Understanding Essential Fish Habitat (EFH) of Queen and Cardinal Snappers and Associated Fish Communities of the Deep-Water Snapper Fishery: From Fishers' Knowledge to Scientific Language

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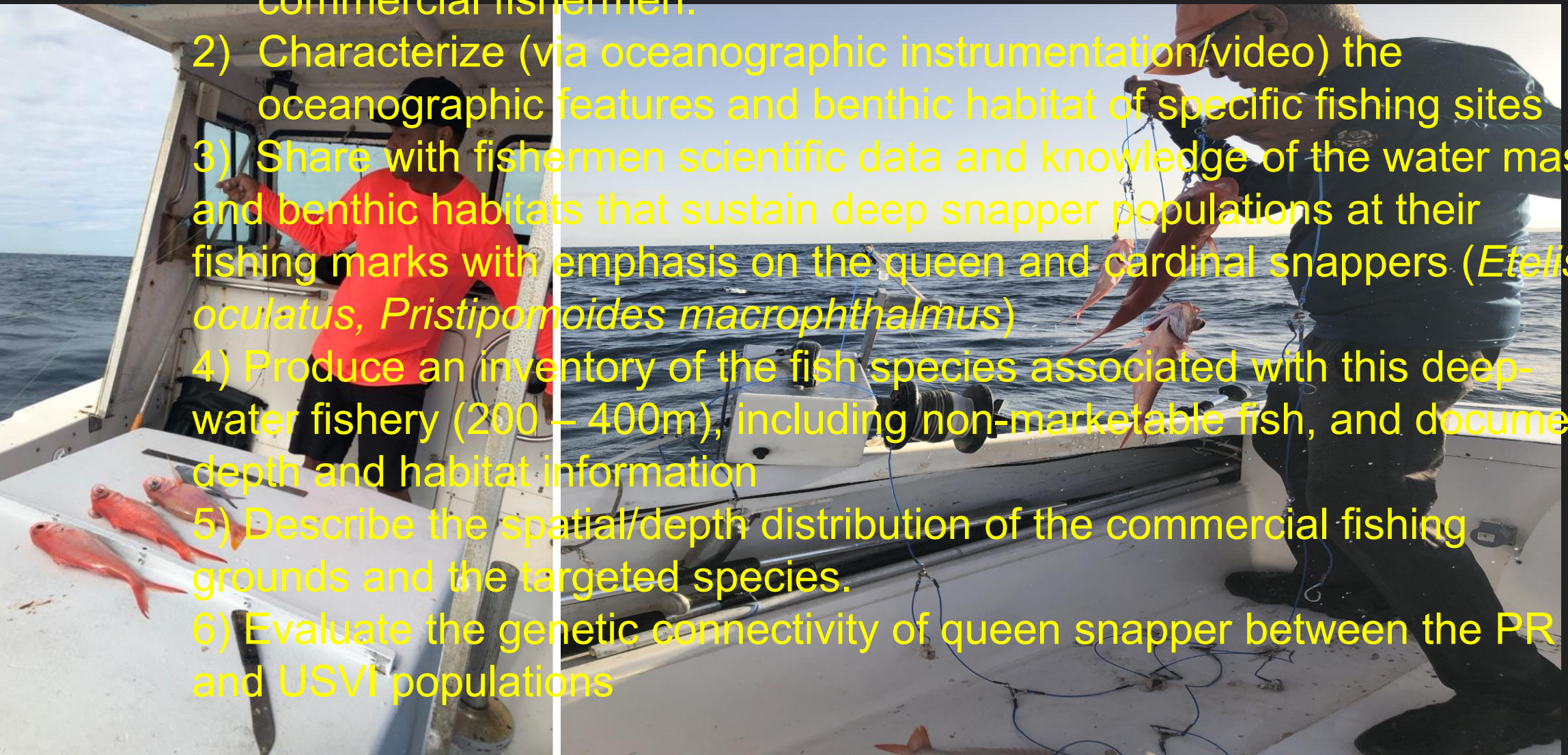
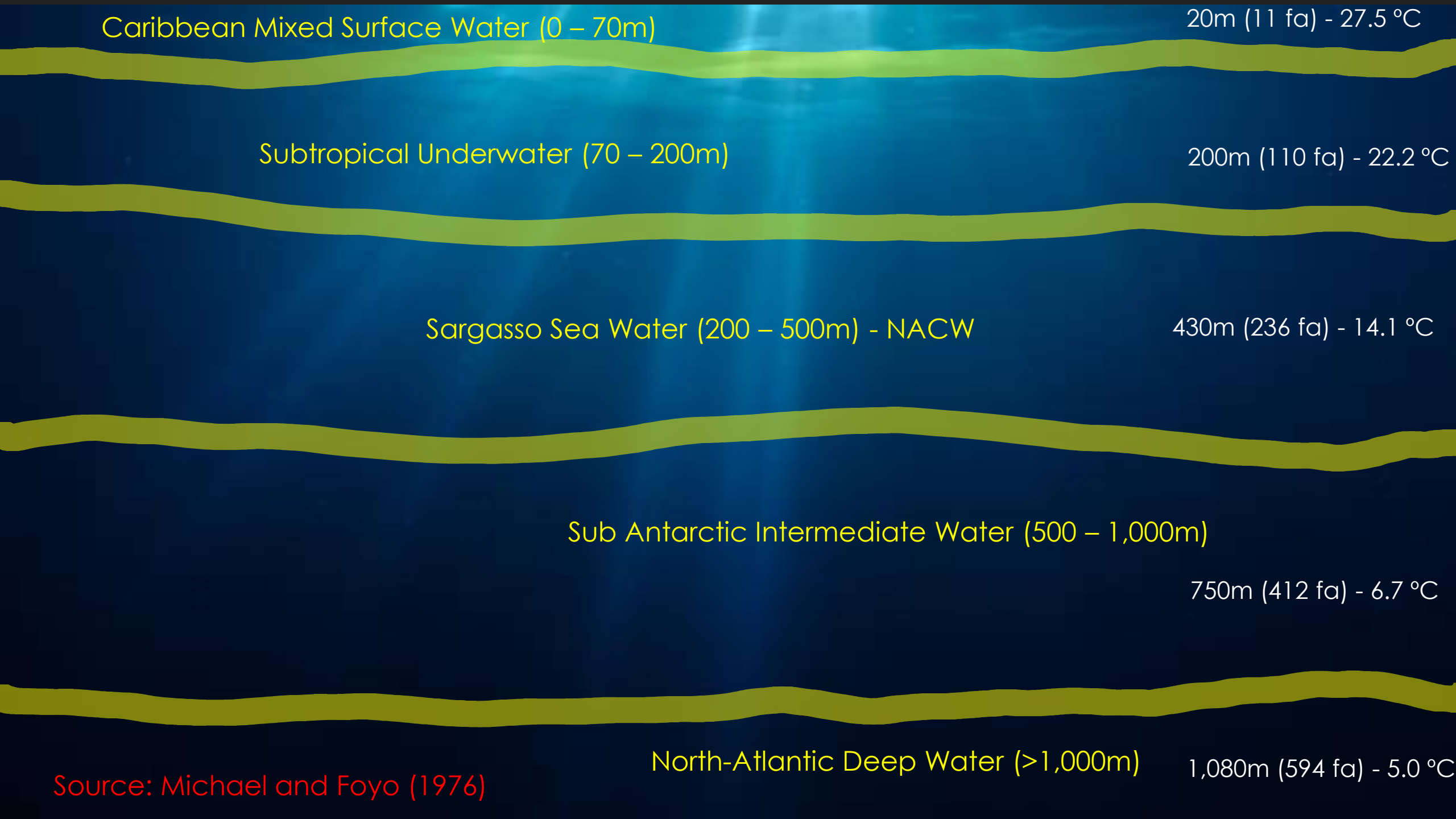
Study Objectives

1) Document the deep-water snapper fishery from on-site surveys with commercial fishermen.
2) Characterize (via oceanographic instrumentation/video) the oceanographic features and benthic habitat of specific fishing sites
3) Share with fishermen scientific data and knowledge of the water mass and benthic habitats that sustain deep snapper populations at their fishing marks with emphasis on the queen and cardinal snappers (*Etelis oculatus, Pristipomoides macrophthalmus*)
4) Produce an inventory of the fish species associated with this deep-water fishery (200 – 400m), including non-marketable fish, and document depth and habitat information
5) Describe the spatial/depth distribution of the commercial fishing grounds and the targeted species.
6) Evaluate the genetic connectivity of queen snapper between the PR and USVI populations

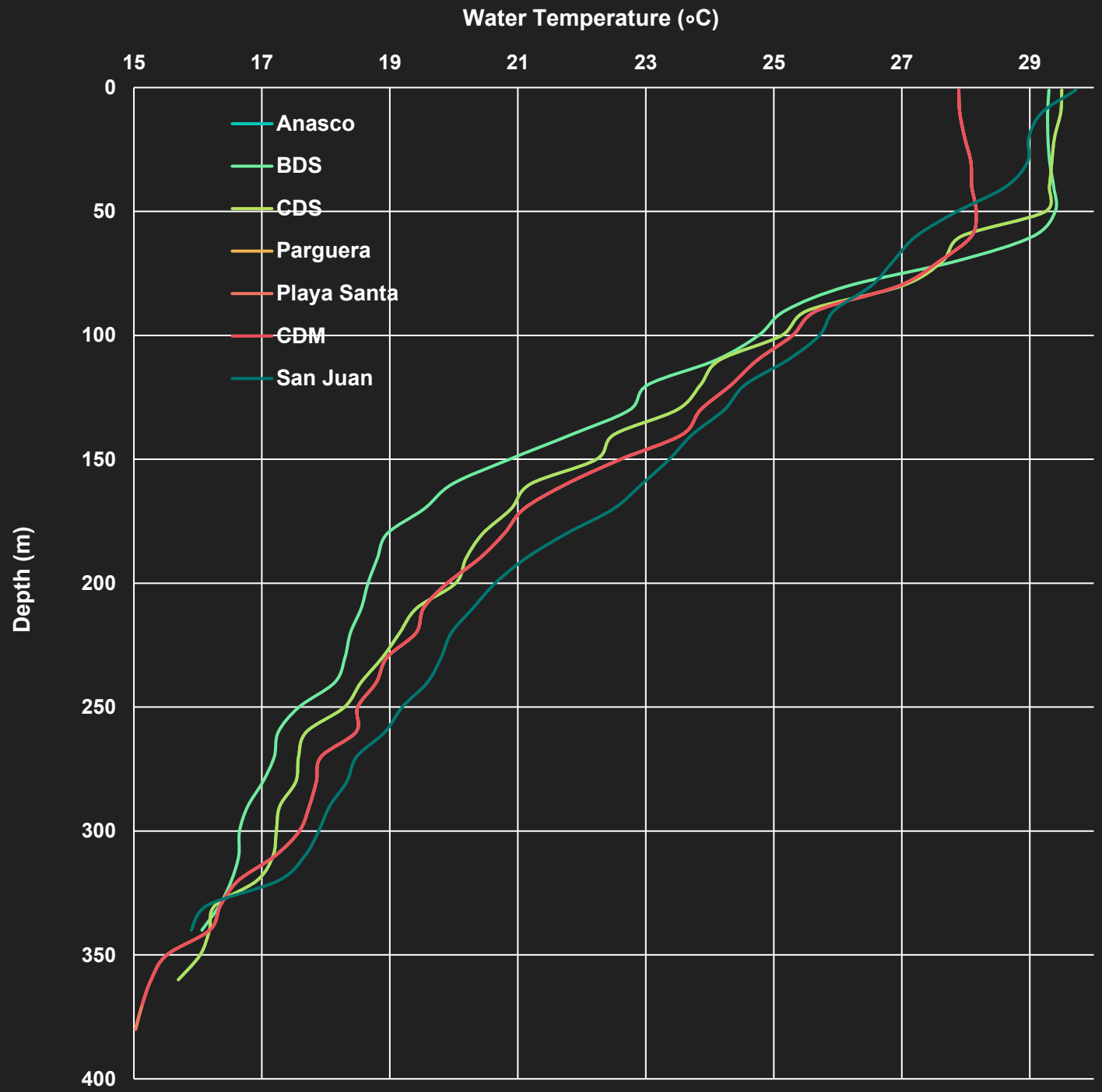


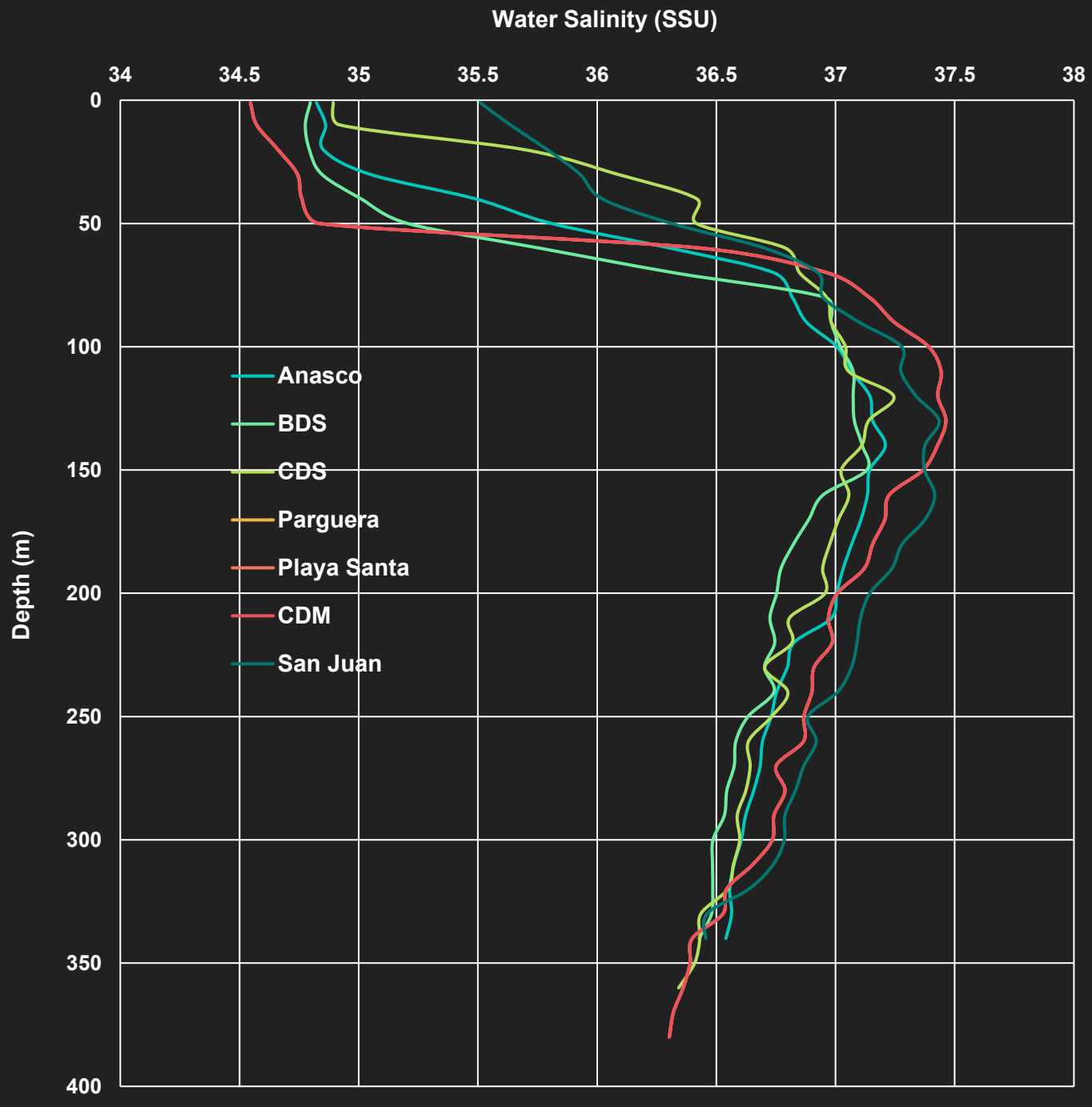
Methods

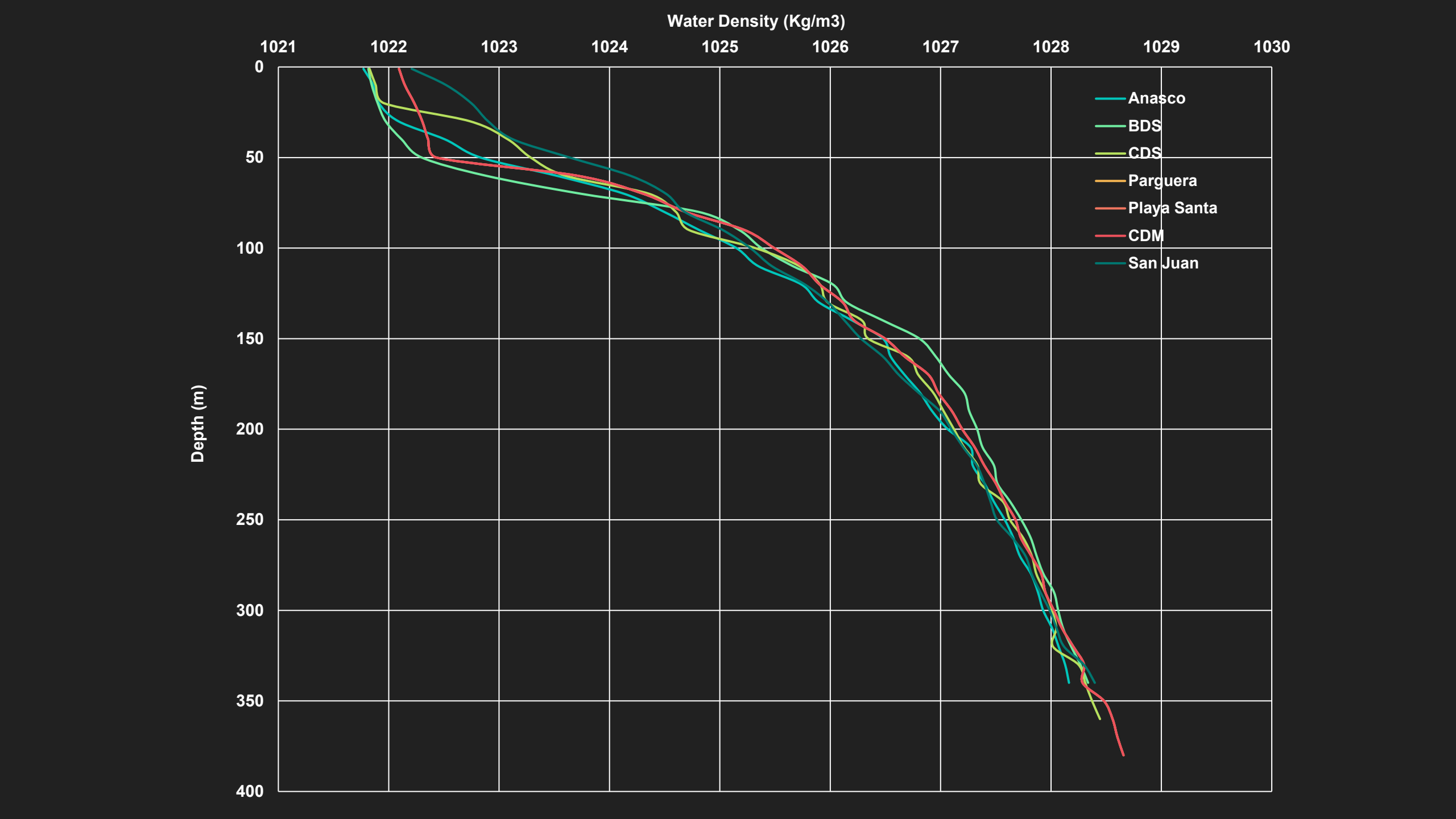
- Sail out with commercial fishermen to obtain oceanographic data and real-time deep-snapper fishery statistics at their fishing grounds
- Obtain catch and fishing effort data, including information on fishing gear, number of gear drops, geographic coordinates, depth, fish species caught, size, weight, gonadal condition, and any food item present aside from bait
- Perform series of CTD deployments to obtain full profiles (water temperature, salinity, density, depth) of the water column at the fishing marks
- Deploy a camera (Go-pro with 1,000m proof housing) with programmable lights to survey the benthic habitat at the fishing mark
- Obtain queen snapper tissue samples and otoliths from 10 fish individuals/fishermen x 10 fishermen (goal: 100 fish samples) to run DNA analyses for determination of genetic connectivity between PR and USVI populations

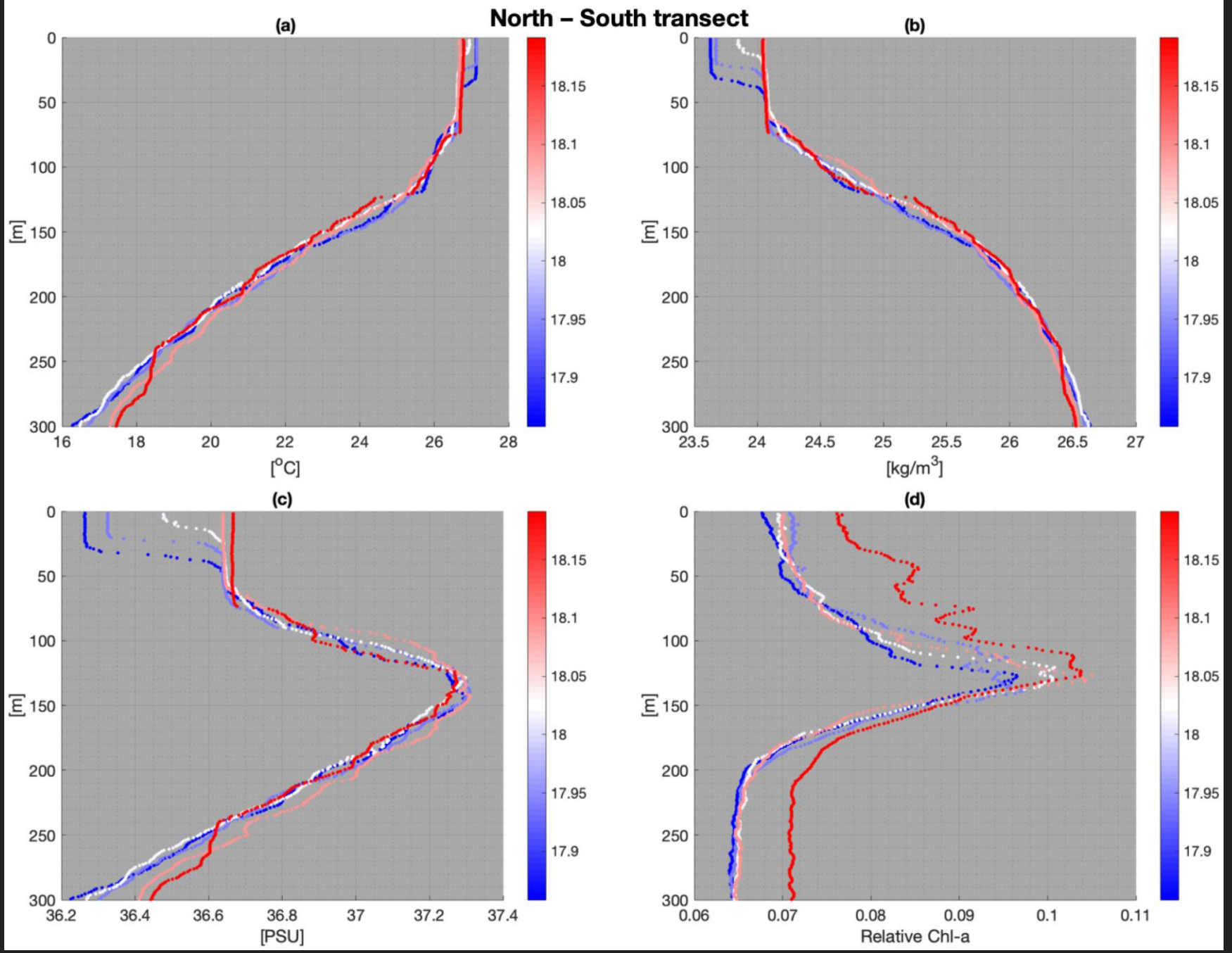

Caribbean Mixed Surface Water (0 – 70m)
20m (11 fa) - 27.5 °C
Subtropical Underwater (70 – 200m)
200m (110 fa) - 22.2 °C
Sargasso Sea Water (200 – 500m) - NACW
430m (236 fa) - 14.1 °C
Sub Antarctic Intermediate Water (500 – 1,000m)
750m (412 fa) - 6.7 °C
North-Atlantic Deep Water (>1,000m)
1,080m (594 fa) - 5.0 °C
Source: Michael and Foyo (1976)


NORTH
AMERICA
SARGASSO SEA
SOUTH AMERICA


Water Temperature (◦C)
15
17
19
21
23
25
27
29
0
50
100
150
200
250
300
350
400
Depth (m)
Anasco
BDS
CDS
Parguera
Playa Santa
CDM
San Juan


Water Salinity (SSU)
34
34.5
35
35.5
36
36.5
37
37.5
38
0
50
100
150
200
250
300
350
400
Depth (m)
Anasco
BDS
CDS
Parguera
Playa Santa
CDM
San Juan


Water Density (Kg/m3)
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
Depth (m)
0
50
100
150
200
250
300
350
400
Anasco
BDS
CDS
Parguera
Playa Santa
CDM
San Juan



Source: Seijo-Ellis et al., 2019)

Understanding the physical and biological variability…

Strong vertical stratification with permanent pycnocline and highly oligotrophic conditions in the SML

Temperature/salinity variations mostly associated with upper 1,200m. Below 2,000m temp/sal are mostly constant.

Water temperature variations in the SML associated with seasons. Variability of salinity influenced by rainfall and water lenses from Amazon and Orinoco River plumes

Vertical variability of the salinity/chl-a maximum increase towards the shelf-break

Drivers of physical/biological variability

1) Regional seasonal variations of the wind stress
2) Distant river plumes moving into the area (Orinoco/Amazonas)
3) Interaction of the local currents and tides with the changing bathymetry
4) Cyclonic and anticyclonic eddies
5) Internal waves
6) Plankton vertical migrations and patchiness

Euphasids (krill)

Potential Sources of Productivity sustaining deep-water fish populations in the 200 – 400m depth range

1- Sedimentation of organic matter with microbial loops from SML

2- Advective transport of organic matter and zooplankton and fishes from STU and SSW masses

3- Zooplankton/micronekton vertical migrations to the chl-a max. and back to the SSW mass

4- infaunal/epifaunal benthic invertebrates living off the seafloor organic matter (incl. demersal zooplankton, equinoderms, crustaceans)

5- local zooplankton/ichthyoplankton


Pitch: 0.0 deg
Heading: 90 deg
Roll: 0.0 deg
Temp Tel/Cam: 93F/135F

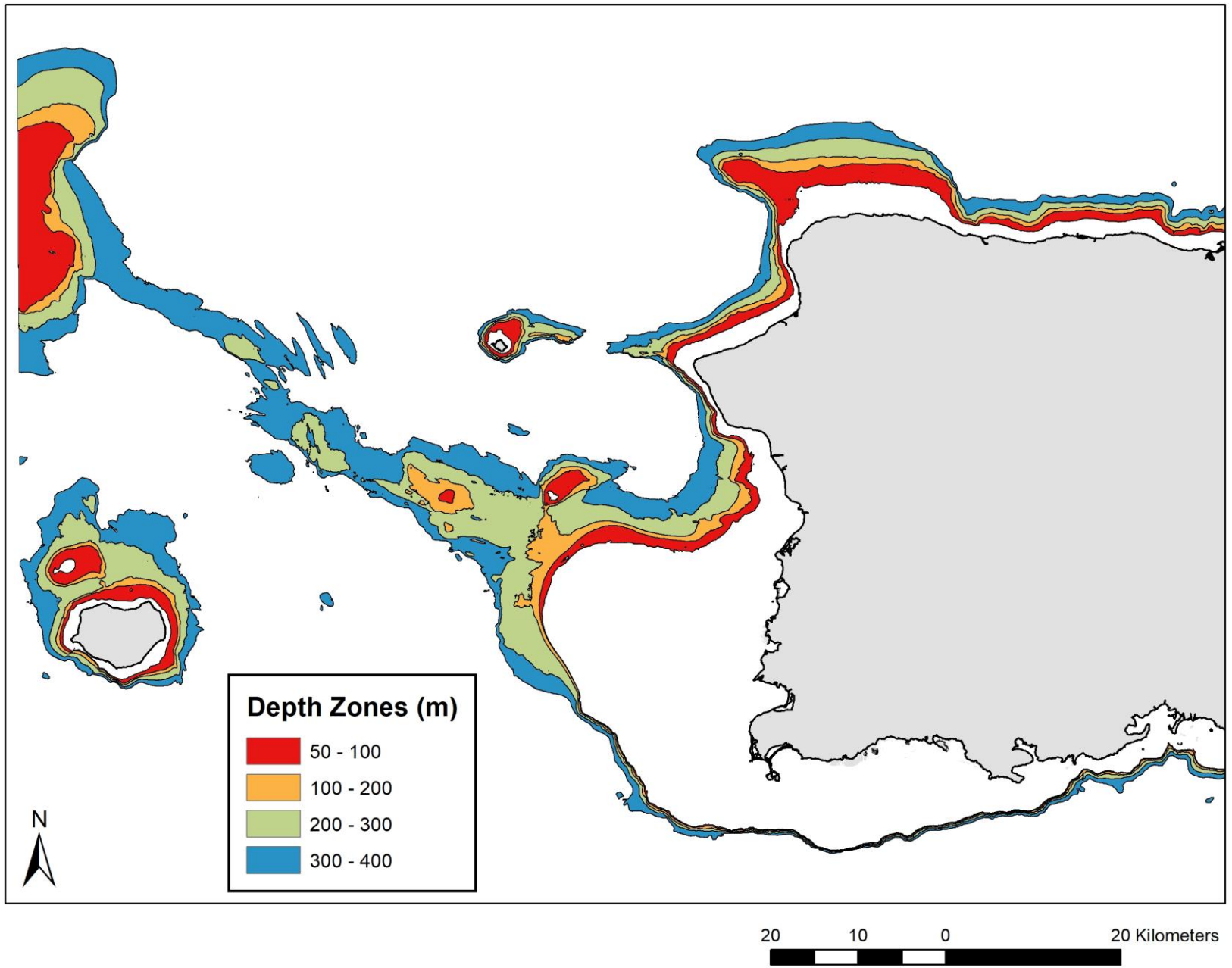
Percent annual fish landings by habitat types (means: 2015-2017) - PR and USVI

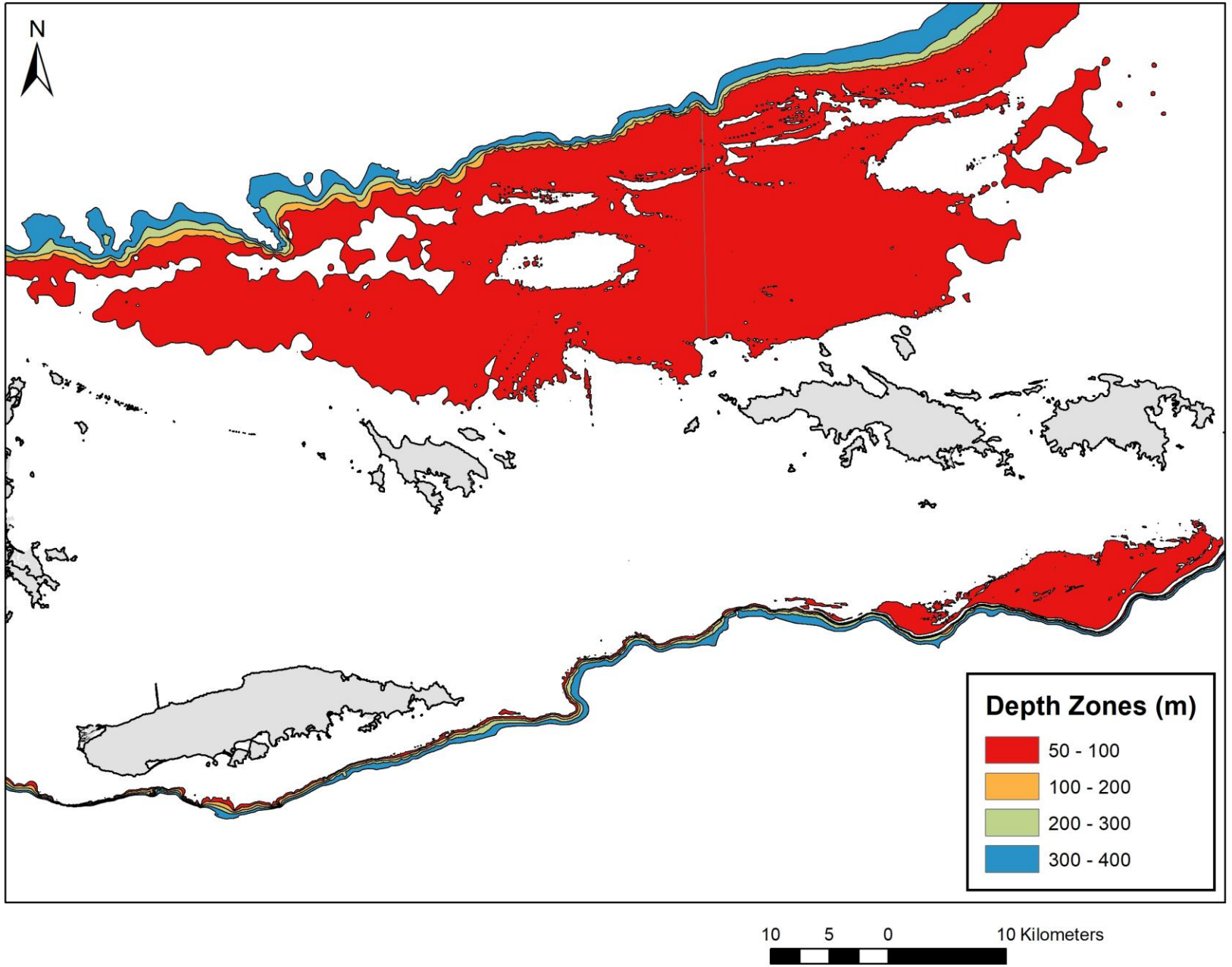
Islands	Deep-sea Demersal	Deep-sea Pelagic	Coastal Demersal	Coastal Pelagic
Puerto Rico	26.4	15.2	46.0	12.4
St. Thomas/St. John	3.5	6.4	76.6	13.5
St. Croix	6.9	35.2	46.0	11.9

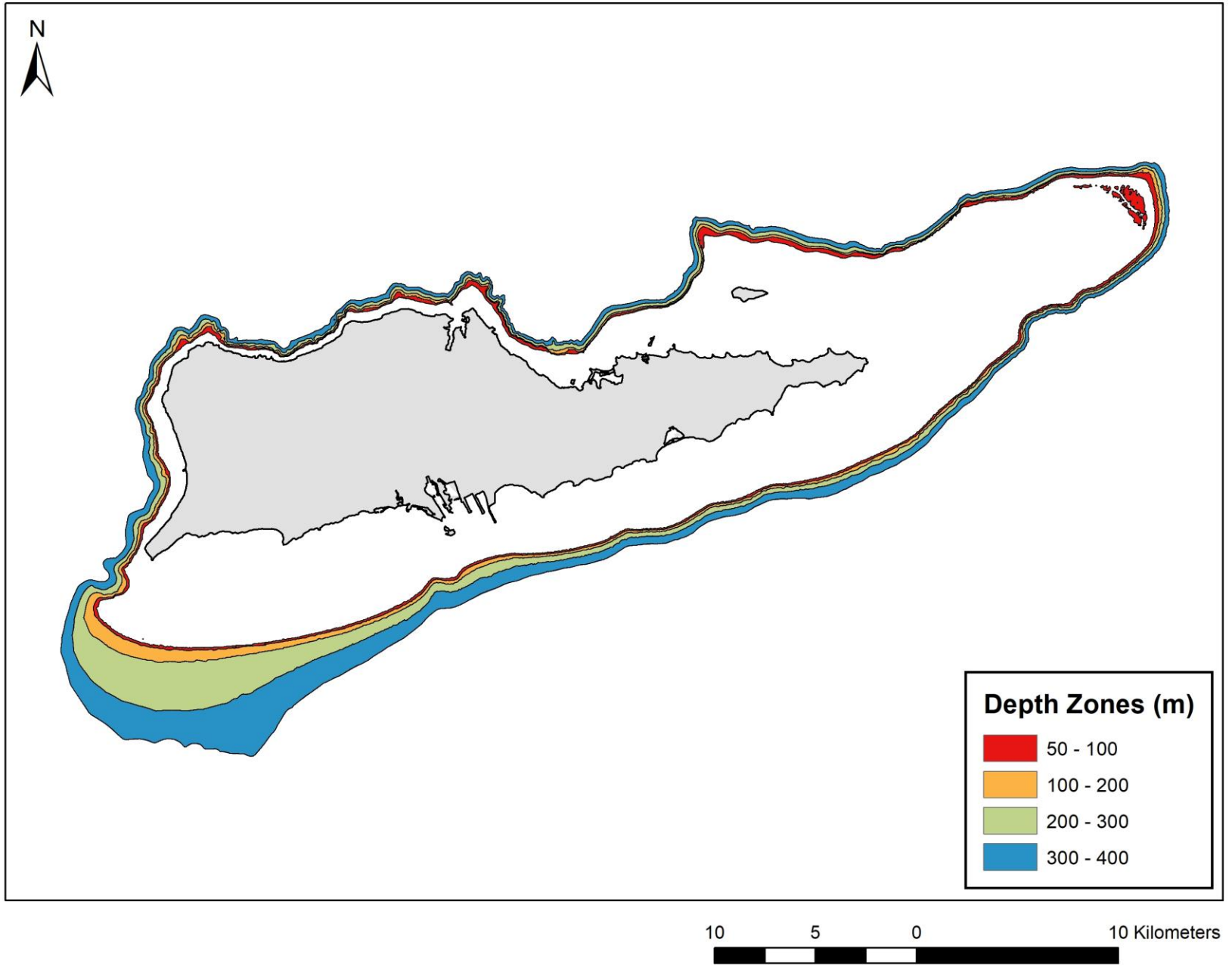
Surface area covered by depth contours (0 - 400m depth range) PR and USVI

source: PR coastal digital elevation model (www.ncei.noaa.gov)

	Area (m2)			
Depth Zones (m)	**PR**		**USVI**	
	Area (km2)	**%**	**Area (km2)**	**%**
0 - 50	4,665.2	60.2	3,750.2	73.7
50 - 100	1,131.1	14.6	827.7	16.3
100 - 200	334.5	4.3	100.8	2.0
200 – 300*	683.6	8.8	137.8	2.7
300 – 400*	938.5	12.1	269.9	5.3
Totals	**7,752.9**		**5,086.5**	


Depth Zones (m)
50 - 100
100 - 200
200 - 300
300 - 400
N
20
10
0
20 Kilometers


N
Depth Zones (m)
50 - 100
100 - 200
200 - 300
300 - 400
10 5 0 10 Kilometers


N
Depth Zones (m)
50 - 100
100 - 200
200 - 300
300 - 400
10
5
0
10 Kilometers

Summary of commercial deep-sea catch statistics

Fishing Effort: 10 days/126 drops

Species	Common Name	# fish	Total Pounds	Average Pounds
Etelis oculatus	queen snapper	117	178.0	1.52
Pristipomoides macrophthalmus	Cardinalfish	45	54.6	1.21
Squalus acanthias	Spiny dogfish	19		
Lutjanus vivanus	Silk snapper	16	18.0	1.12
Pending id	brilloso	10		0.37
Hexanchus vitalus	Atlantic six-gill shark	1		
Squalus cubensis	Cuban dogfish	1		
Pending id	conger eel	3		
Mustelus canis	dusky smooth hound	1		
Seriola dumerilly	great amberjack	1		13.23
Lutjanus buccanella	blackfin snapper	1	0.9	0.86
Epinephelus mystacinus	misty grouper	1		0.60
Pending id	puffer	1		

Total Pounds : 251.4

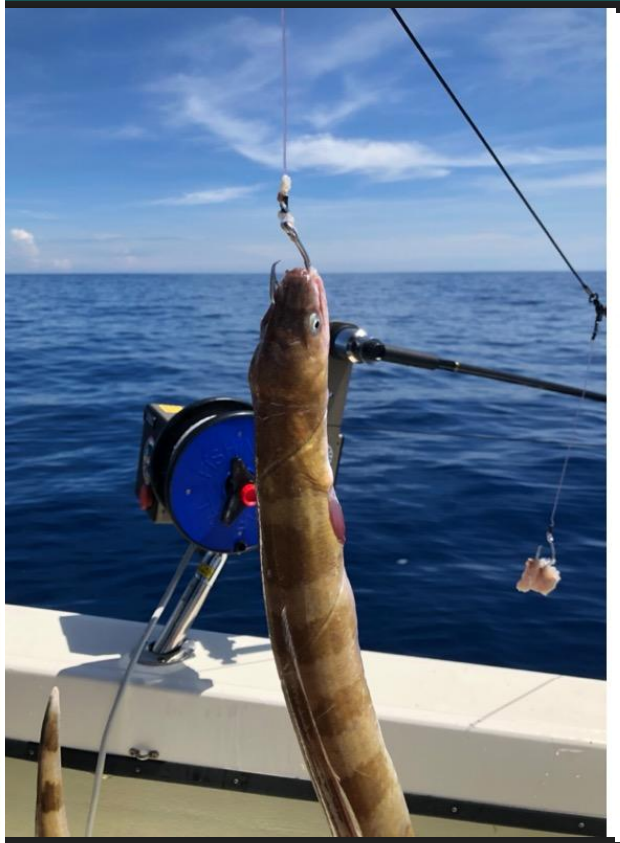
Average catch/day (lbs): 25.1

Average catch/drop (lbs): 2.0

Fishermen: Luis A. Roman, Jorge Gonzalez, Rodolfo Abrahams

The fish community at the fishing marks…






Preliminary Conclusions

- 1) Deep-water snapper fishery in the 200-400m depth range associated with SSW mass
- 2) Water column physical/biological properties relatively stable and dominated by strong permanent stratification and oligotrophic conditions
- 3) Productivity appears to be strongly based on a plankton food web, but also with an important benthic component associated with reef biota including corals
- 4) we suggest that zooplankton/micronekton patchiness may be a key factor influencing the productivity, seasonality, and spatial distribution of queen snapper and other top predator populations in the SSW mass (inverted pyramid concept)
- Higher percentages of deep-sea demersal fish landings in PR relative to USVI influenced with larger habitat area in the 200-400m depth range (among other things…)