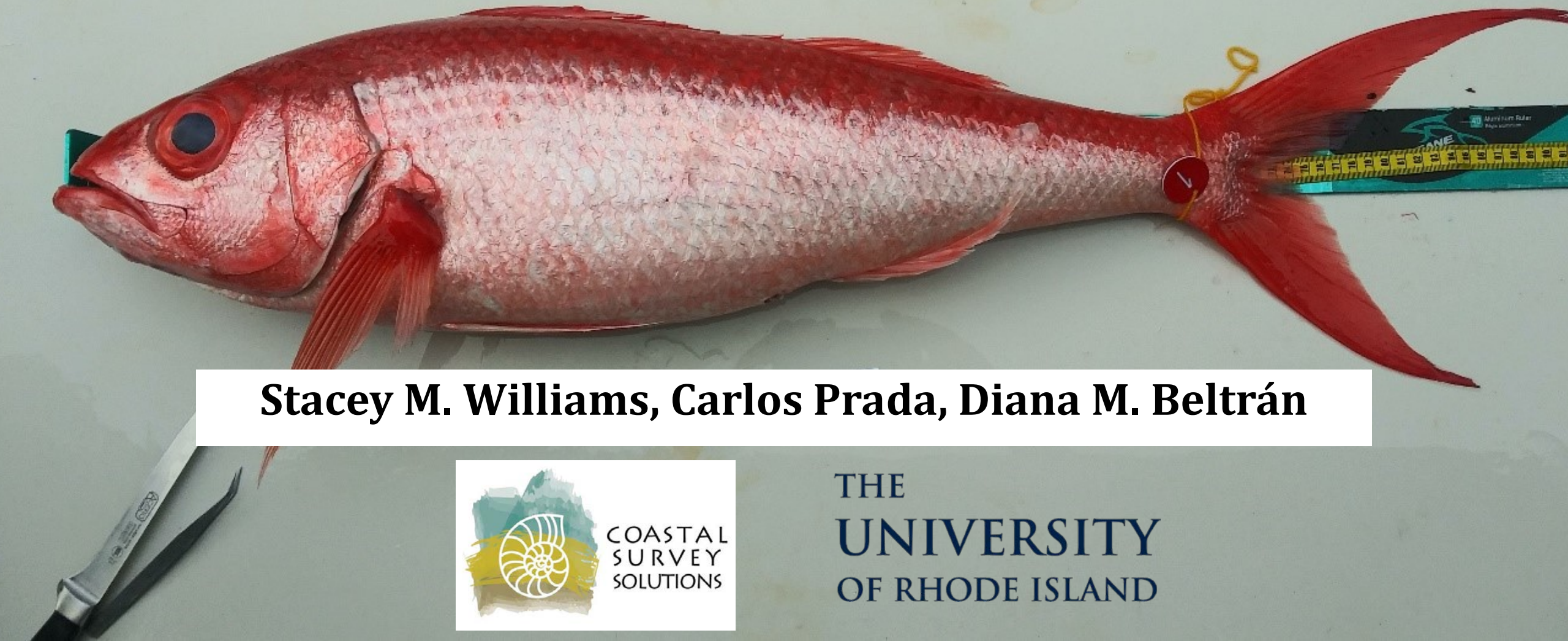
Characterization of Prey Diversity of the Commercially-Important Queen Snapper (Cartucho), *Etelis oculatus*



Stacey M. Williams, Carlos Prada, Diana M. Beltrán

COASTAL SURVEY SOLUTIONS

THE UNIVERSITY OF RHODE ISLAND

Queen snapper (cartucho)

Queen snapper fishery is becoming an increasingly important fishery

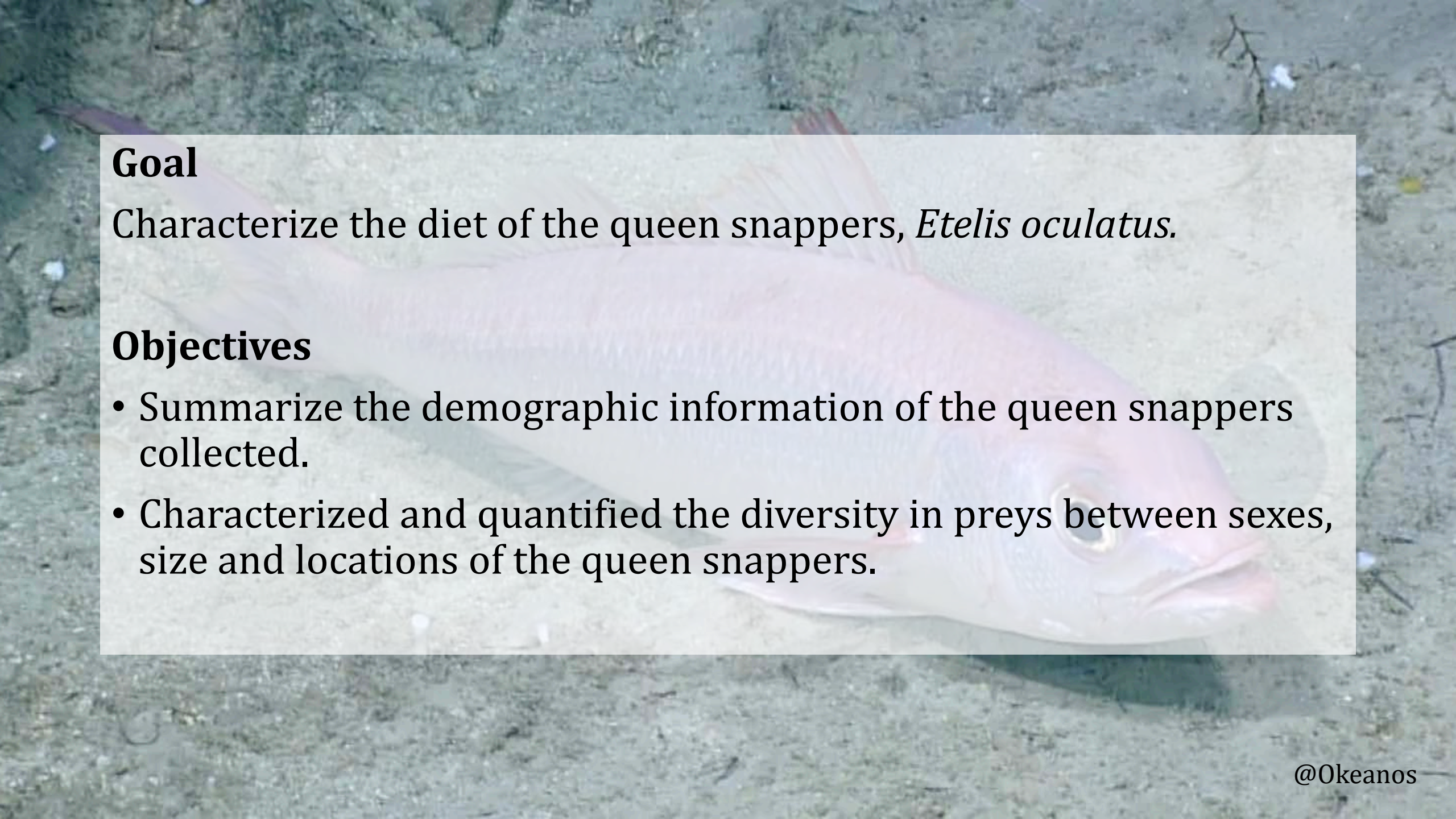
What do we know

- Extensive distribution-North Carolina to Brazil
- Depth distribution from 130 m to 539 m
- Assumed an ontogenetic relationship with depth
  - Juveniles spotted < 30m (Appledoorn et al. 1987)
- Spawn throughout the year
  - Peaks during October and November (Rosario et al. 2006)
  - Females mature at 23 cm and males at 31 cm
- Queen snappers are associated with areas of high topographical relief and substrate discontinuities

What we do not know

- Life history, habitats preference, prey?

@L. Roman



Goal

Characterize the diet of the queen snappers, *Etelis oculatus*.

Objectives

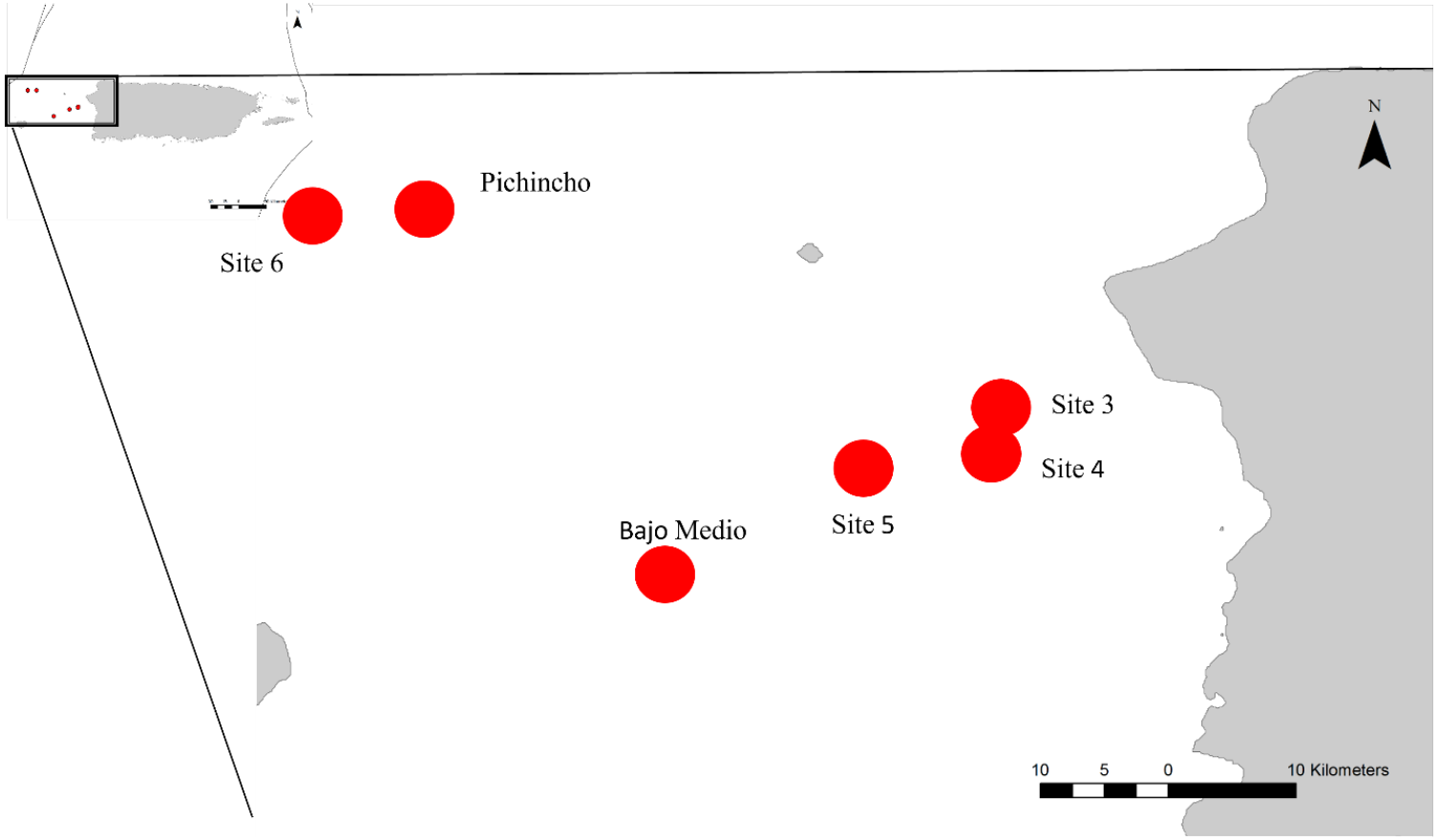
- Summarize the demographic information of the queen snappers collected.
- Characterized and quantified the diversity in preys between sexes, size and locations of the queen snappers.


JUST


4/30/20
P27

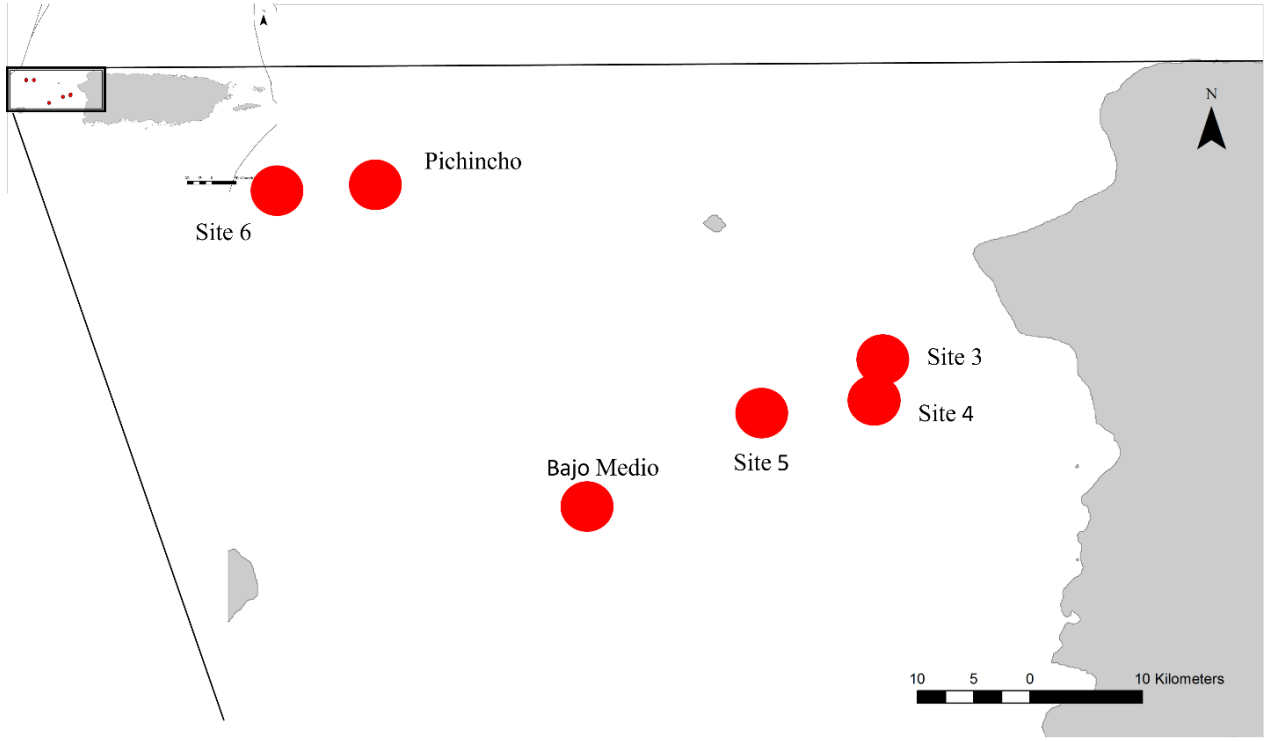
Results

- Total 157 queens from November 2019 to July 2020
- Seven different locations
- Depths 256 m at Bajo Medio to 402 m at Site 3
- Total of fish caught varied greatly between location and sampling time

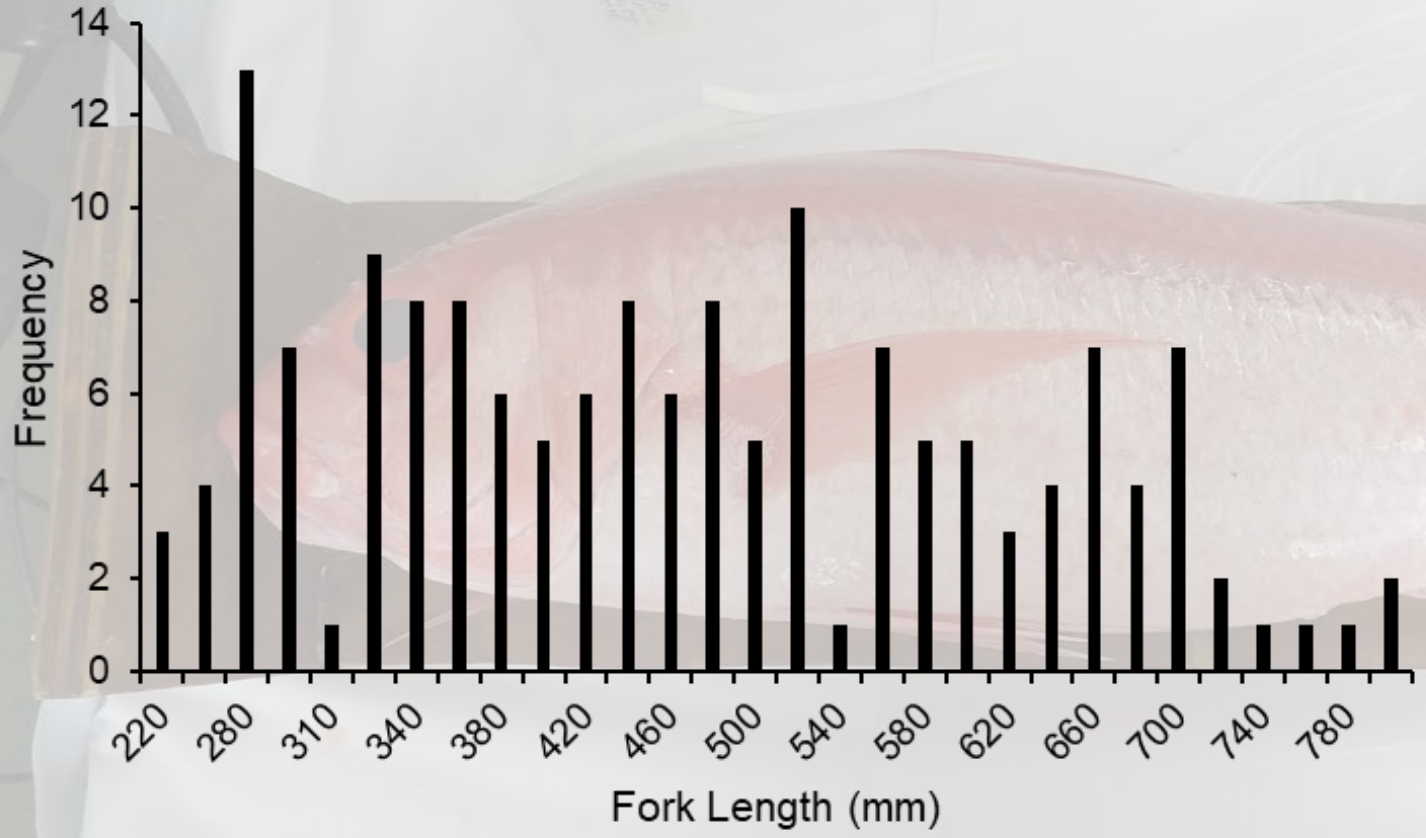


Sampling

Site	Sampling time	# samples
Bajo Medio	11/13/2020	10
Bajo Medio	1/16/2020	10
South of Pichincho	1/29/2020	8
Bajo Medio	2/2/2020	15
Bajo Medio	2/4/2020	20
Site 3	2/21/2020	15
Site 4	2/29/2020	15
Pichincho	4/30/2020	29
Site 5	4/30/2020	15
Site 6	7/6/2020	20



Size

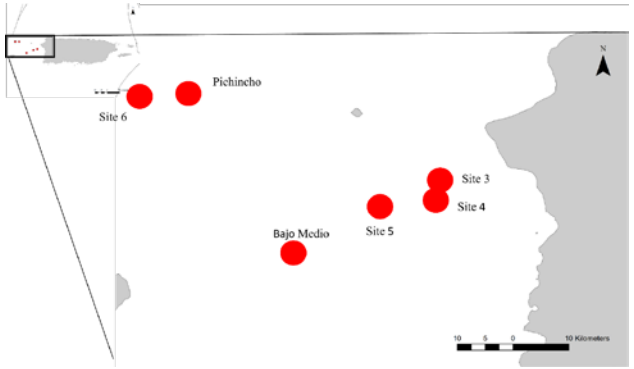


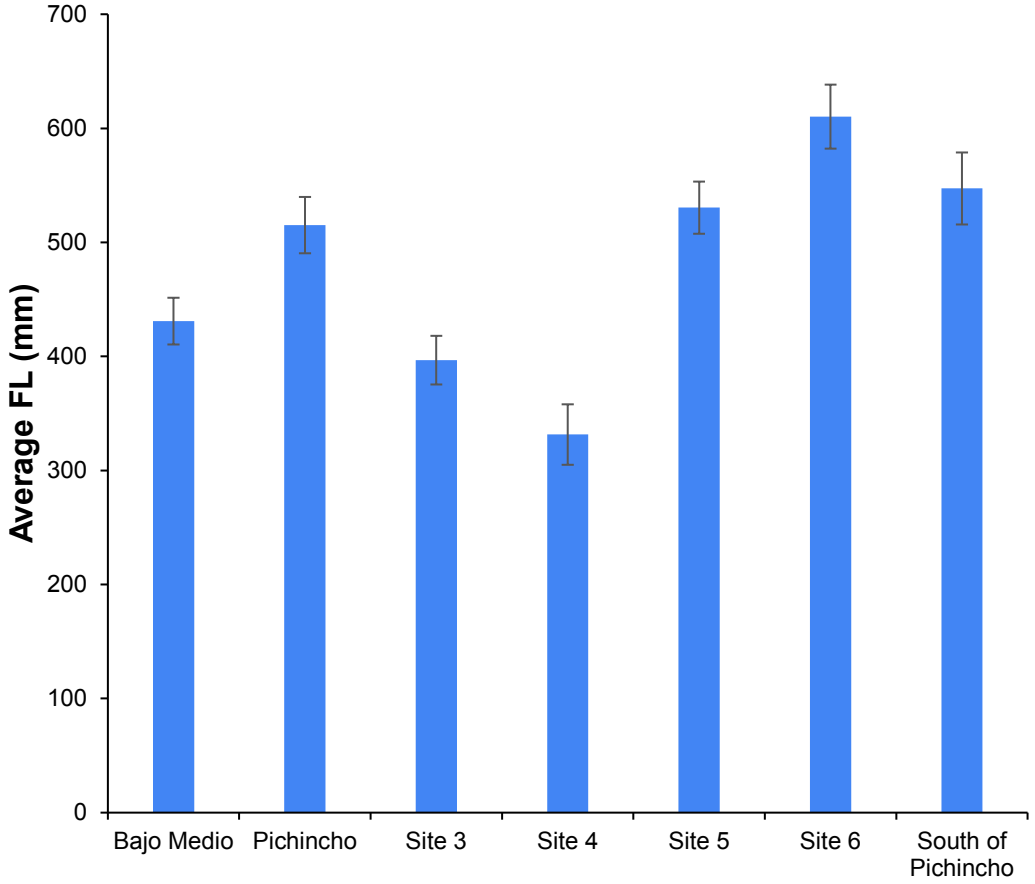
Standard: 442.73 ± 11.53 mm

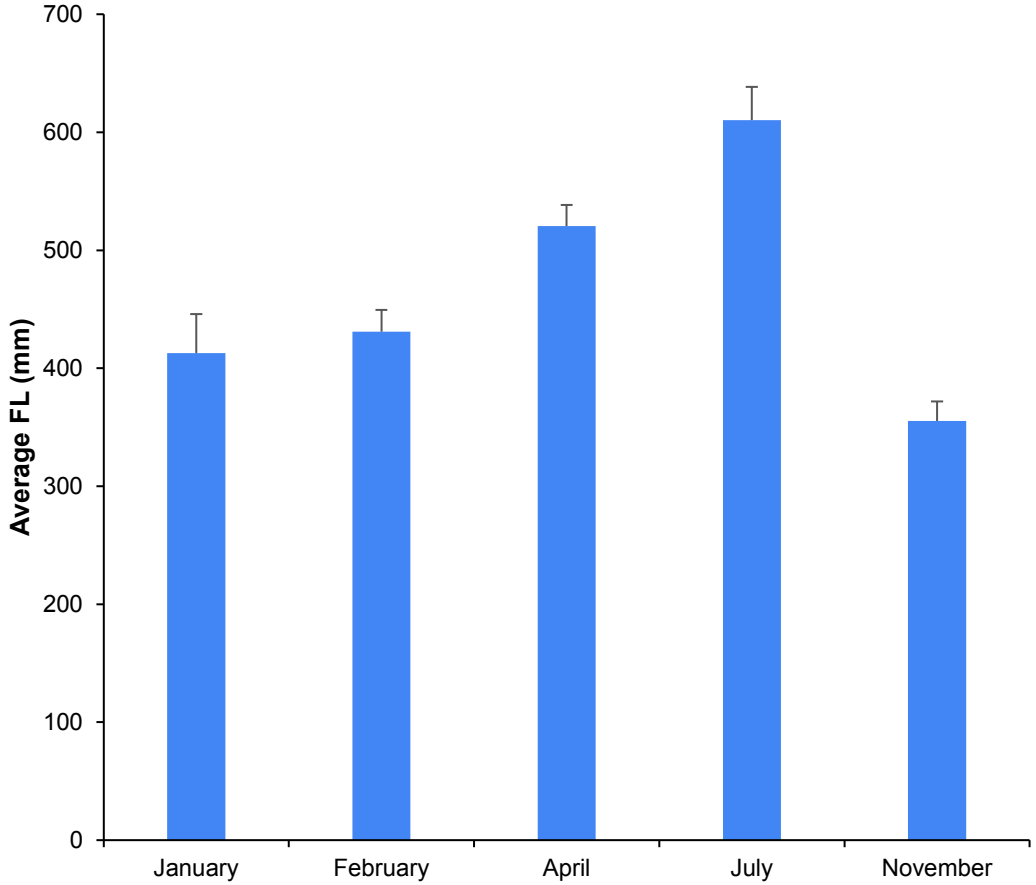
Fork: 472.06 ± 11.90 mm

Total: 595.34 ± 15.24 mm

Fork ranging: 220 mm to 808mm

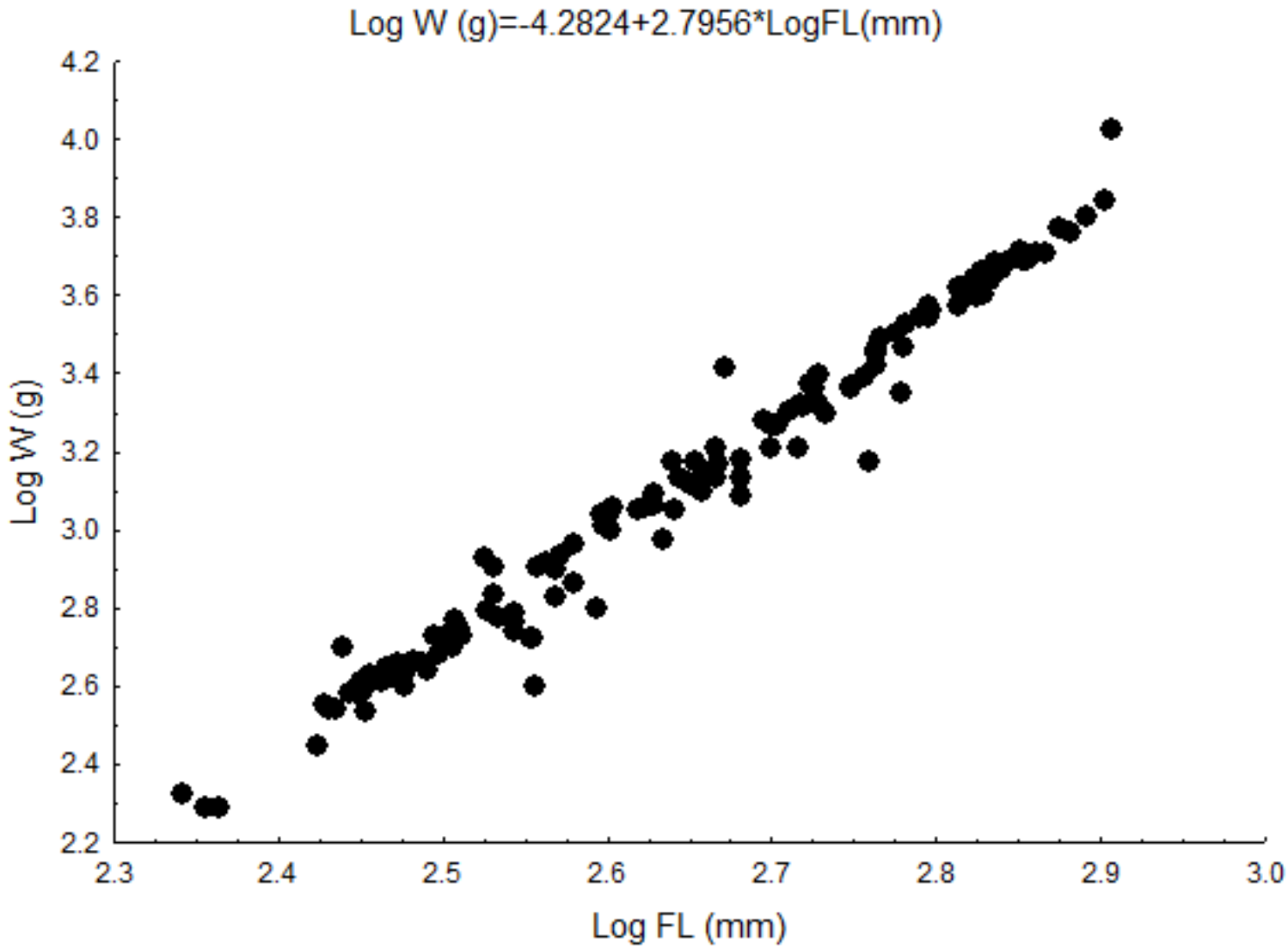






One-way PERMANOVA based on Euclidean distance measures

Weight


Log W (g)=-4.2824+2.7956*LogFL(mm)
Log W (g)
Log FL (mm)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0

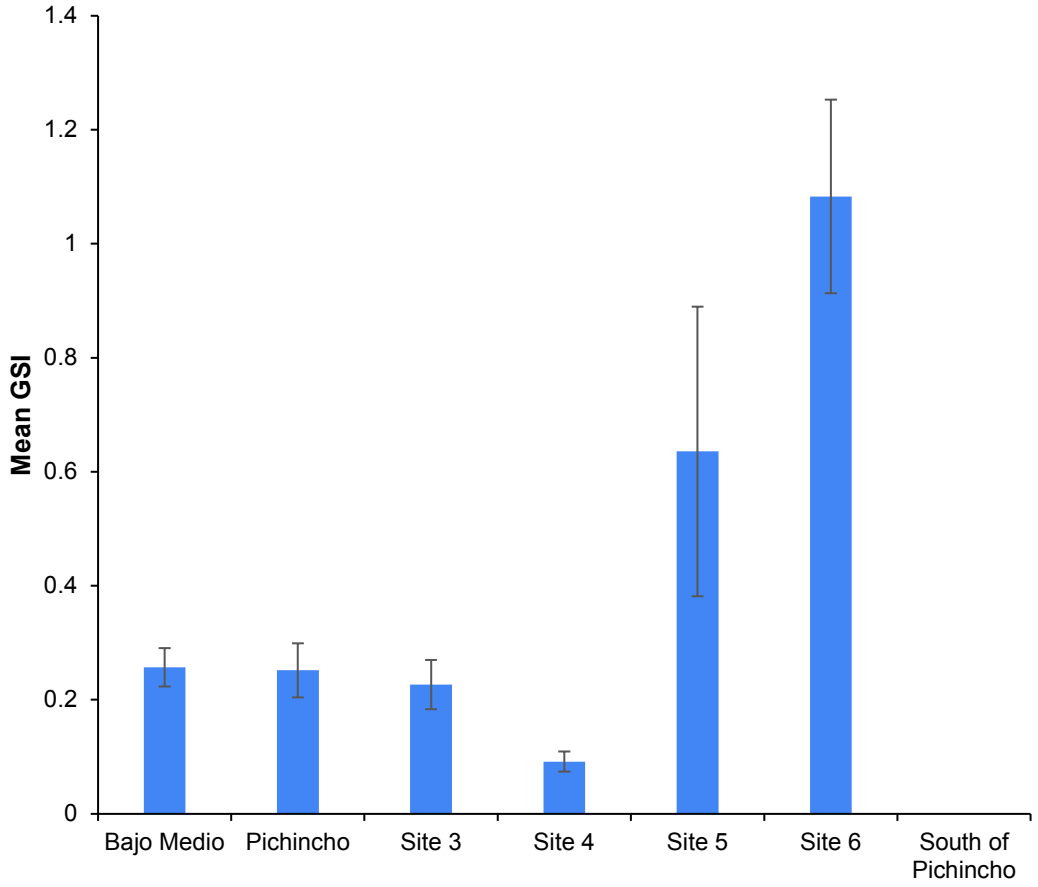
Gonads

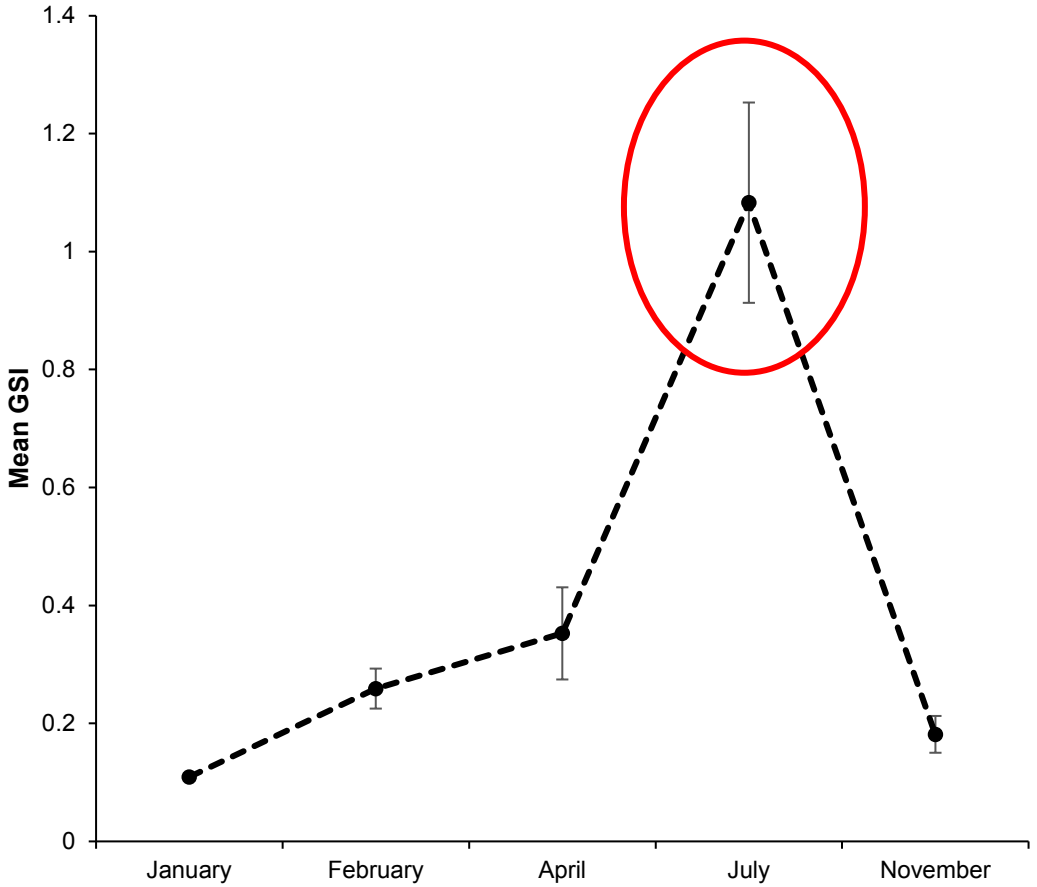
110 gonads sexed

- 69% males
- 31% females

Females had slightly a greater average fork length than males

Gonadosomatic Index (GSI)





What does Cartucho eat? Prey Diversity of the Commercially-Important Queen Snapper (*Etelis oculatus*)

Two approaches to identify preys

We received the stomachs of *E. oculatus* frozen from Puerto Rico

- 146 of collected stomachs

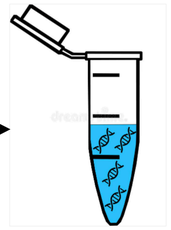
fishtory.co

Regurgitation of gut contents due to rapid decompression remains a problem

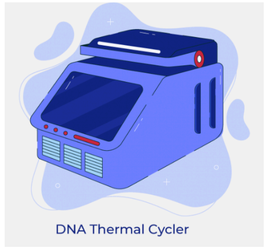
- Out of the 146 of collected stomachs, 35 had undigested items (24% of the captures). **First approach**.
- We processed 107 stomachs for metabarcoding, as 39 of them were fully empty. **Second approach**.

Undigested items were removed intact and preserved frozen

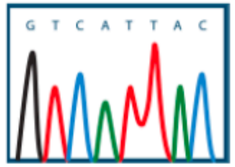
First approach: Individual preys



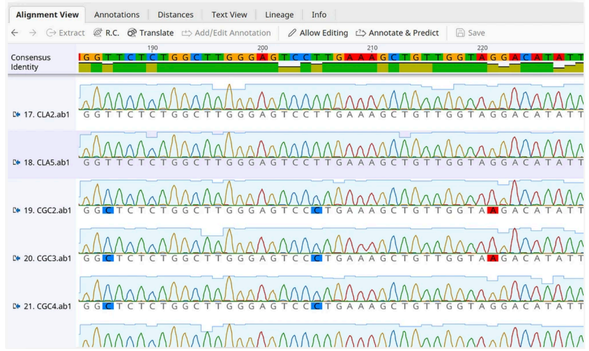
Each prey pieces
DNA Extraction



PCR reaction using COI



DNA Sequencing
and Data



Blast using Geneious software
and the NCBI

- Identification of some prey items was difficult in some samples because of co-amplification of the COI marker with the queen snapper's DNA.

- The issue persisted even after we washed the sample multiple times and used blocking primers. We often got unreadable chromatograms, resulting from coamplification of multiple DNA templates.

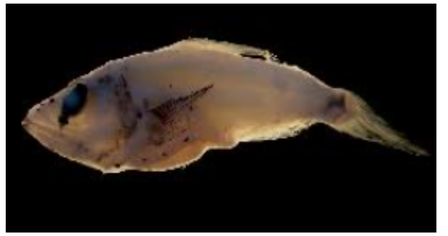
- Seven invertebrates species (2 arthropods, 4 mollusks, and 1 isopod) and 16 fish species were found within those undigested items.

Invertebrates and vertebrates are part of the queen snapper's diet

	Scientific name	*Common name*	*Prey number*
1	*Abralia veranyi* *	midwater squid	9
2	*Oplophorus gracilirostris*	shrimp	7
3	*Myctophum selenops*	Wisner's lantern fish	4
4	*Coccorella atlantica*	Atlantic sabretooth	4
5	*Diaphus dumerilii*		3
6	*Systellaspis debilis*	shrimp	3
7	*Gonostoma elongatum*		2
8	*Opisthonema oglinum* *	Atlantic thread herring	2
9	*Doryteuthis (possible pealeii)* *	longfin inshore squid	2
10	*Euthynnus alletteratus* *	little tunny	2
11	*Lampadioteuthis megaleia* *	wonderful firefly squid	2
12	*Electrona paucirastra*	belted lanternfish	1
13	*Abralia redfieldi* *	Redfield's enope squid	1
14	*Argyropelecus aculeatus*	lovely hatchetfish	1
15	*Lepidophanes guentheri*	Günther's lanternfish	1
16	*Astronesthes similus*		1
17	*Scomberomorus regalis**	cero	1
18	*Katsuwonus pelamis* *	skipjack tuna	1
19	*Myctophum obtusirostre*	bluntsnout lanternfish	1
20	*Diaphus perspicillatus*	transparent lantern fish	1
21	*Sphyraenops bairdianus*	triplespine deepwater cardinalfish	1

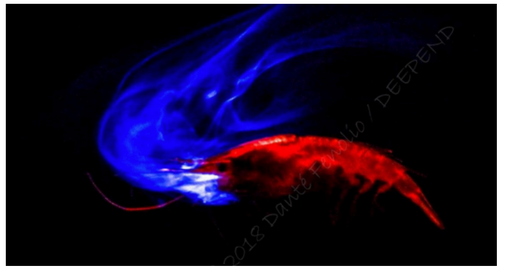
* Bait species were identified with a red asterisk

Abralia veranyi
Mid water squid



Myctophum selenops
Wisner's lantern fish

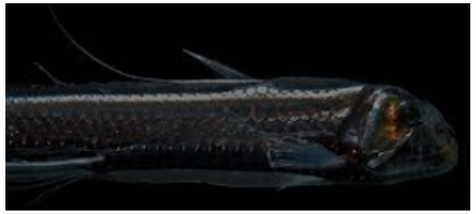
Diaphus dumerilii



Oplophorus gracilirostris
Deep sea shrimp

Coccorella atlantica
Atlantic sabretooth

Systellaspis debilis
Deep water shrimp



Gonostoma elongatum

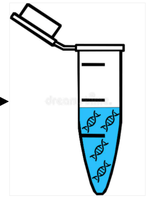
Second approach:
Metabarcoding using digested liquid/content

If the stomach came empty:
Without any prey fragment

We recovered the
digested content
in the stomach and intestines

Homogenized all
the digested material

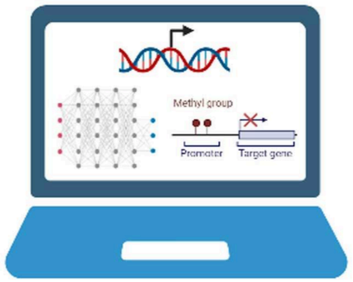
DNA Extractions
per triplicate per sample



PCR reaction using 12S
triplicate per sample

Library
preparation

Next-Generation
Sequencing
Illumina MiSeq

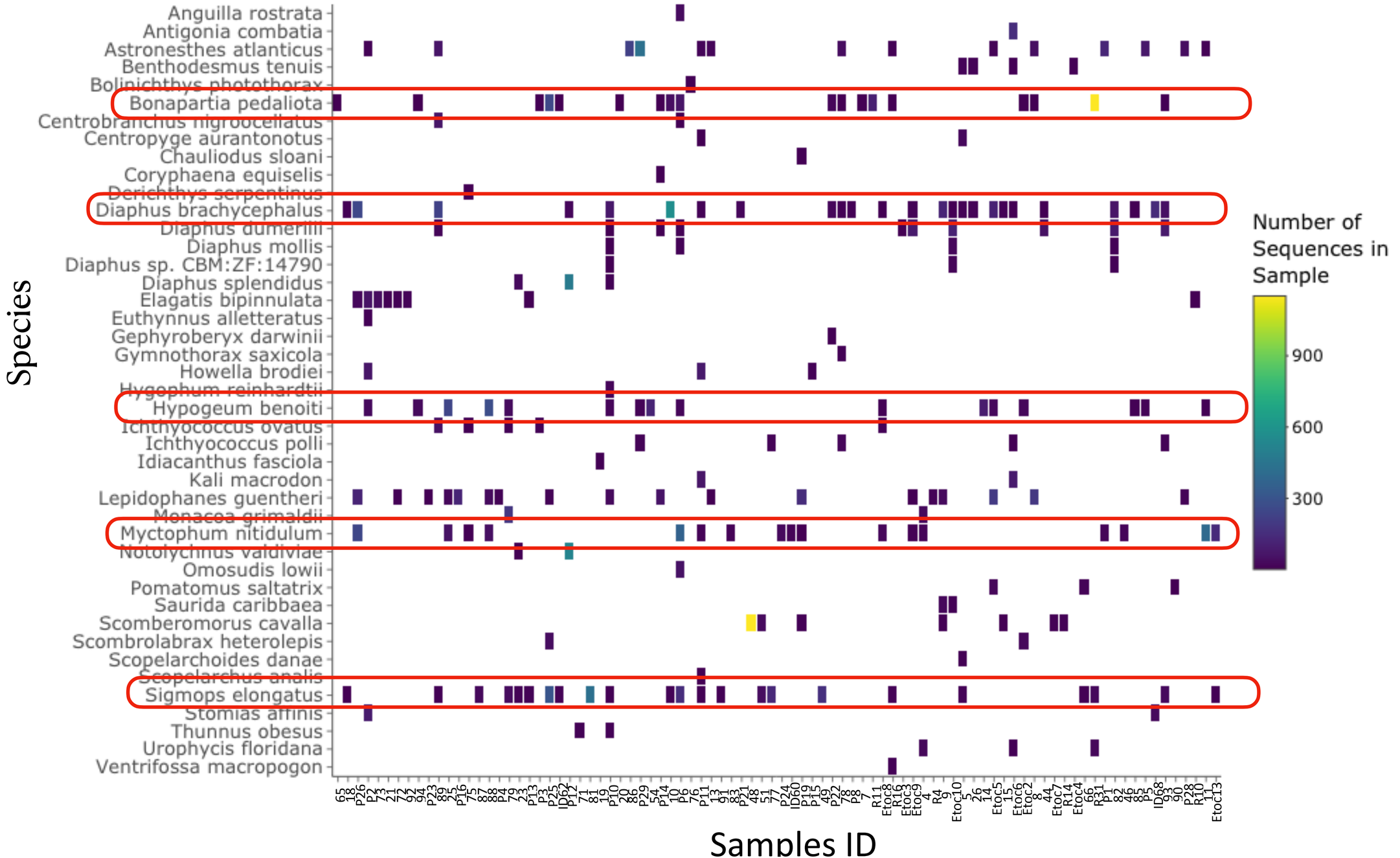


DADA2 processing
of the Amplicons
Sequence Variance (ASVs)

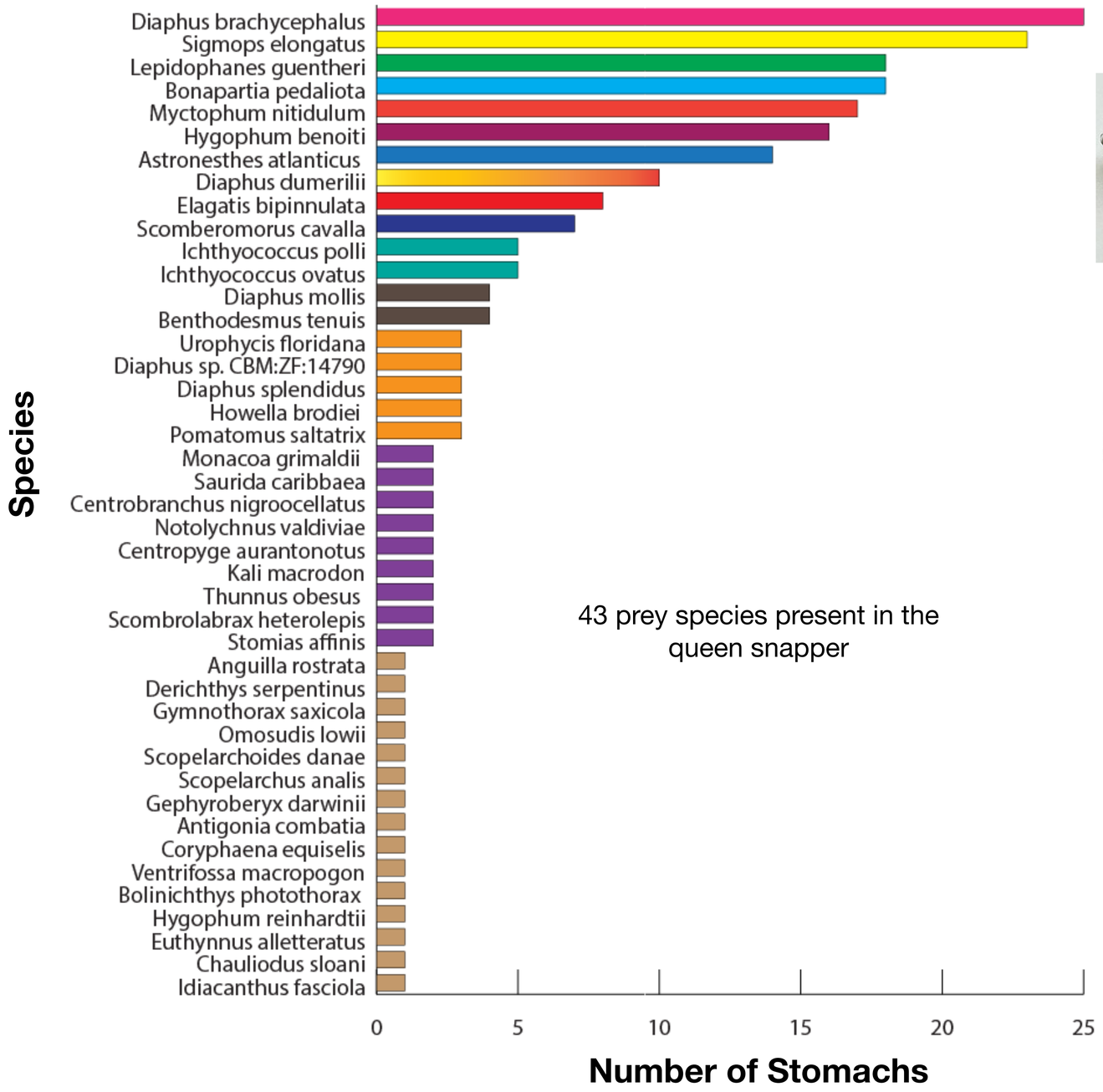
We obtained metabarcoding data from 89 out of 107 stomachs samples (83%).

We found 43 fish species (potential preys) present in queen snapper stomachs. Representing 37 genera and 24 prey families .

Many fish species compose the queen snapper's diet



At least ten fish species are common in the queen snapper's stomachs



43 prey species present in the queen snapper

Diaphus brachycephalus
Short-headed lantern fish

Lepidophanes guentheri
Günther's lanternfish

Myctophum nitidulum
Pearly lanternfish

Diaphus dumerilii
Dumeril's lanternfish

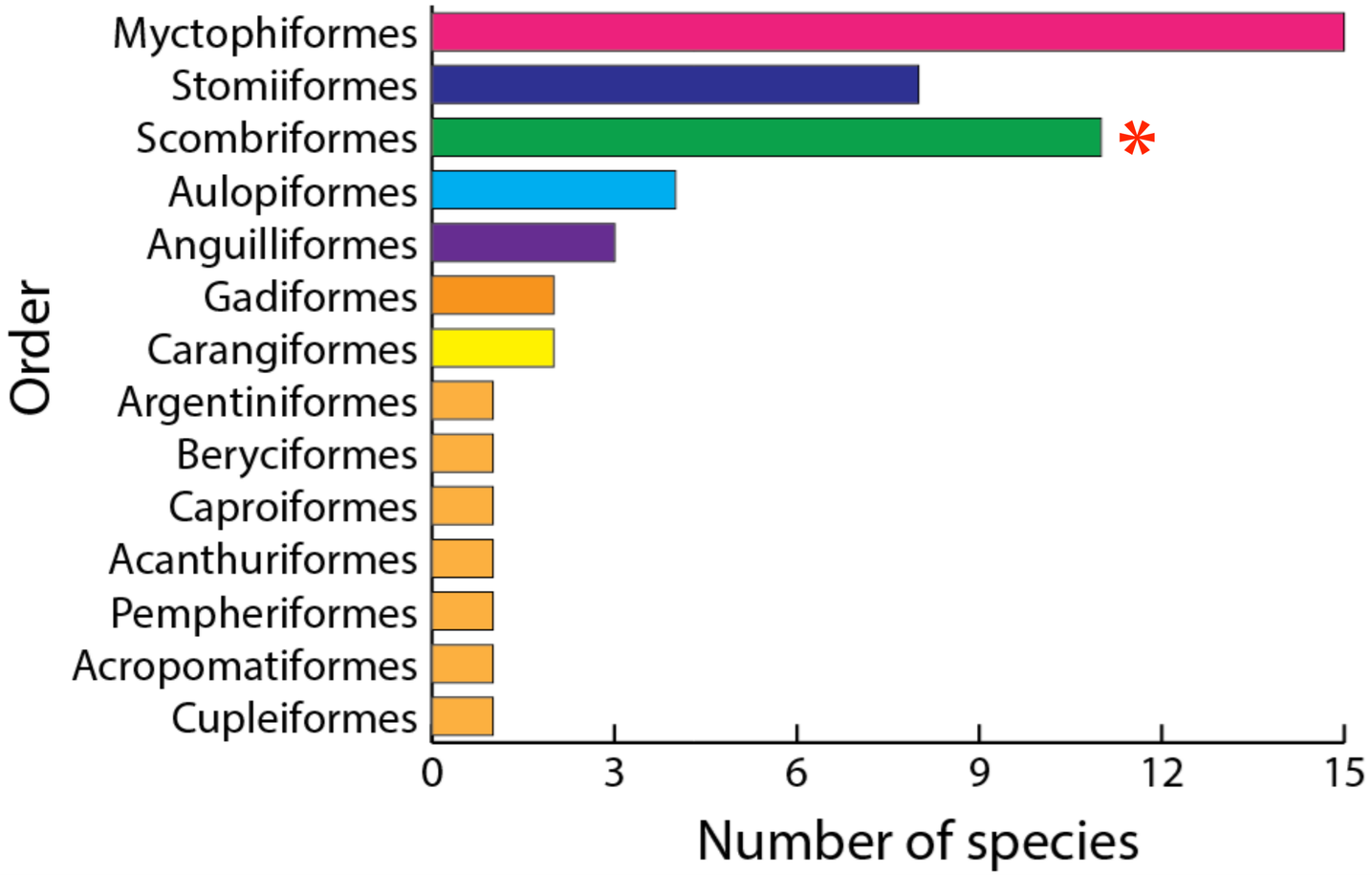
Sigmops elongates
Elongated bristle mouth

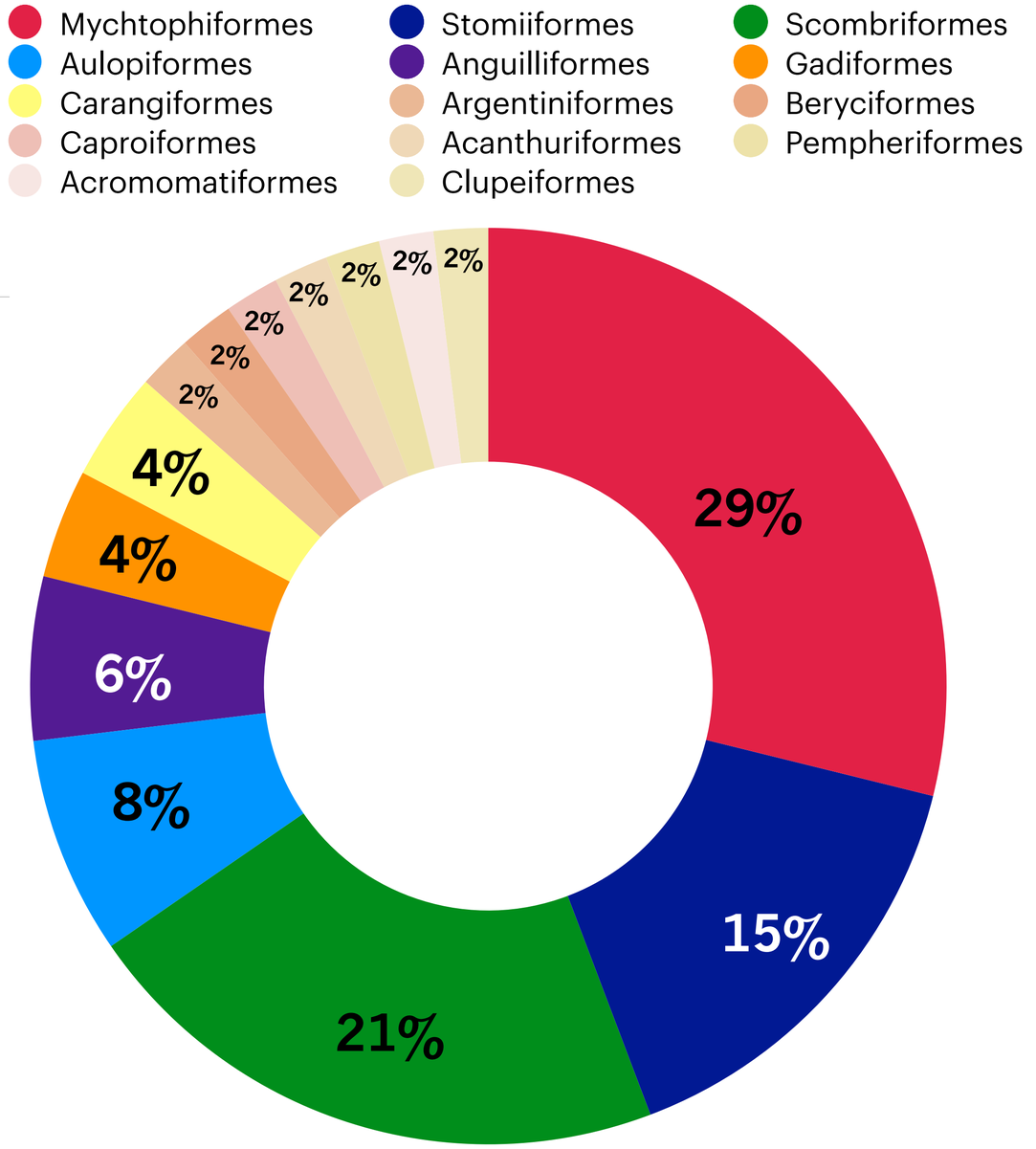
Bonapartia pedialota
Elongated bristle mouth

Hygophum Benoiti
Benoit's lanternfish

Astronesthes
Dragonfish

Myctophiformes and Stomiiformes are the most common orders





* Scombriformes are used as baits. Six families have been reported by fishermen, yet we found nine of families

Table 18.1

Representative teleostean taxa from the three major deepsea habitat types. The approximate number of deepsea families is given in parentheses the first time a group is listed. Based on Marshall (1971, 1980); Wheeler (1975); Gage and Tyler (1991); Nelson (2006). Figures from Marshall (1971), used with permission.

Mesopelagic (750 spp.)
Superorder Elopomorpha
Albuliformes (3): Notacanthidae – spiny eels
Anguilliformes (6): Nemichthyidae – snipe eels; Synaphobranchidae – cutthroat eels
Superorder Protacanthopterygii
Argentiniformes (5): Microstomatidae – deepsea smelts; Opisthoproctidae – barreleyes; Alepocephalidae – slickheads; Platytroctidae – tubeshoulders
Superorder Stenopterygii
Stomiiformes (5): Gonostomatidae – bristlemouths; Sternoptychidae – hatchetfishes; Stomiidae – barbeled dragonfishes


hachetfish

Superorder Cyclosquamata
Aulopiformes (11): Evermannellidae – sabertooth fishes; Alepisauridae – lancetfishes; Paralepididae – barracudinas; Giganturidae – telescopefishes


giganturid

Superorder Scopelomorpha
Myctophiformes (2): Neoscopelidae – blackchins; Myctophidae – lanternfishes
Superorder Lampriomorpha
Lampriformes (4): Stylephoridae – tube-eyes
Superorder Acanthopterygii
Stephanoberyciformes: Mirapinnidae – hairyfish
Perciformes: Chiasmodontidae – swallowers; Gempylidae – snake mackerels

Bathypelagic (200 spp.)
Superorder Elopomorpha
Anguilliformes: Nemichthyidae – snipe eels; Serrivomeridae – sawtooth eels
Saccopharyngiformes: Saccopharyngidae – swallower and gulpers; Eurypharyngidae – pelican eels


gulper

Superorder Protacanthopterygii
Argentiniformes: Alepocephalidae – slickheads
Superorder Stenopterygii
Stomiiformes: Gonostomatidae – bristlemouths
Superorder Paracanthopterygii
Gadiformes: Melanonidae – pelagic cods; Macrouridae – grenadiers and rattails
Ophidiiformes: Ophidiidae – cusk-eels; Bythitidae – viviparous brotulas
Lophiiformes (12): Ceratioidei – deepsea anglerfishes, seadevils (11)
Superorder Acanthopterygii
Stephanoberyciformes: Melamphaidae – bigscale fishes; Stephanoberycidae – pricklefishes; Cetomimoidea – whalefishes (3)
Beryciformes (9): Anoplogastridae – fangtooths
Perciformes: Chiasmodontidae – swallowers


whalefish

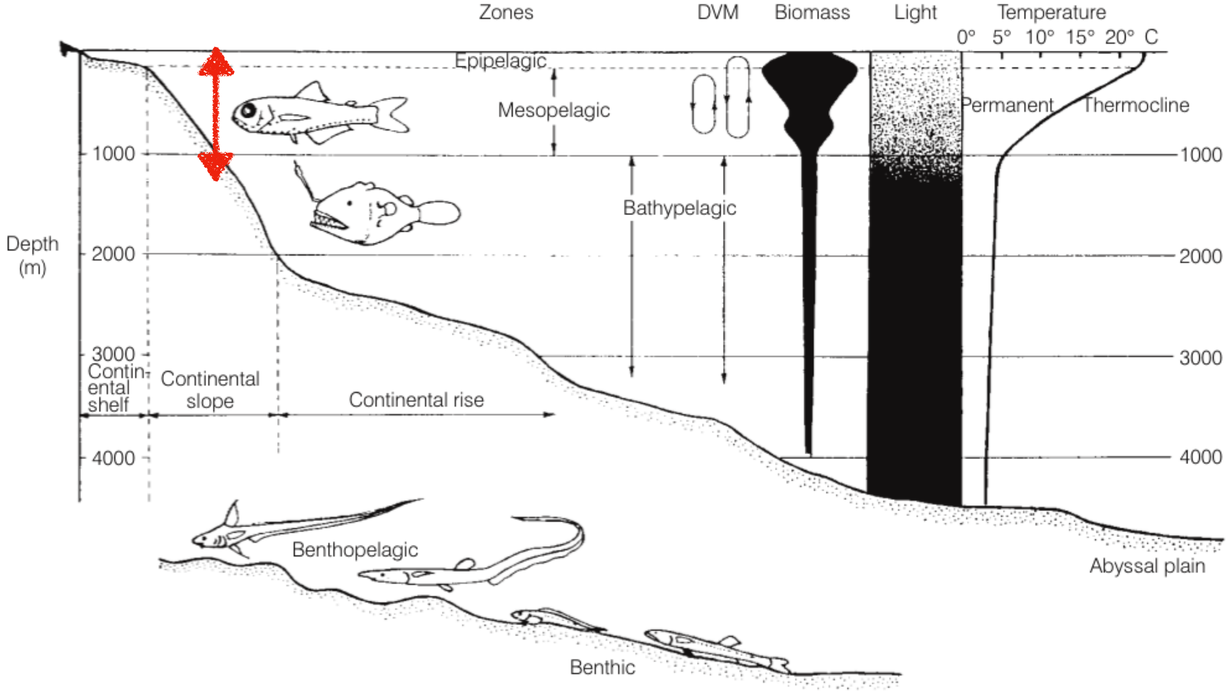
Benthal[a] (1000 benthopelagic and benthic spp.)
Superorder Elopomorpha
Albuliformes: Halosauridae – halosaurs; Notacanthidae – spiny eels
Anguilliformes: Synaphobranchidae – cutthroat eels
Superorder Cyclosquamata
Aulopiformes: Synodontidae – lizardfishes; Chlorophthalmidae – greeneyes; Ipnopidae – spiderfishes and tripodfishes
Superorder Paracanthopterygii
Gadiformes: Macrouridae – grenadiers; Moridae – morid cods; Merlucciidae – merlucciid hakes
Ophidiiformes: Ophidiidae – cusk-eels; Bythitidae – viviparous brotulas; Aphyonidae – aphyonids
Lophiiformes: Ogcocephalidae – batfishes
Superorder Acanthopterygii
Scorpaeniformes: Liparidae – snailfishes
Perciformes: Zoarcidae – eel-pouts; Bathydraconidae – Antarctic dragonfishes; Caproidae – boarfishes


brotula

[a] Chimaeras and many squaloid sharks are benthopelagic. Most benthal fishes live above 1000 m, although some grenadiers and rattails live between 1000 and 4000 m, macruronid southern hakes live somewhat deeper, tripodfish live to 6000 m, snailfishes to 7000 m, and neobythitine cusk-eels live do to 8000 m.

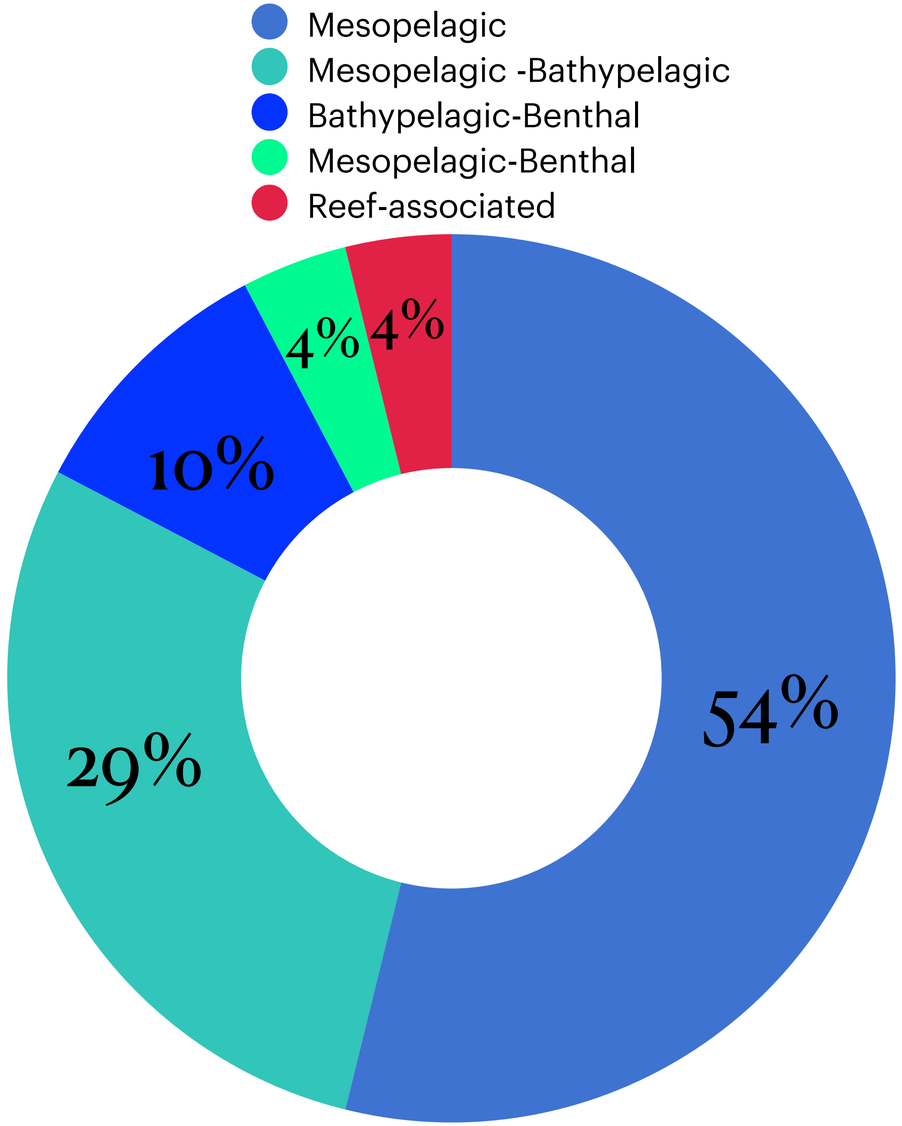
Helfman et al., 2009

Preys occupy two habitats: Mesopelagic and benthypelagic

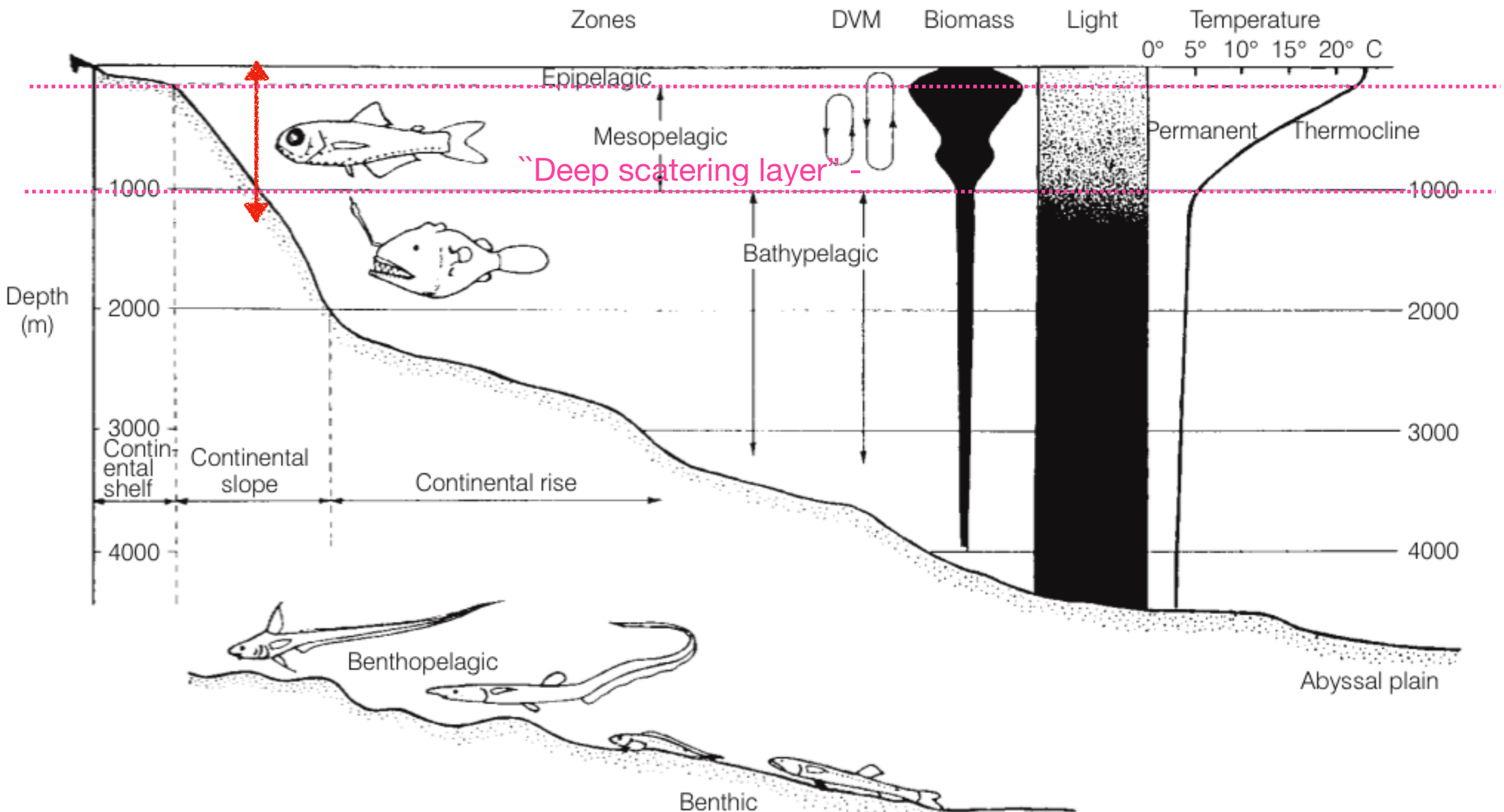


Transfer of energy to dermersal areas through mesopelagic and bathypelagic preys due to fish vertical migrations

	Major regions open water	*order*	*Number of species*
1	Mesopelagic	Myctophiformes	12
2	Mesopelagic - Bathypelagic	Stomiiformes	8
3	Mesopelagic	Scombriformes	7
4	Mesopelagic - Bathypelagic	Aulopiformes	4
5	Mesopelagic - Bathypelagic	Anguilliformes	3
6	Bathypelagic -Benthal	Gadiformes	2
7	Mesopelagic	Carangiformes	2
8	Bathypelagic -Benthal	Argentiniformes	1
9	Mesopelgic - Benthal	Beryciformes	1
10	Mesopelgic - Benthal	Caproiformes	1
11	reef-associated	Acanthuriformes	1
12	bathypelagic	Pempheriformes	1



Transfer of energy to dermersal areas through mesopelagic and bathypelagic preys due to fish vertical migrations



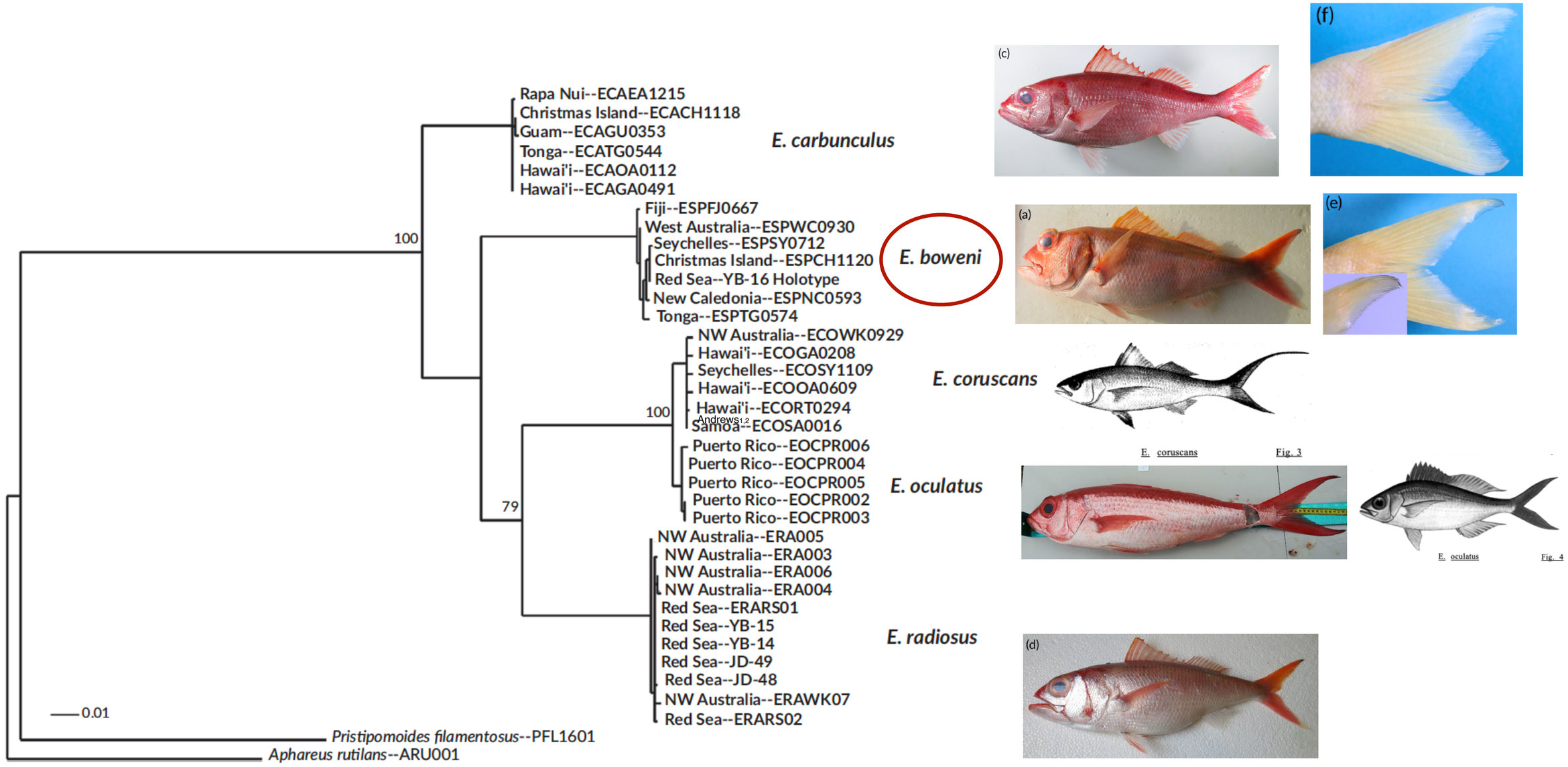


FIGURE 7 Maximum likelihood phylogeny of *Etelis* inferred using concatenated cyt*b* and COI sequences. Nodes show bootstrap support from 1000 replicates for bootstrap values >75%. See Supporting Information Table S1 for details

Andrews et al 2020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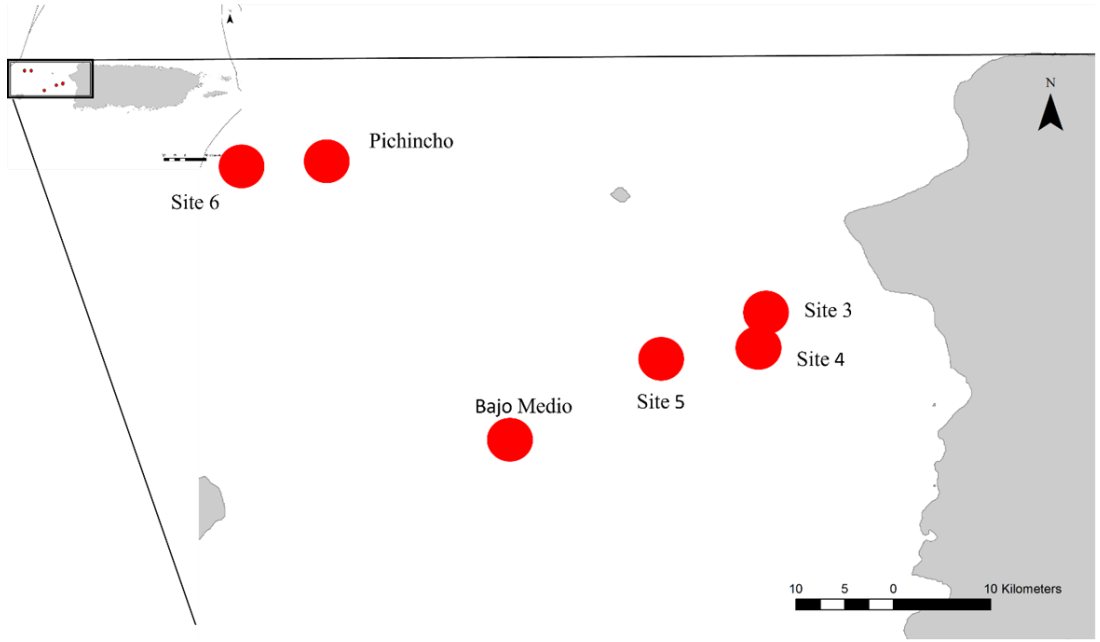
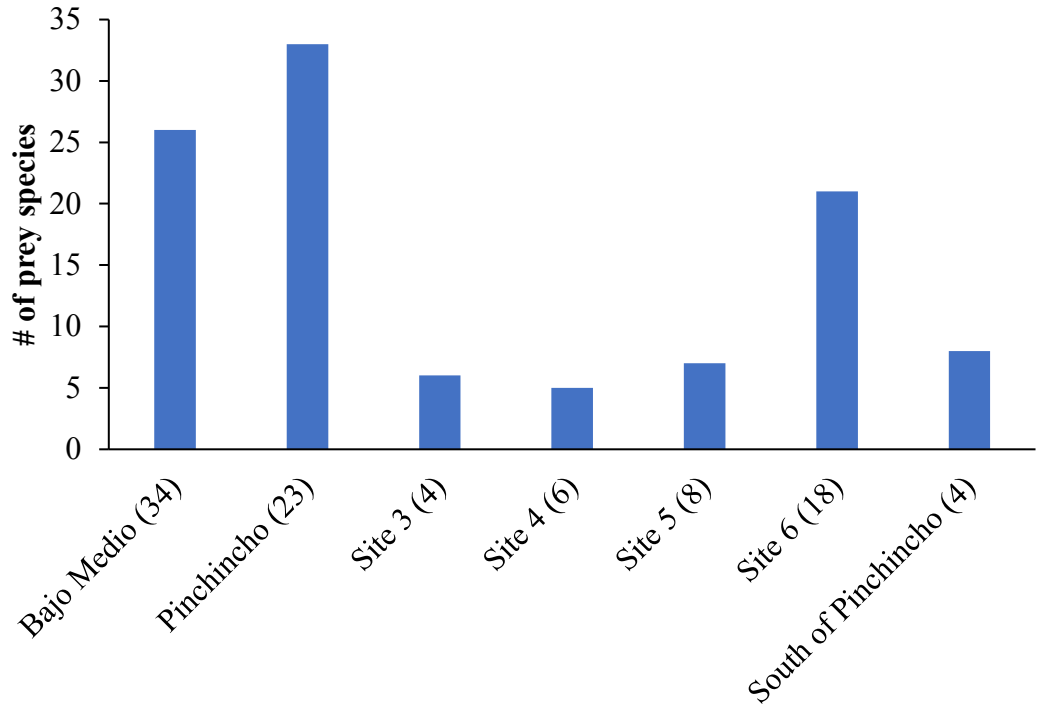
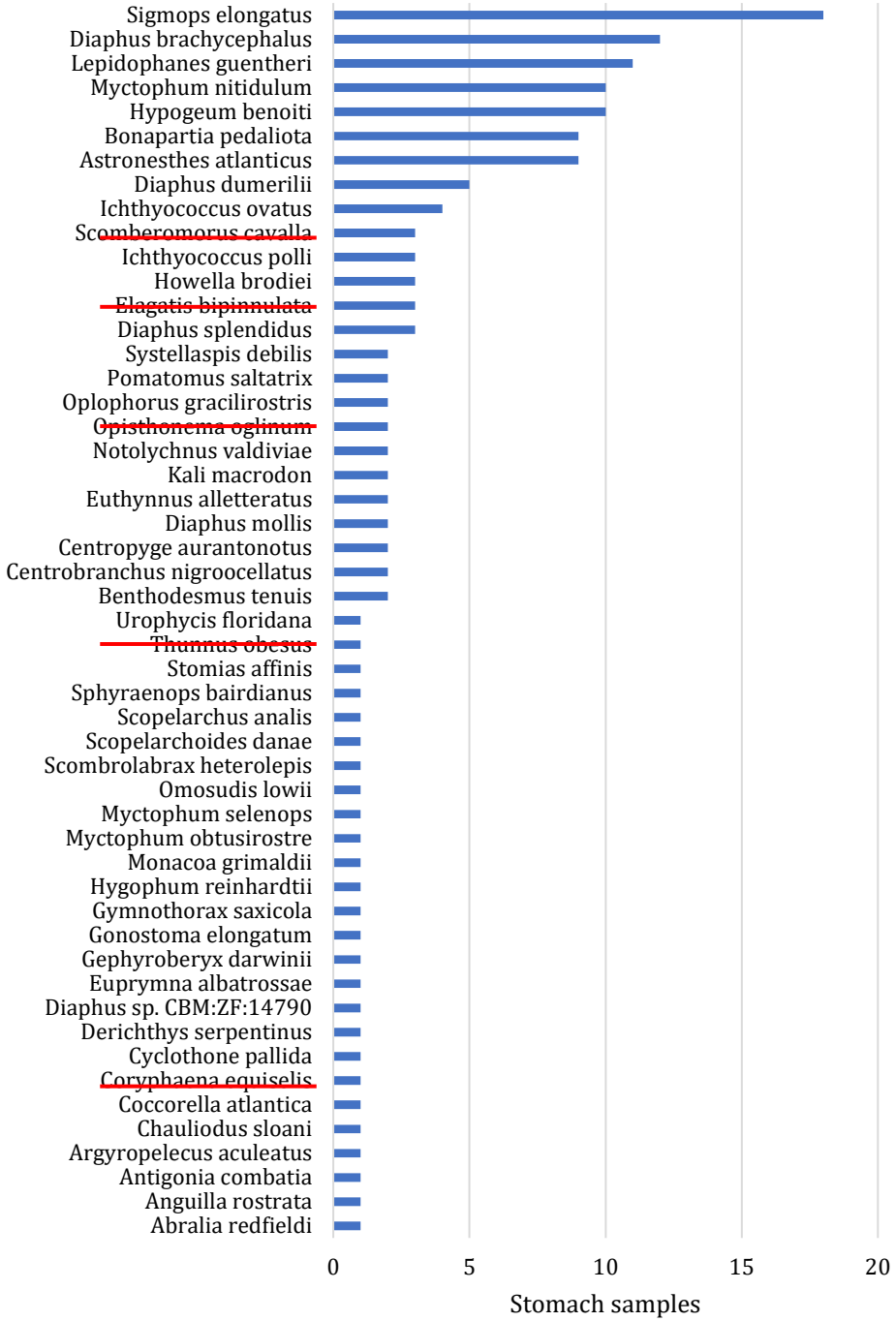
Prey vs location





Pichincho

46 prey species



Elongated bristlemouth fish

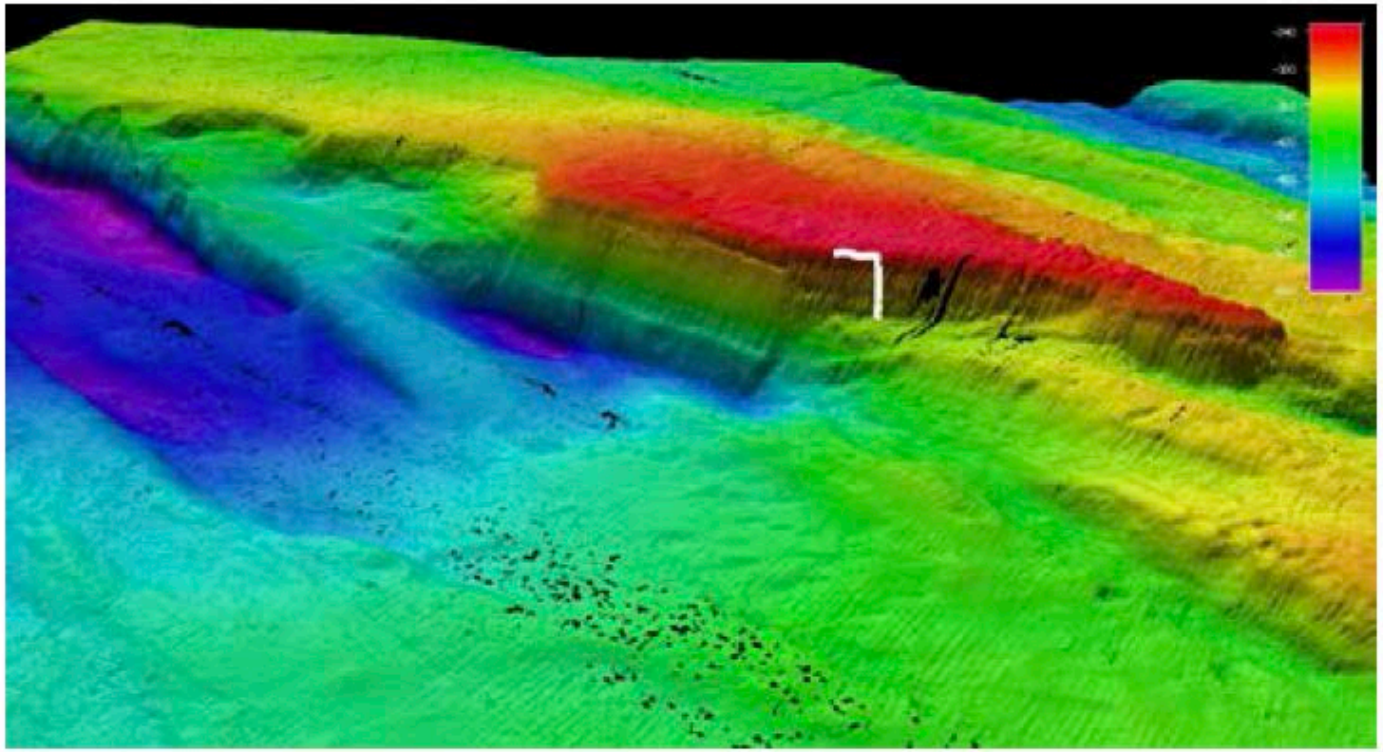
Short-head lanternfish

Günther's lanternfish

Pearly lanternfish

@Fishbase

Pichincho



@Okeanos

Prey vs Size

203-508 mm- 40 species

Short-head lanternfish
(*D. brachycephalus)*

Pearly lanternfish
(*Myctophum nitidulum)*

Dumeril's lanternfish
(*D. dumerilii)*

508-1016 mm fork- 39 species

Longray fangjaw
(*B. pedaliota)*

Elongated
Bristlemouth
(*S. elongatus)*

Benoit's lanternfish
(*H. benoiti)*

Gobert et al. 2005

Conclusions

- Strong weight-fork length relationship
  - Power parameter was 2.80 (similar to Rosario et al. 2006)
  - Queen snapper exhibits isometric growth
- Queens may also spawn in July (October and November)
  - Supports anecdotal accounts by fishers
- Metabarcoding is an effective approach to identify stomach contents of deep-water fish
- A total of 61 species belonging to 18 orders, 38 genera and 31 families were observed in the stomach contents

Conclusions

- Queens are large carnivore, which feeds on squid, shrimp and deep-water fishes
  - *E. coruscans* and *E. carbunculus*
- *E. oculatus* is feeding mainly on mesopelagic fishes, mostly Myctophidae, that likely inhabit the mesopelagic boundary
- Queens maybe the key link between shallow highly productive environments and demersal mostly unproductive areas
- Prey composition may vary between locations, sex and age
- Essential to incorporate fishers in any future queen snapper research

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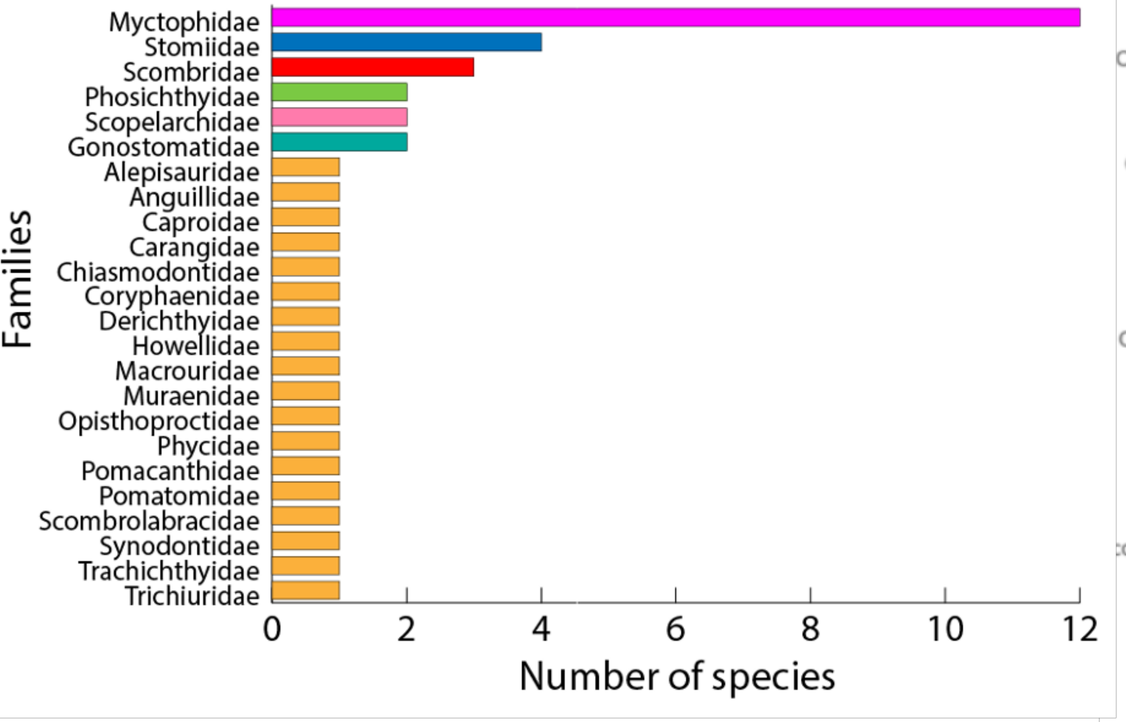
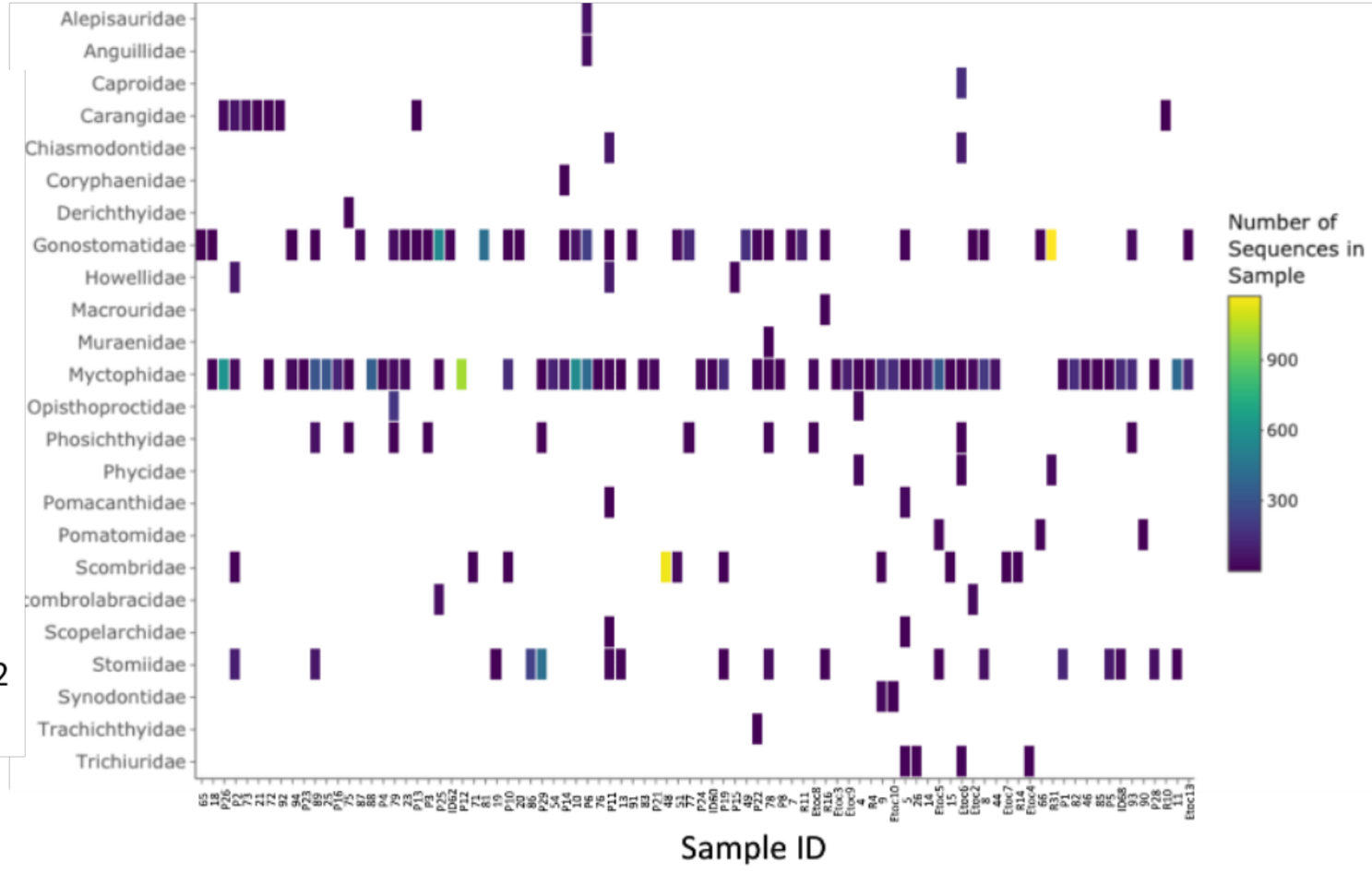
Myctophidae and stomiidae are the most common families

31 families





Specie	Distribution				
Diaphus brachycephalus	Marine	bathypelagic	oceanodromous	depth range 200 - 600 m	Deep-water
Sigmops elongatus	Marine	bathypelagic		depth range 25 - 4740 m	Deep-water
Bonapartia pedaliota	Marine	bathypelagic		depth range 100 - 1200 m	Deep-water
Lepidophanes guentheri	Marine	pelagic-oceanic	oceanodromous	depth range 40 - 750 m	
Myctophum nitidulum	Marine	bathypelagic	oceanodromous	depth range 412 - 1537 m	Deep-water
Hygophum benoiti	Marine	bathypelagic	oceanodromous	depth range 51 - 700 m	Deep-water
Astronesthes atlanticus	Marine	bathypelagic		depth range 300 - 1200 m	
Diaphus dumerilii	Marine	pelagic-oceanic	oceanodromous	depth range - 805 m	
Coccorella atlantica	Marine	bathypelagic	oceanodromous	depth range 50 - 1000 m	Deep-water
Dasyscopelus selenops	Marine	bathypelagic	oceanodromous	depth range 40 - 500 m	Deep-water

Helfman et al., 2009