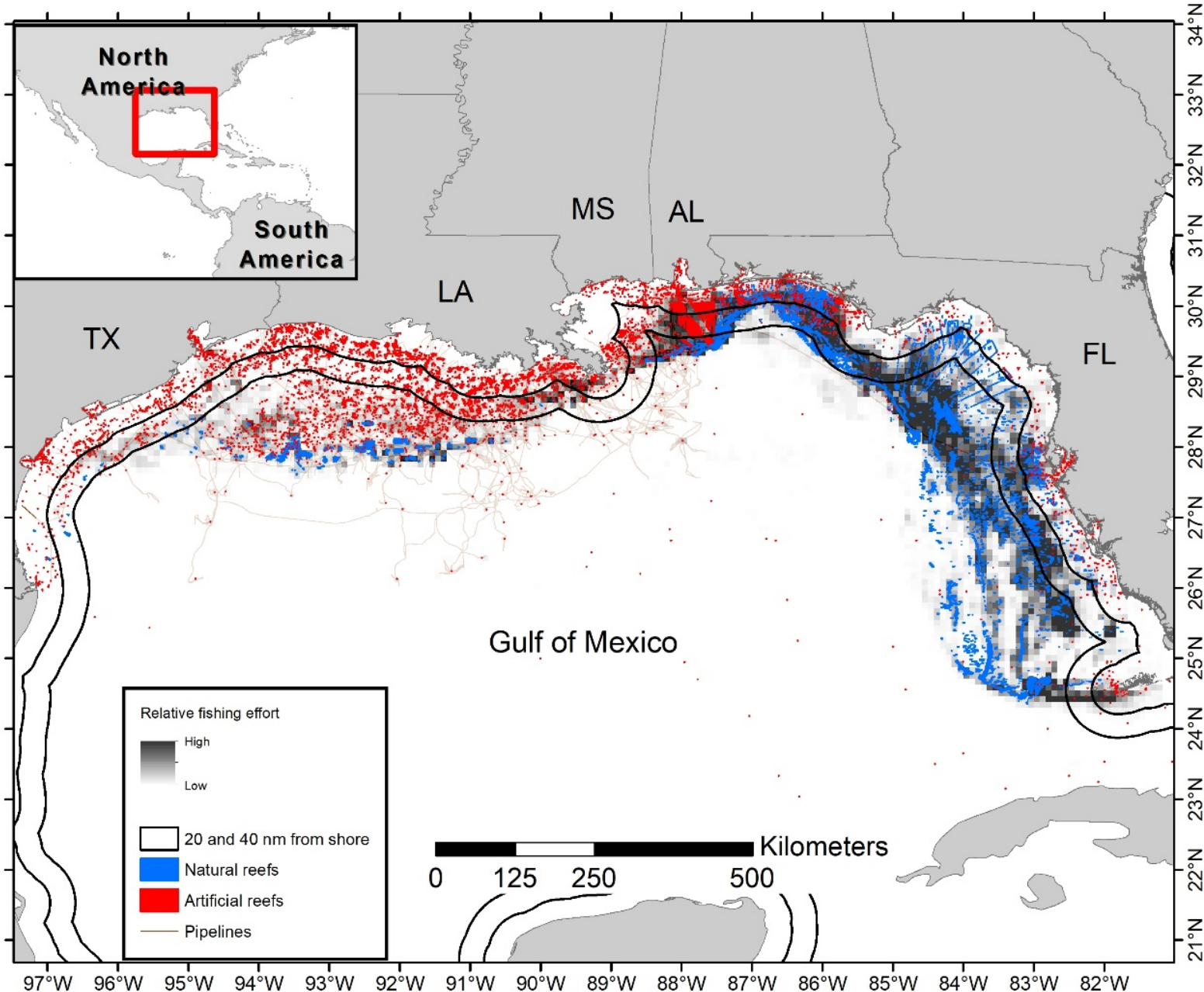
Relative biomass maps from Karnauskas et al raised to GRSC abundance

Biomass (GRSC totals (92 million) converted to kg) applied to Karnauskas et al. 2017 state specific red snapper distribution patterns



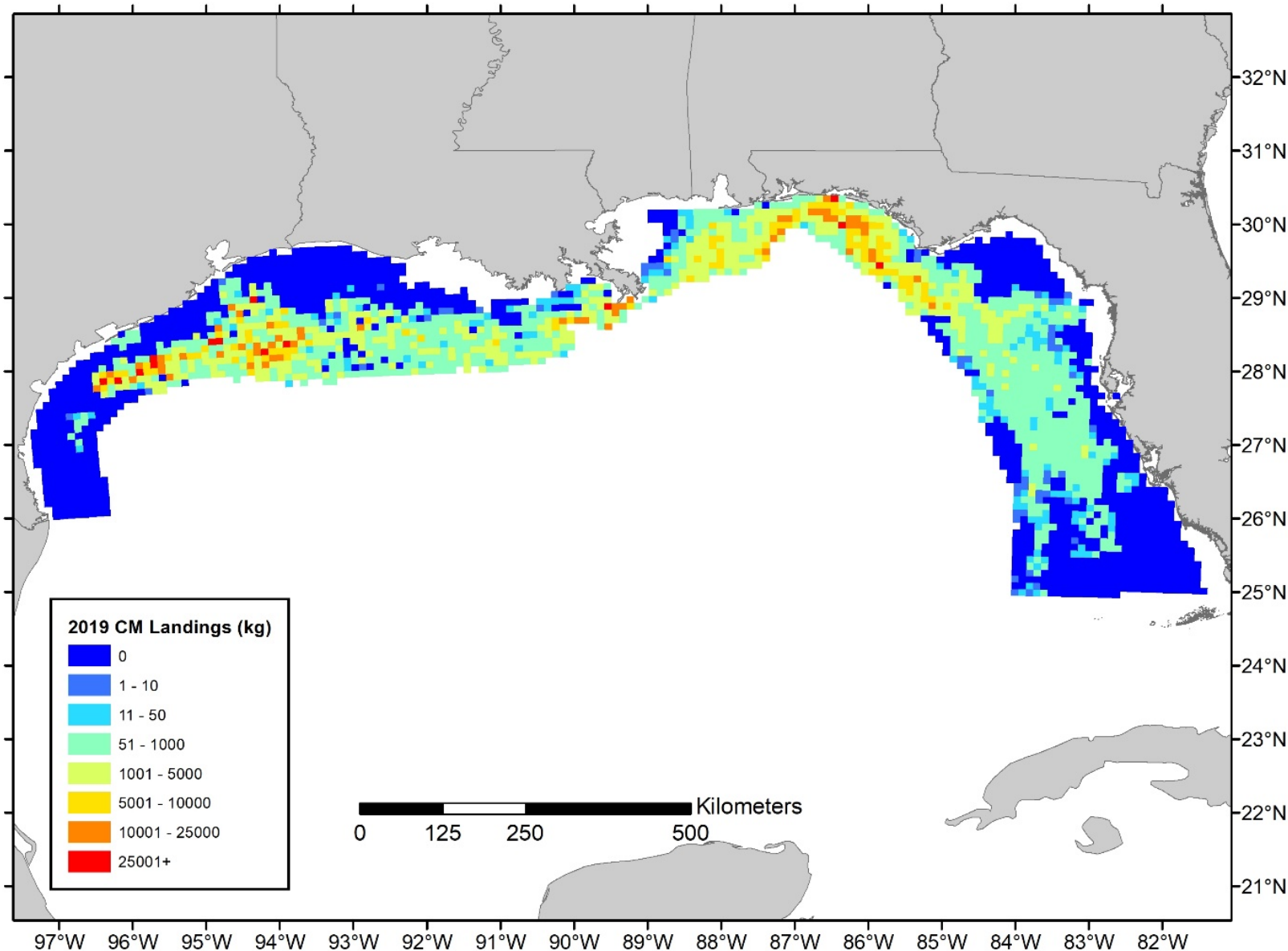
State/Region	Habitat Type	Area (km ²) or Structures	Number of Samples (n)	Area Sampled (km ²)	Mean Density (100m ²) or by Structure	Number
TX	Natural	1,570	36	6.13		5,218,915
	Deep	209	11		0.09	178,682
	Mid	953	22		0.35	3,381,753
	Shallow	409	3		0.41	1,658,480
	Artificial	12,010	31			706,327
	Pyramids	10,902	13		11	125,300
	Non-Pyramids	1,108	18		524	581,027
	Uncharacterized Bottom	57,535	140	6.22		10,332,018
	Deep	4,034	4	1.35	0.002	71,460
	Mid-North	8,765	39	1.75	0.015	747,705
	Mid-Central	6,450	22	1.05	0.033	2,159,374
	Mid-South	6,503	16	0.92	0.005	340,824
	Shallow- North	17,036	36	0.51	0.014	2,335,968
	Shallow- Central	8,951	15	0.38	0.038	3,367,881
	Shallow- South	5,797	8	0.25	0.023	1,308,806
Total			198			16,257,260
LA	Natural	821	22	N/A		3,683,745
	Deep	105	6		0.14	151,361
	Mid & Shallow	716	16		0.49	3,532,384
	Artificial	1,771	42			3,849,325
	Deep	93	7		710	66,046
	Mid	602	29		1,399	842,219
	Shallow	1,076	6		2,733	2,941,060
	Uncharacterized Bottom	53,052	65	2.42		11,043,973
	Deep	5,348	3	0.68	0.01	406,320
	Mid	19,077	11	0.85	0.02	3,756,598
	Shallow	28,627	51	0.89	0.02	6,881,055
Total			129			18,577,043
AL/MS	Natural	211	32	0.01	1.78	3,751,988
	Artificial	9,410	128		160	1,509,625
	Uncharacterized Bottom	18,500	3	0.74	0.02	4,425,687
	Total		163			9,687,300
FL	Natural & Uncharacterized	143,538	748	0.61		46,921,038
	Red Snapper low probability	92,616				14,633,325
	NW Region- Deep	1,557	13	0.009	0.000	0
	NW Region- Mid	1,148	17	0.014	0.007	81,238
	NW Region- Shallow	2,009	23	0.024	0.000	0
	Mid Region- Deep	3,295	2	0.001	0.000	0
	Mid Region- Mid	3,013	0	-	-	0
	Mid Region- Shallow	19,460	77	0.052	0.271	5,265,679
	Southern Region- Deep	9,871	15	0.010	0.000	0
	Southern Region- Mid	18,358	13	0.013	0.315	5,786,192
	Southern Region- Shallow	33,905	53	0.048	0.104	3,520,216
	Red Snapper probable	28,065				15,454,698
	NW Region- Deep	98	7	0.005	0.211	20,614
	NW Region- Mid	693	7	0.006	0.000	0
	NW Region- Shallow	1,145	11	0.008	1.847	2,115,089
	Mid Region- Deep	419	2	0.001	0.000	0
	Mid Region- Mid	4,026	10	0.009	1.057	4,256,027
	Mid Region- Shallow	8,030	138	0.107	1.021	8,199,695
	Southern Region- Deep	1,928	6	0.004	0.000	0
	Southern Region- Mid	9,383	10	0.016	0.000	0
	Southern Region- Shallow	2,343	49	0.038	0.368	863,273
	Red Snapper high probability	22,858				16,813,015
	NW Region- Deep	8	6	0.004	0.000	0
	NW Region- Mid	220	5	0.004	0.000	0
	NW Region- Shallow	399	18	0.016	0.635	253,470
	Mid Region- Deep	45	0	-	-	0
	Mid Region- Mid	5,074	10	0.011	1.418	7,195,848
	Mid Region- Shallow	6,487	210	0.174	1.424	9,236,065
	Southern Region- Deep	390	4	0.003	0.000	0
	Southern Region- Mid	9,301	14	0.014	0.000	0
	Southern Region- Shallow	932	28	0.022	0.137	127,631
	Artificial	7,763	84		16	123,377
Total			832			47,044,415
Pipelines (Gulf-wide)		26,686 linear km	27	0.49	0.021	546,988
Gulf of Mexico						92,113,006
TX, MS, AL, FL						73,535,963
Louisiana*						18,577,043

Estimating commercial reef fish (vertical line) effort



- Vessel Monitoring System (VMS) provides a dataset of time stamped “pings” that show Latitude and Longitude, speed, course, vessel characteristics, etc.
- Algorithms outlined in O’Farrell et al. to predict fishing and steaming.
- Restricted to GOM vertical line fishery
 - ~96% of commercial RS landings (SERO 2020)
- Merged in GIS w/structure (Natural or artificial (reef, platform, wreck or pipeline))
 - Queried the data to match to any habitat within 250m (100m of AR’s (Reynolds 2015), added additional buffer for inaccuracies in VMS and mapping products

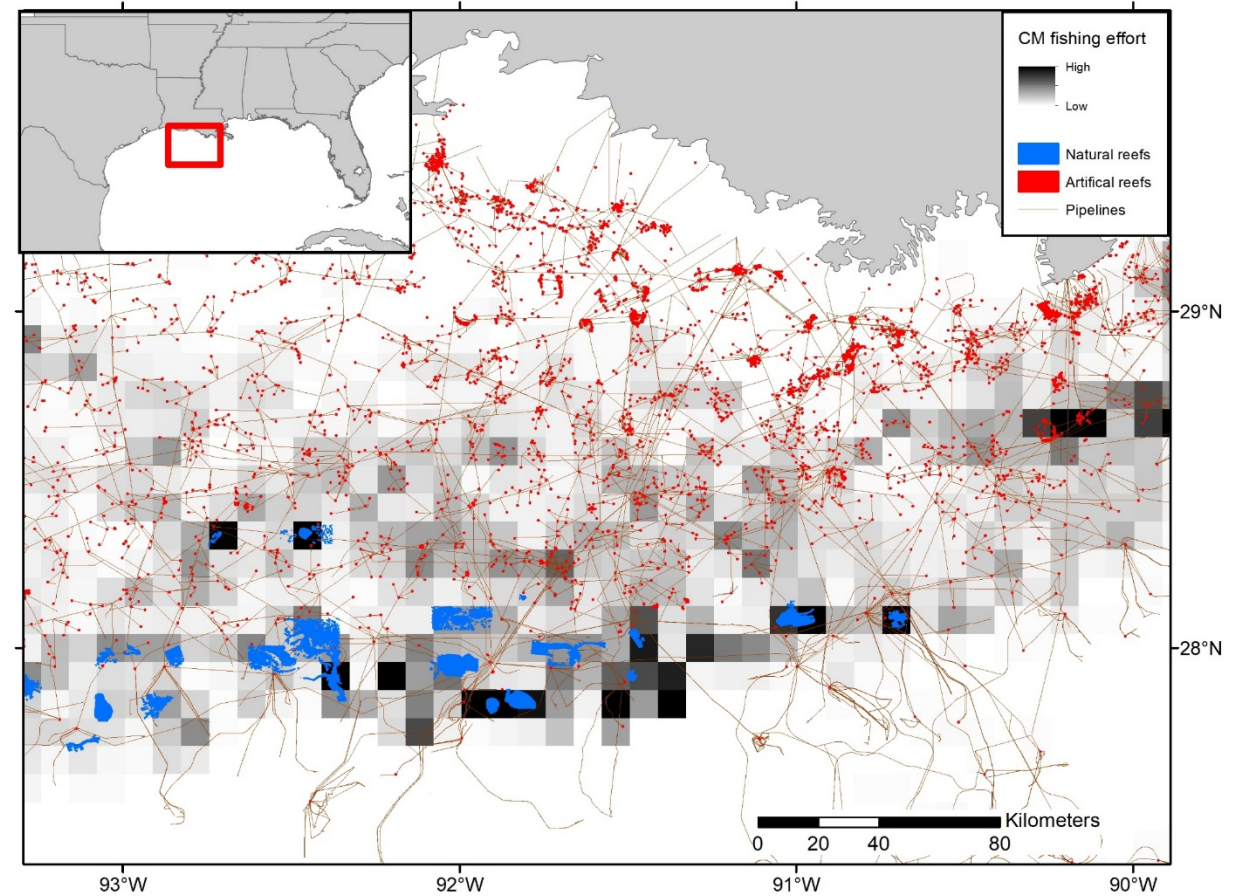
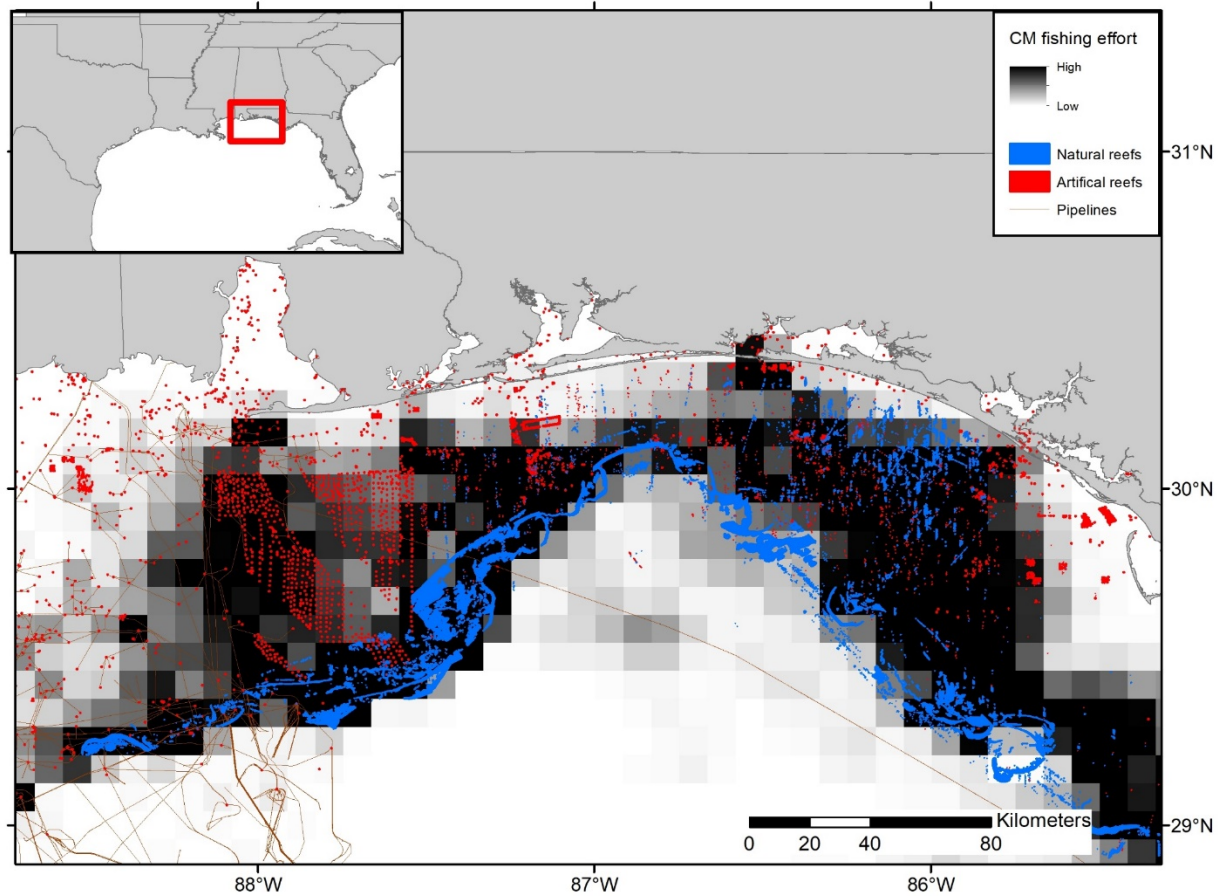
Estimating commercial red snapper catch in space



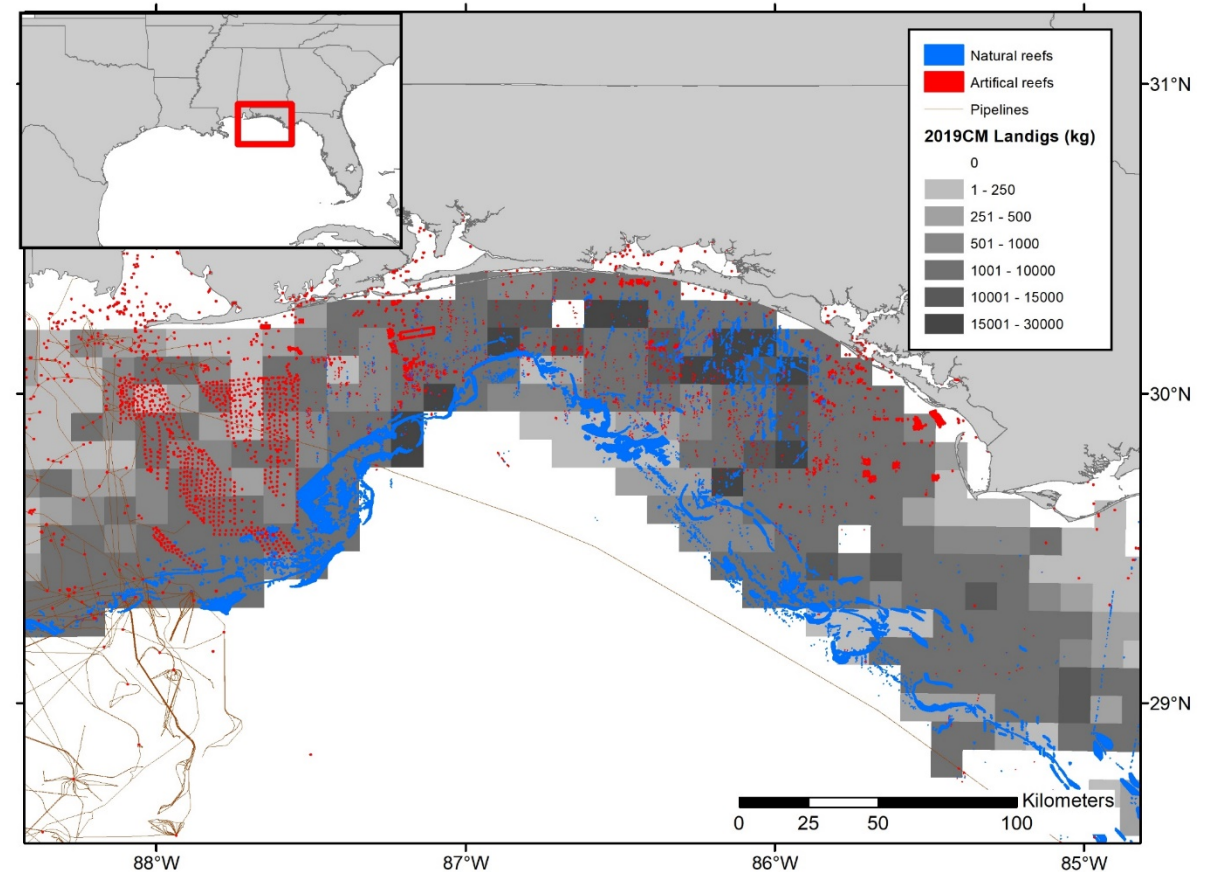
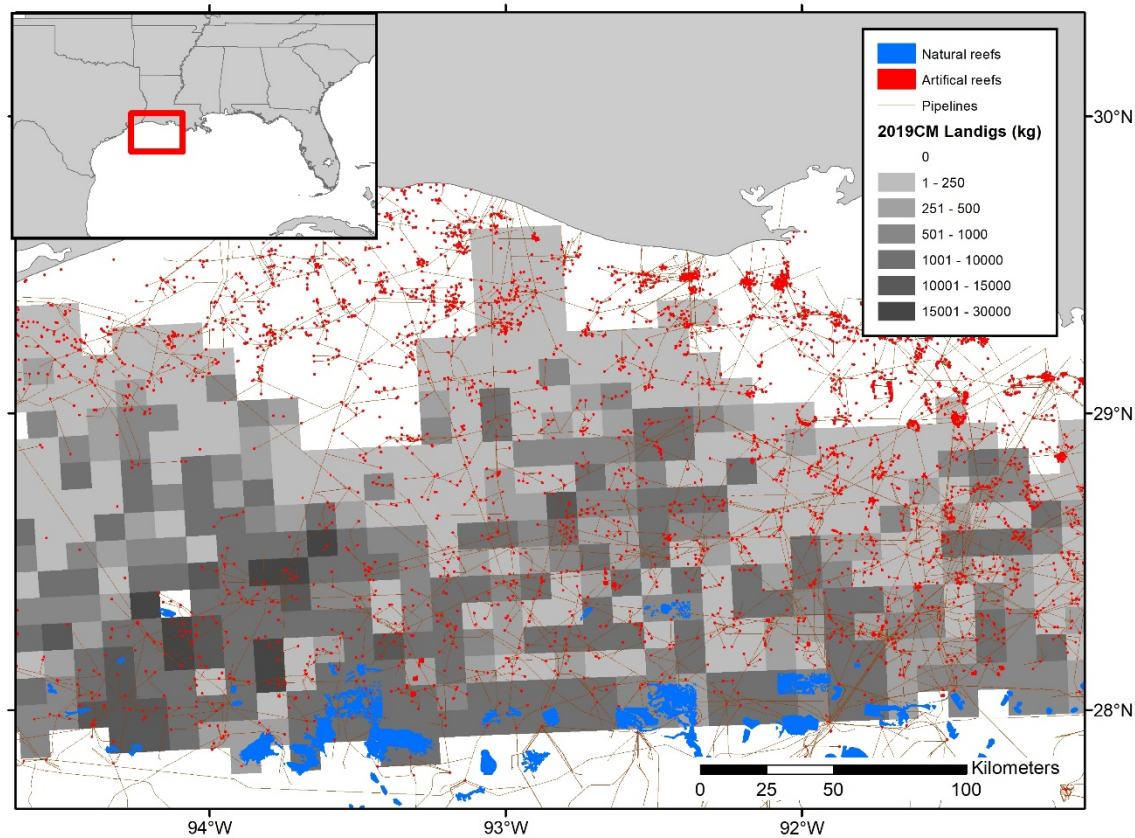
- Matched VMS data (proportion of habitat fished) with dockside Trip Interview Program (TIP) landings
- Calculated trip level CPUE, applied to individual fishing points in 10x10 km blocks.
- Landings estimated by proportion of trip per block

From Gardner et al. in review.

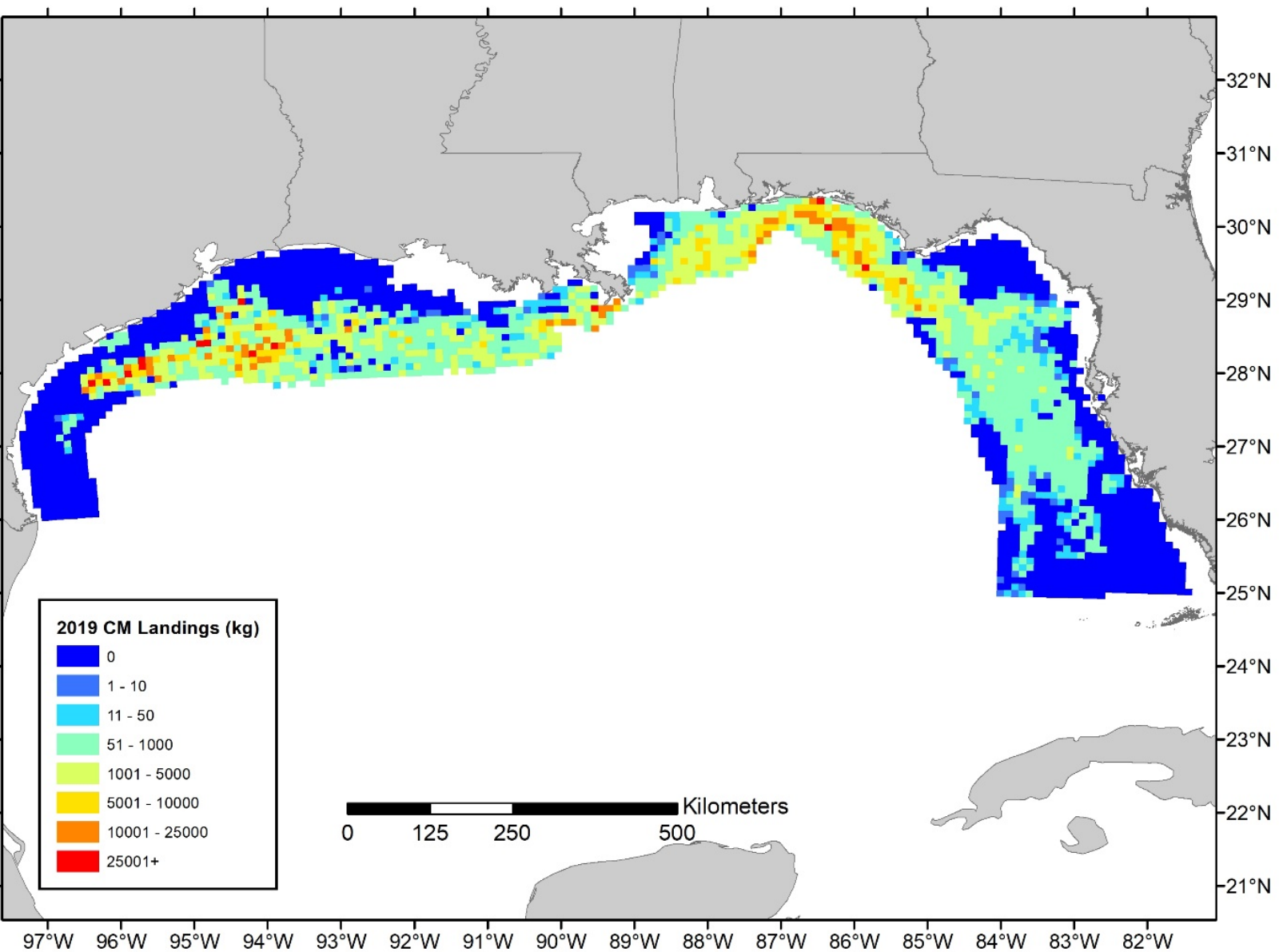
Distribution of VMS effort



Distribution of commercial landings



Spatially explicit landings (Commercial only)



From Gardner et al. in review.

Table 2. Annual Gulf wide estimates of red snapper proportion of landings by structure (NR=Natural reef, AS=Artificial Structure, UNK=Unknown) along with mean proportion (across all years) of catch per habitat from the VMS-TIP linked trips ($x \pm 95\%$ CI are provided in parenthesis). Values are provided for the VMS-TIP non-extrapolated data set along with the VMS-TIP extrapolated data set (i.e., columns starting with 'Ext_'; see text for a full description of the methods used to derive both sets of values).

Year	NR	AS	UNK	Ext NR	Ext AS
2011	0.29	0.17	0.54	0.69	0.31
2012	0.21	0.24	0.55	0.54	0.46
2018	0.19	0.3	0.51	0.5	0.5
2019	0.19	0.28	0.53	0.51	0.49
Mean	0.22±0.07	0.25±0.09	0.53±0.03	0.54±0.14	0.46±0.14

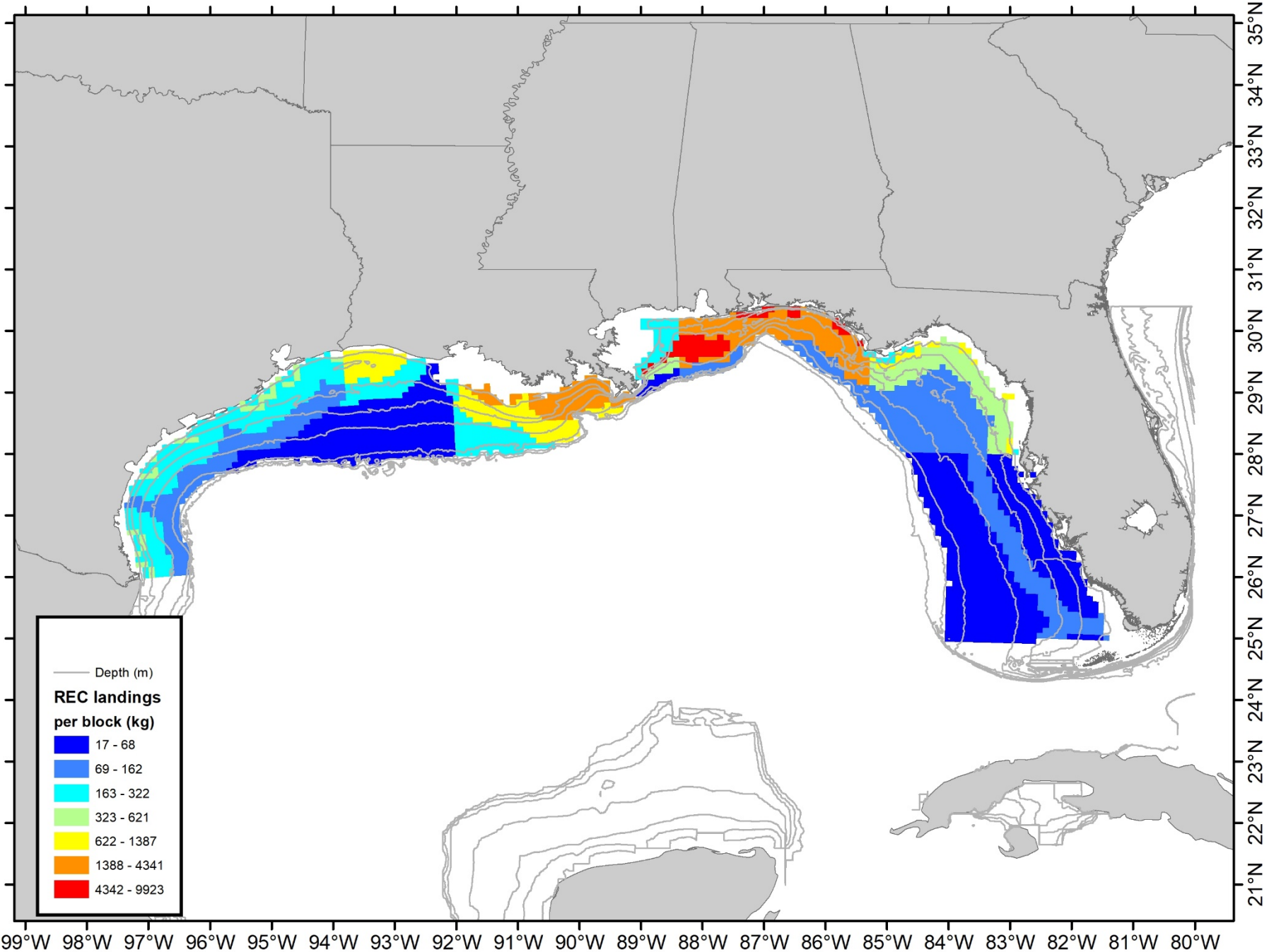
Spatial allocation of catch to recreational sector

State specific estimates and variables for proportion of catch

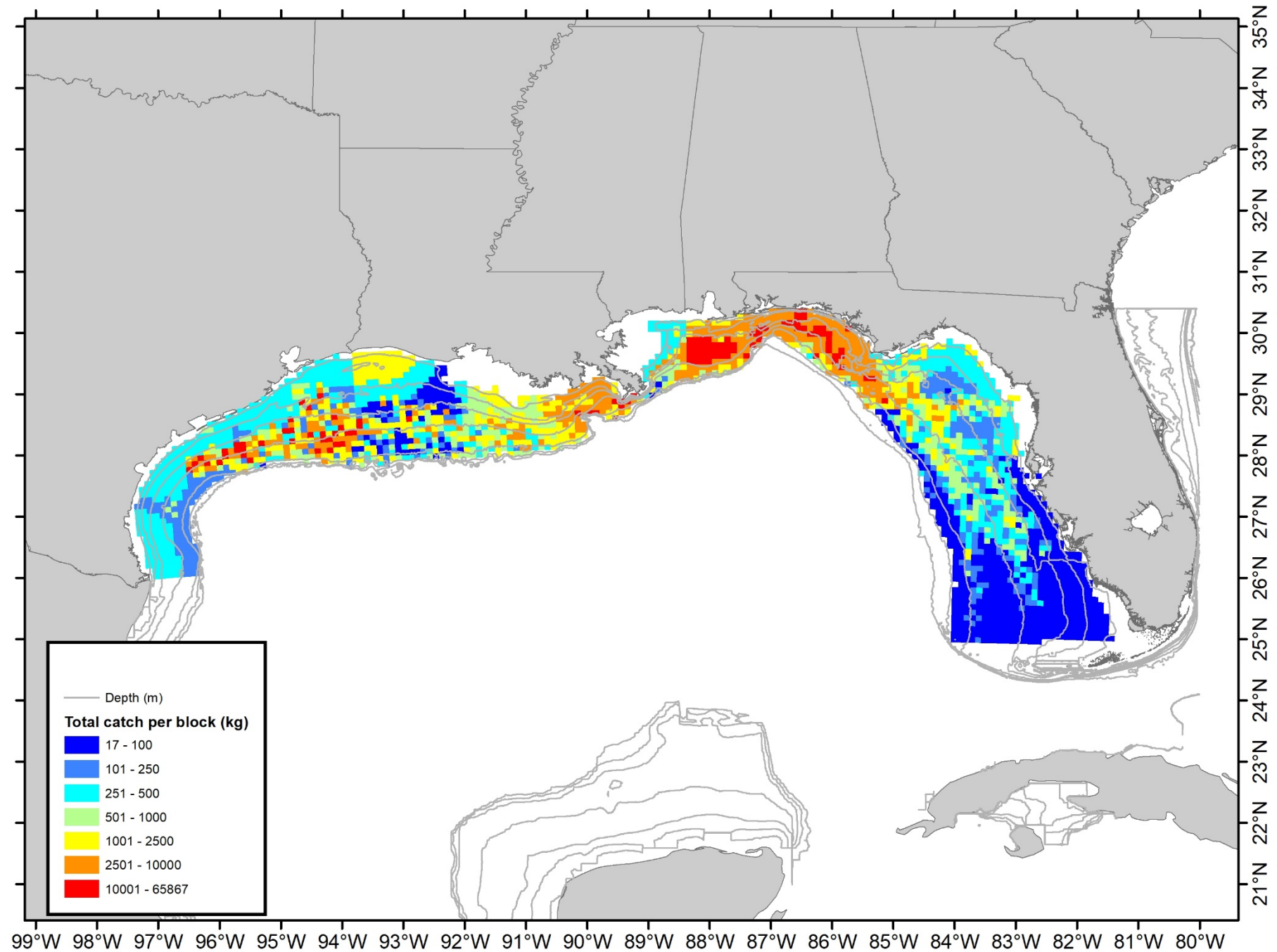
Variables included distance from pass, depth, region

- FL:
 - Observer data (charter and headboat)
 - State Reef Fish Survey dockside interviews (private boats)
 - Treated as two fleets and allocated by catch/region as well then combined by proportion of REC catch
- AL/MS
 - AL provided proportion of catch by depth
 - Used same depth structure for MS
- LA
 - LA creel data used to assign proportion of catch in E LA v W LA.
 - Applied TX iSnapper point data to provide proportion of fishing by distance to pass
- TX
 - iSnapper point data
 - Estimated proportion of catch by distance to pass

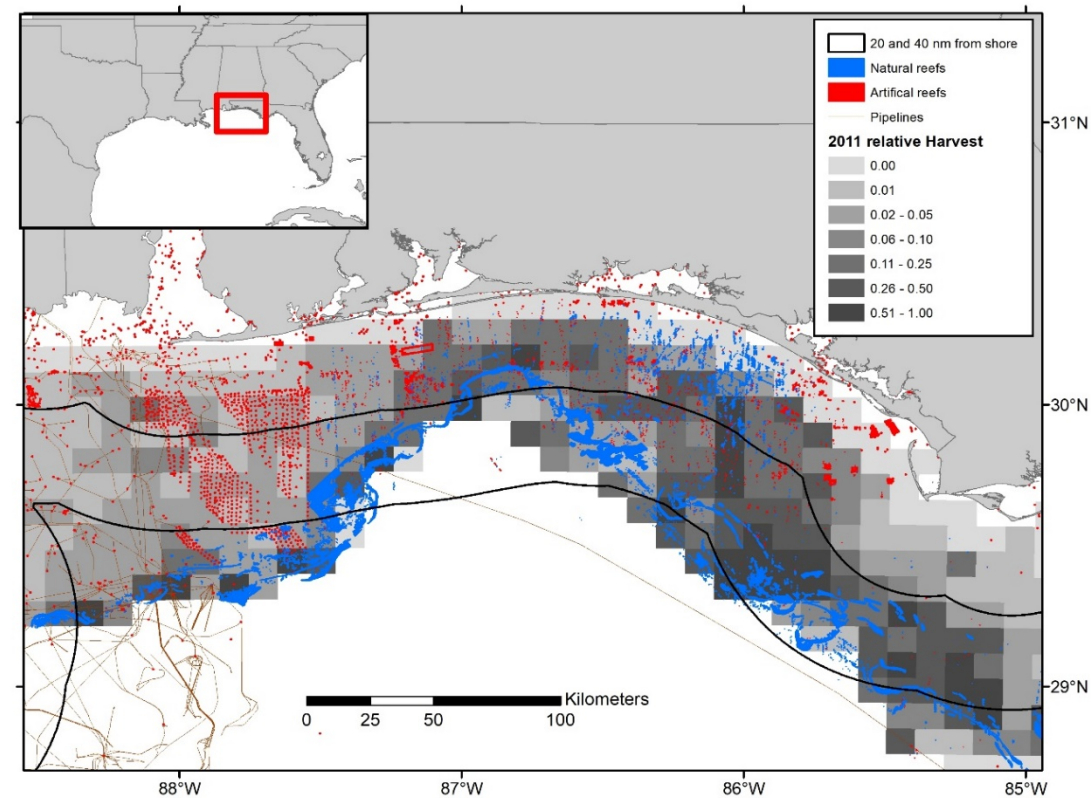
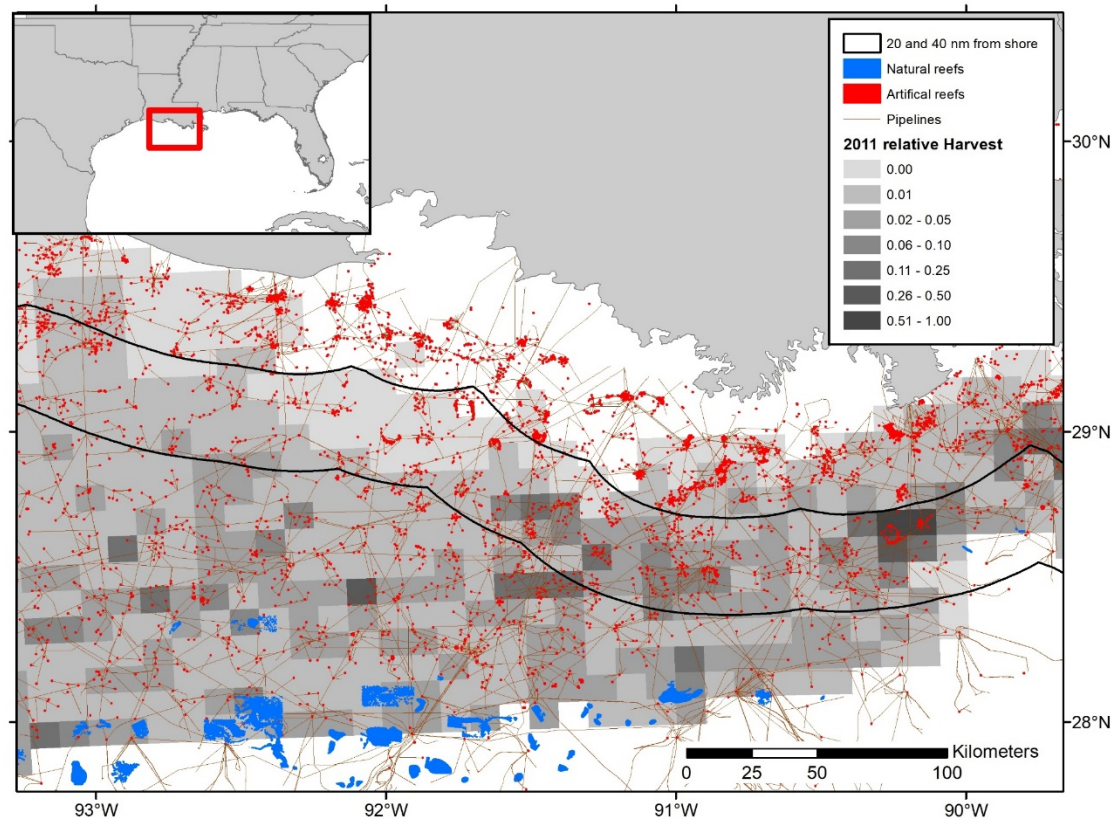
2019 REC landings
estimates based on
data outlined
previously per 10x10km
block



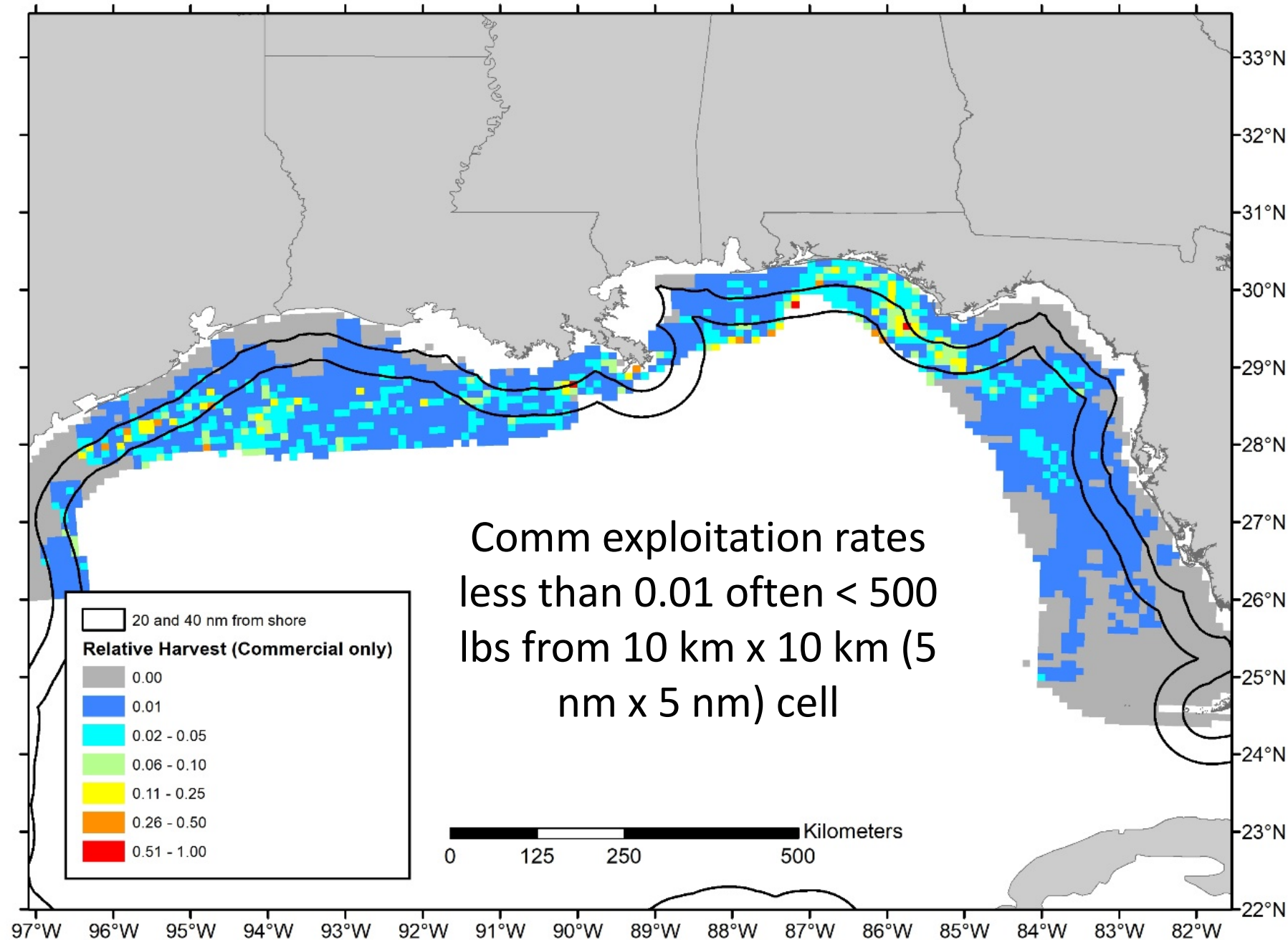
2019 recreational
and commercial
landings estimates
(summed together
in space)



Relative exploitation rate per block calculated by dividing estimated catch per block/biomass



Relative exploitation rates

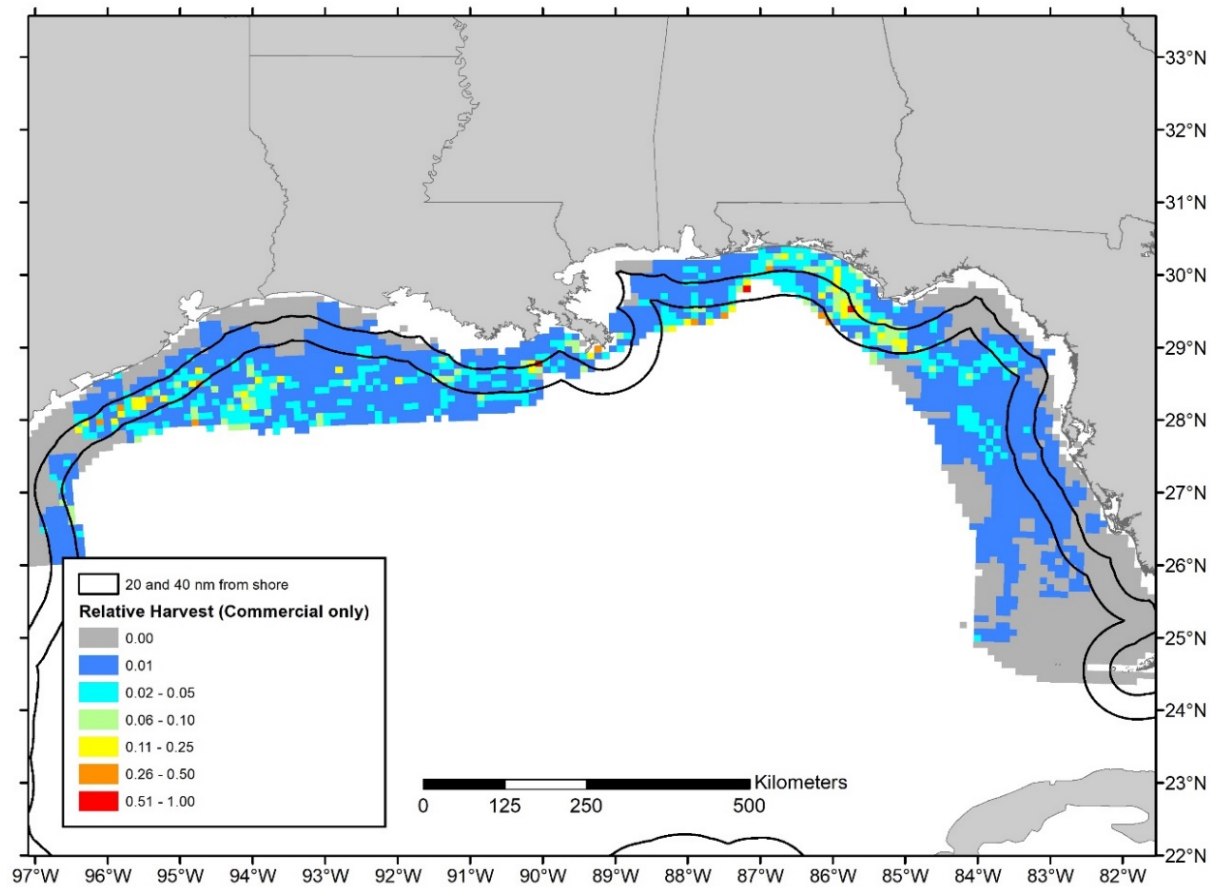


Commercial estimate calculations:

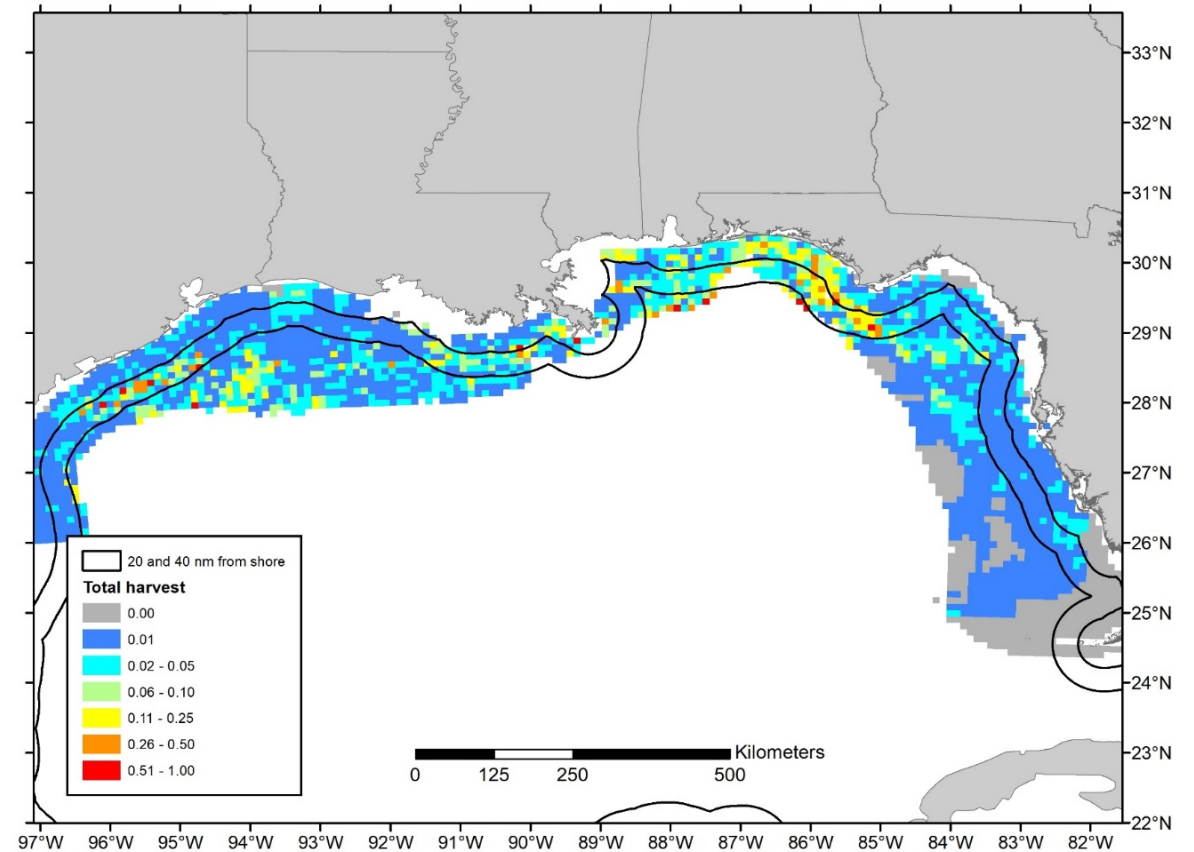
1. Estimated catch and effort by structure
2. Subtracted exploitation out from known structures.
3. Remainder exploitation assumed to be on UCB

Relative exploitation rates

Commercial exploitation rates

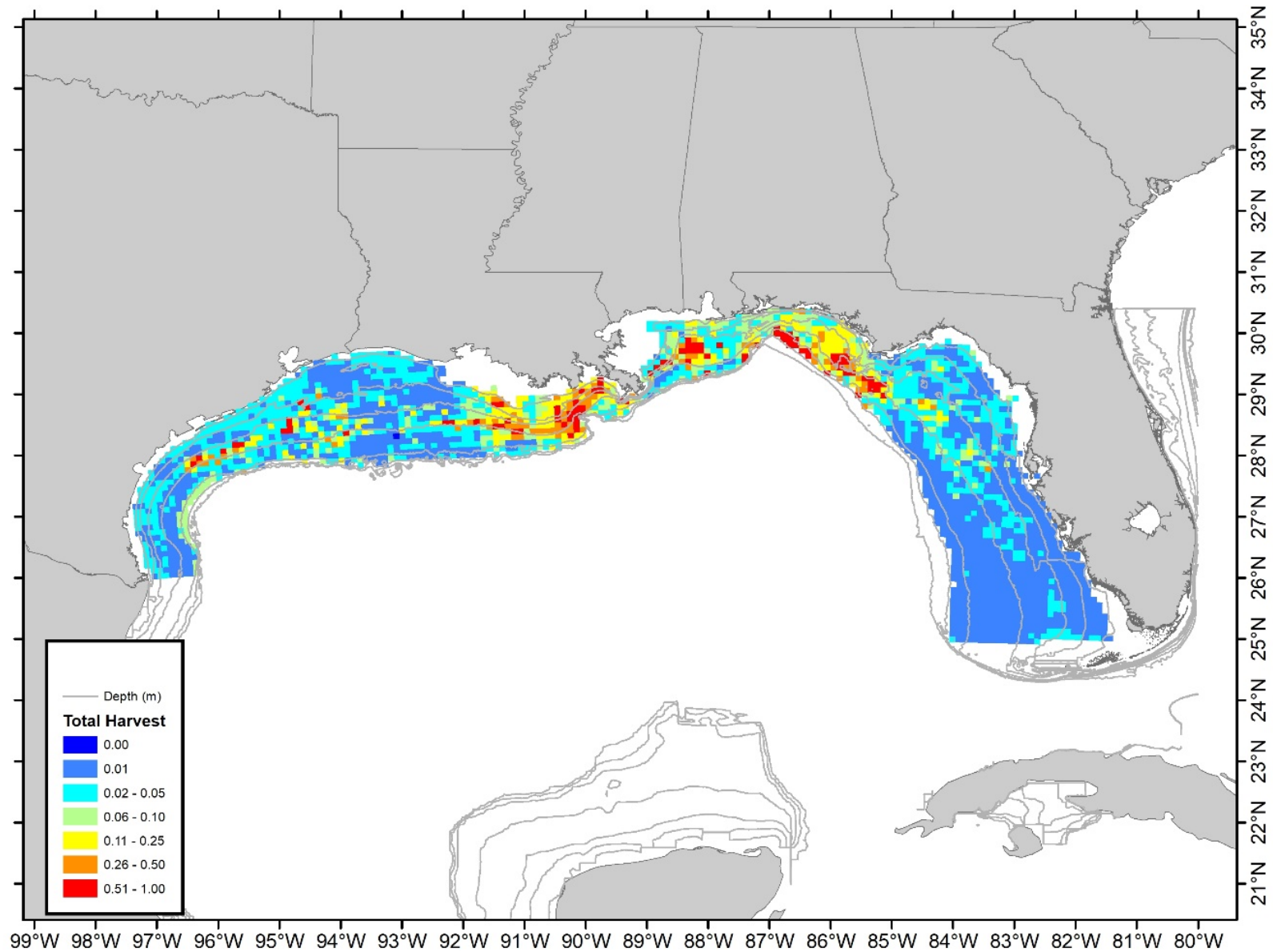


Recreational exploitation rates



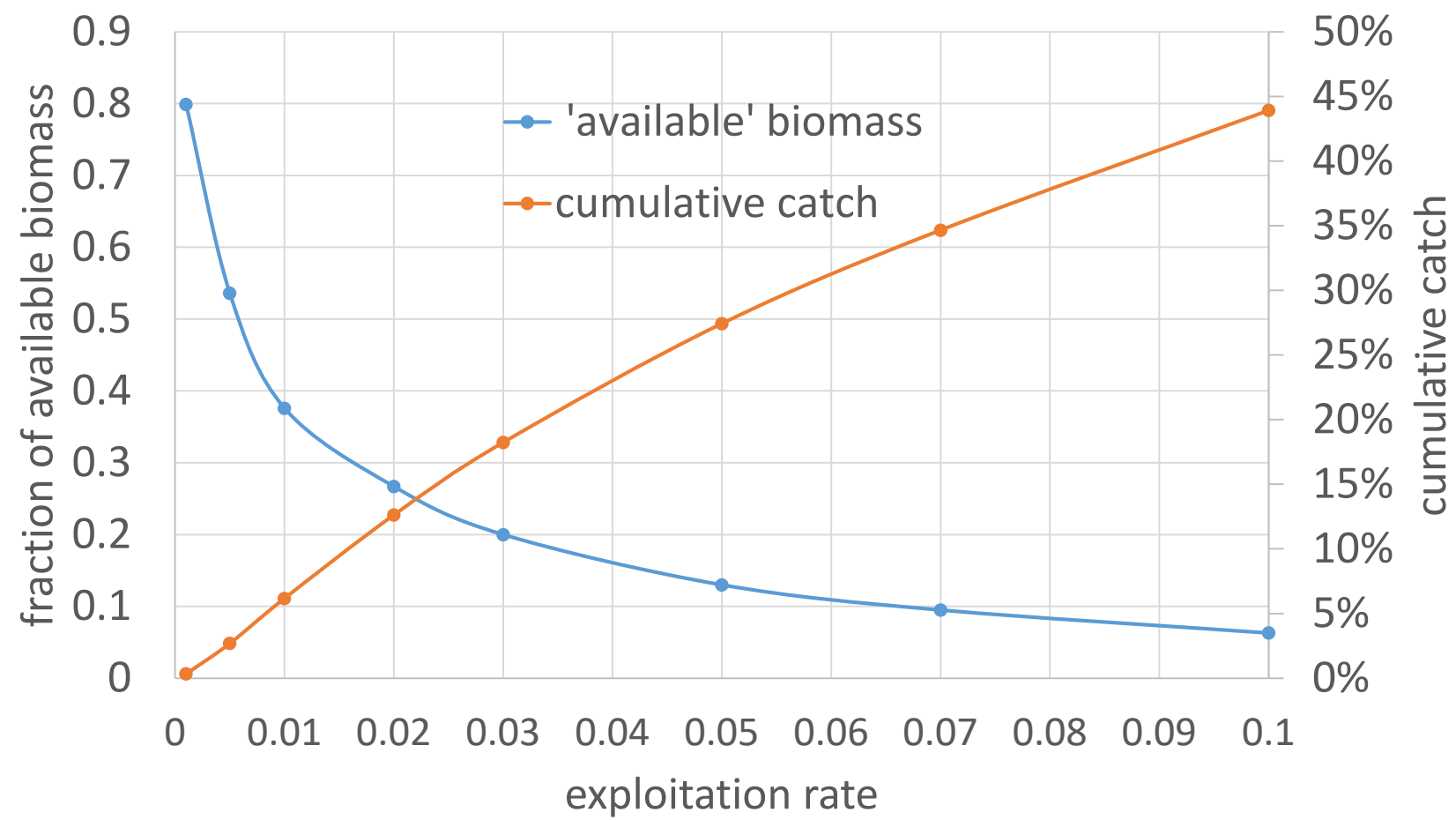
Commercial +
Recreational
exploitation rate
2019
(catch/biomass)

Harvest rates >
0.01% assumed
'fishable'

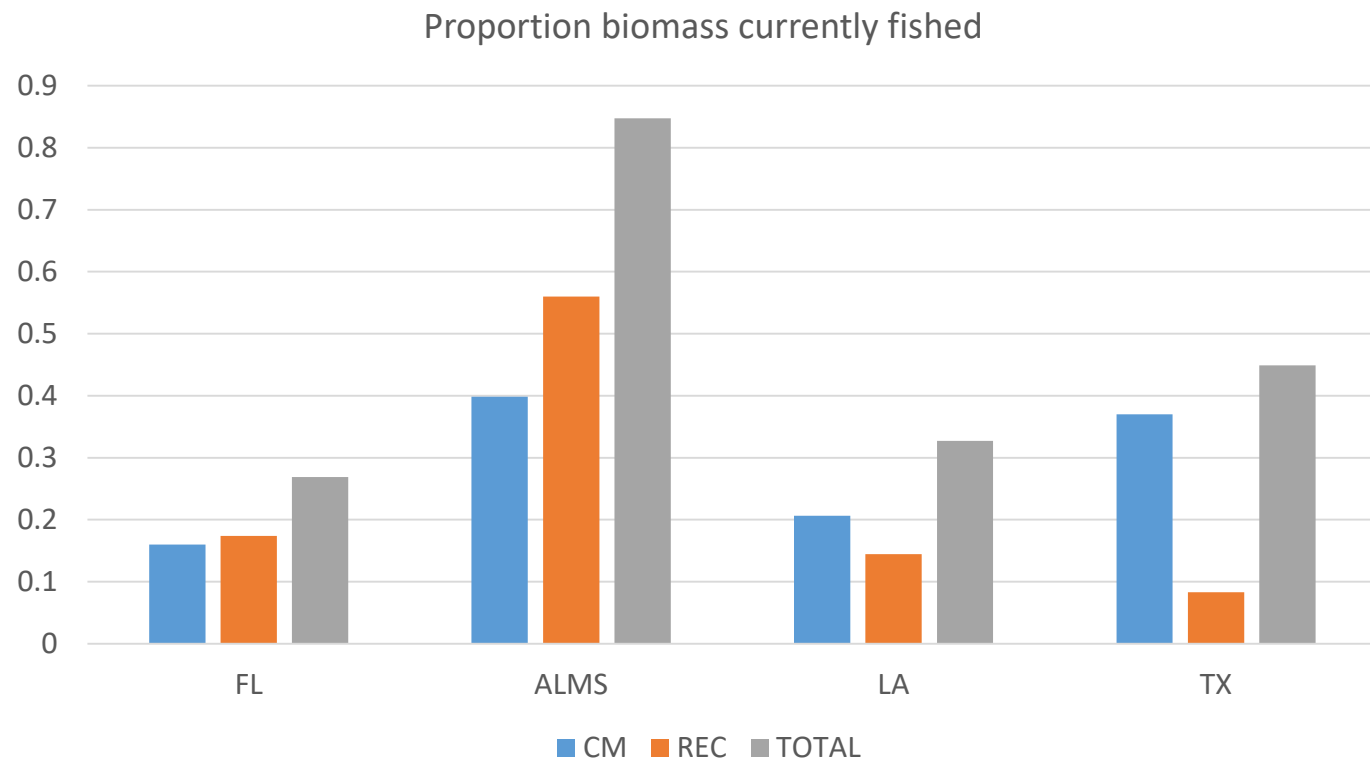


Overall: .376 of biomass in currently fished areas

NEW: Fraction of available biomass and cumulative catch



Assuming that biomass that experiences less than 0.01% exploitation would then mean that we account for 94% of the total catch



	FL	ALMS	LA	TX	GOM Total
TOTAL fishable	0.269	0.847	0.327	0.449	0.376
CM fishable	0.16	0.4	0.206	0.37	0.241
Rec fishable	0.174	0.56	0.144	0.083	0.179

Summary

- Previous (April 2021) best-guess of overall population vulnerable to status quo fishing distribution
 - 22% based on weighted average of rec (17%) and comm (26%)
 - preliminary and did not have recent recreational data
- Revised estimate ~37%
 - Based on summed comm and recreational catch.
 - This is likely an upper limit, given that we have not explicitly allocated recreational fishing to artificial structures
- Key take home is that the spatial mapping from the GRSC does not match Karnauskas
 - We could have estimated the exploitation rates based on the GRSC 'mapping' but low catches of red snapper occur in the areas (Big bend, 10-40 m) where a large fraction of the GRSC numbers are estimated to occur
 - There is substantial commercial and recreational effort in these areas, it just does not catch much red snapper



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Acknowledgements

Matt Smith and Latreese Denson (co-lead red snapper analysts), Shannon Cass-Calay and Kate Seigfried.

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