SHARK MANAGEMENT NEEDS IN PUERTO RICO
A FEW NOTES ON HOW TO PROCEED

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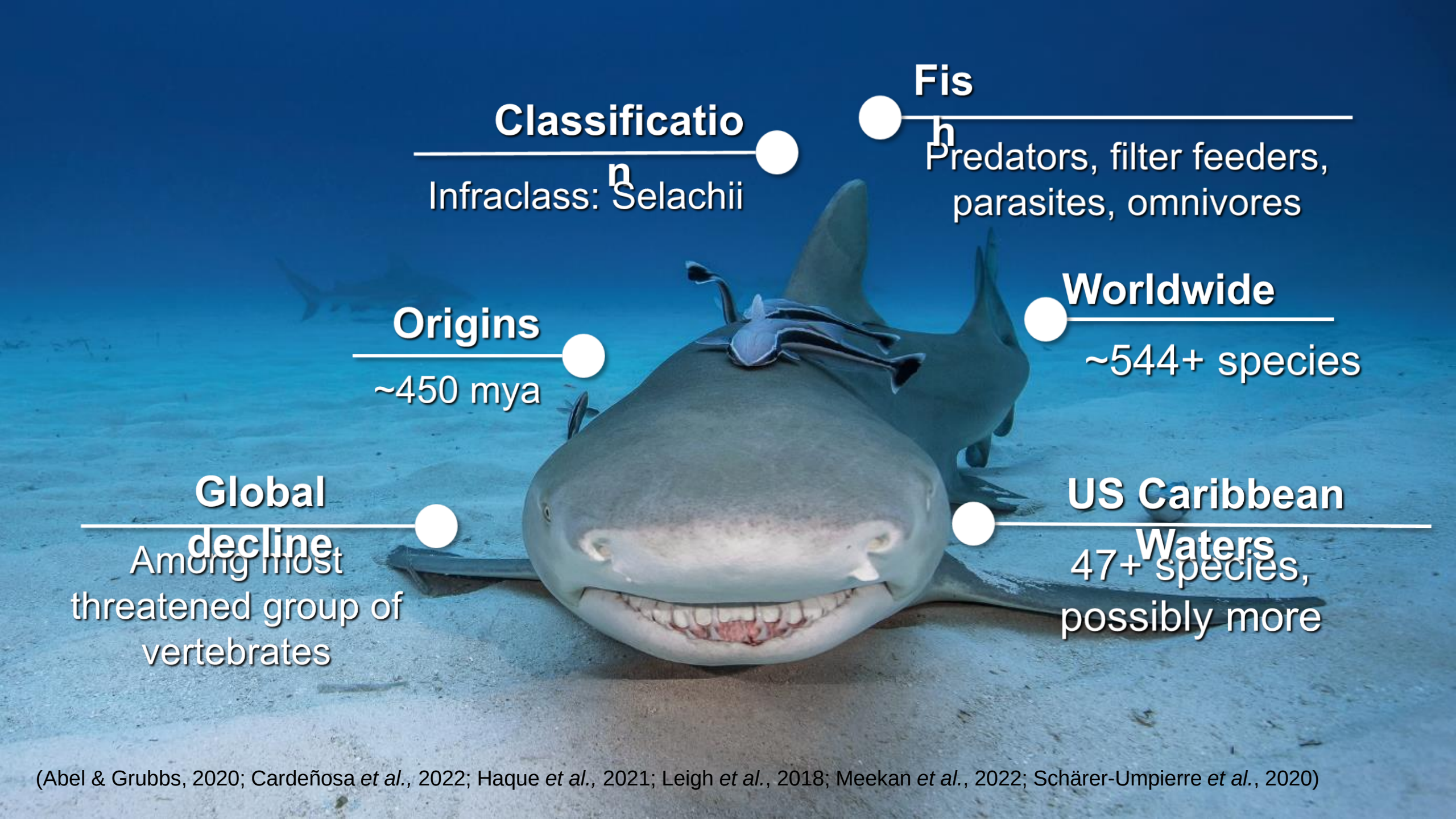
Little Women, Big Sharks

Special thanks to Michelle Schärer Umpierre
and Emmanuel Maldonado González



(Abel & Grubbs, 2020; Cardeñosa *et al.,* 2022; Haque *et al.,* 2021; Leigh *et al.*, 2018; Meekan *et al.*, 2022; Schärer-Umpierre *et al.*, 2020)

Threats

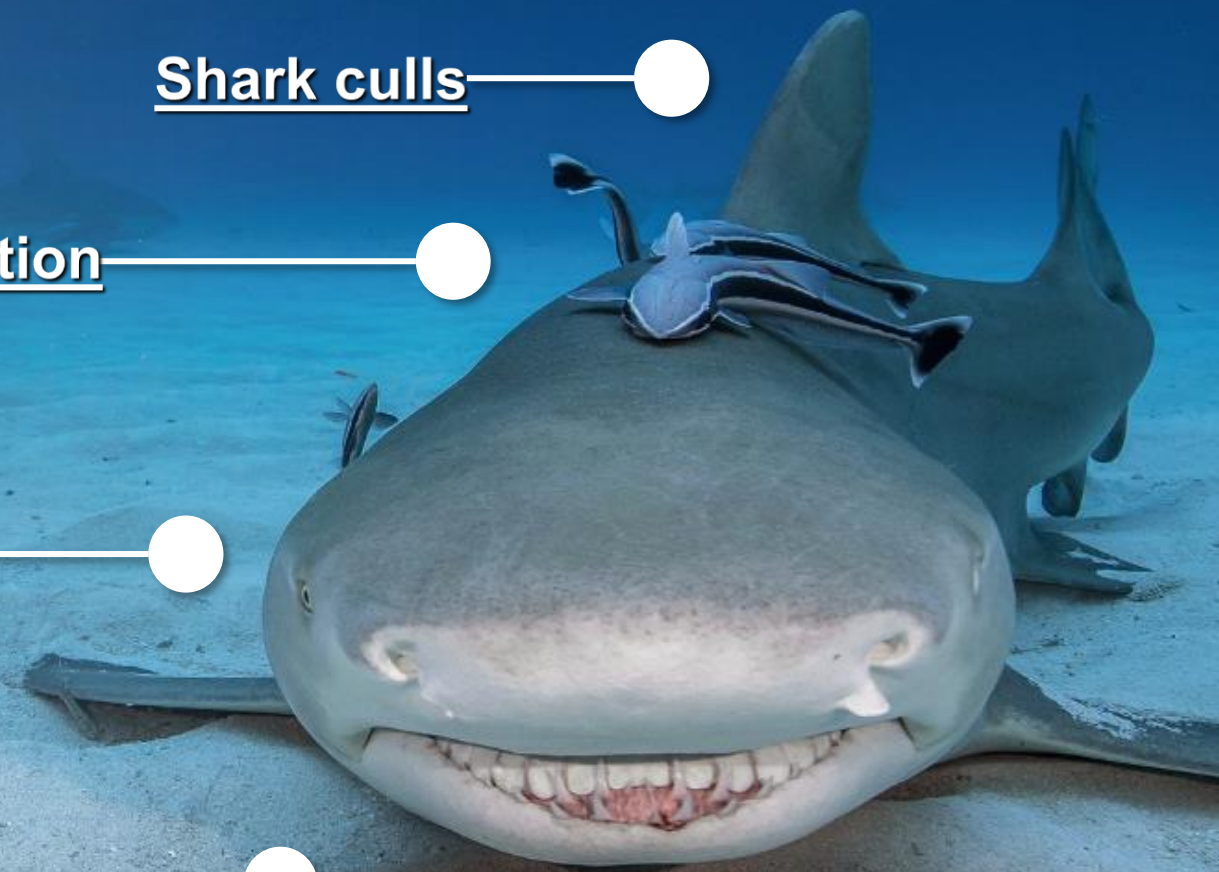
Overfishing
- Target species & bycatch
- Mixed fisheries
- Uses

Shark culls

Habitat degradation & destruction
- ESH
- Natal philopatry

Pollution & marine debris
- Entanglement
- Microplastic aspiration by filter feeders

Climate change
- "Deadly trio" (i.e. ocean warming, acidification & deoxygenation)



(Carrier *et al*., 2022; Dulvy *et al*., 2014; Stevens *et al*., 2000)

Decline

Threats
- Exploitation
- Habitat degradation

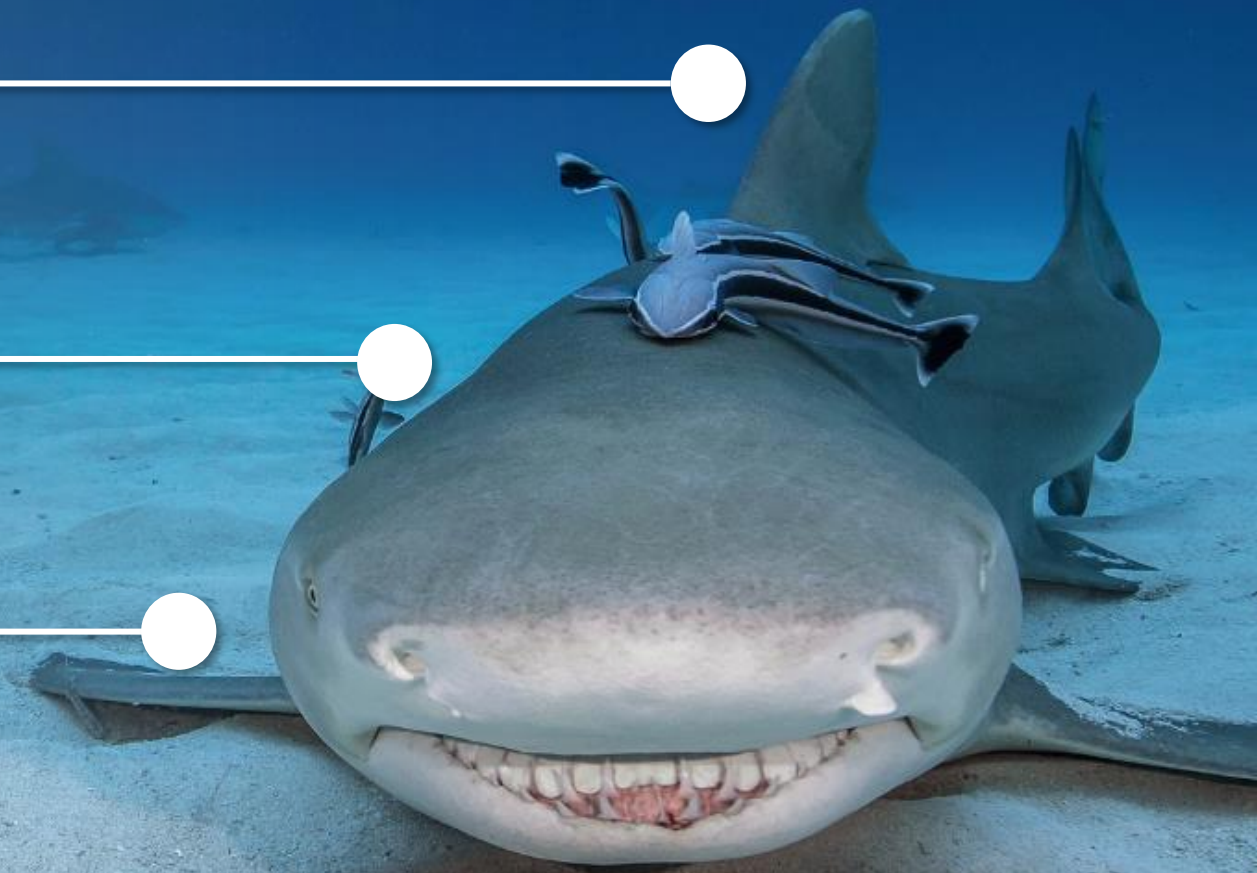
Progression of threats
- Incresing magnitude
- Increasing speed

(e.g. fast expansion of fisheries)

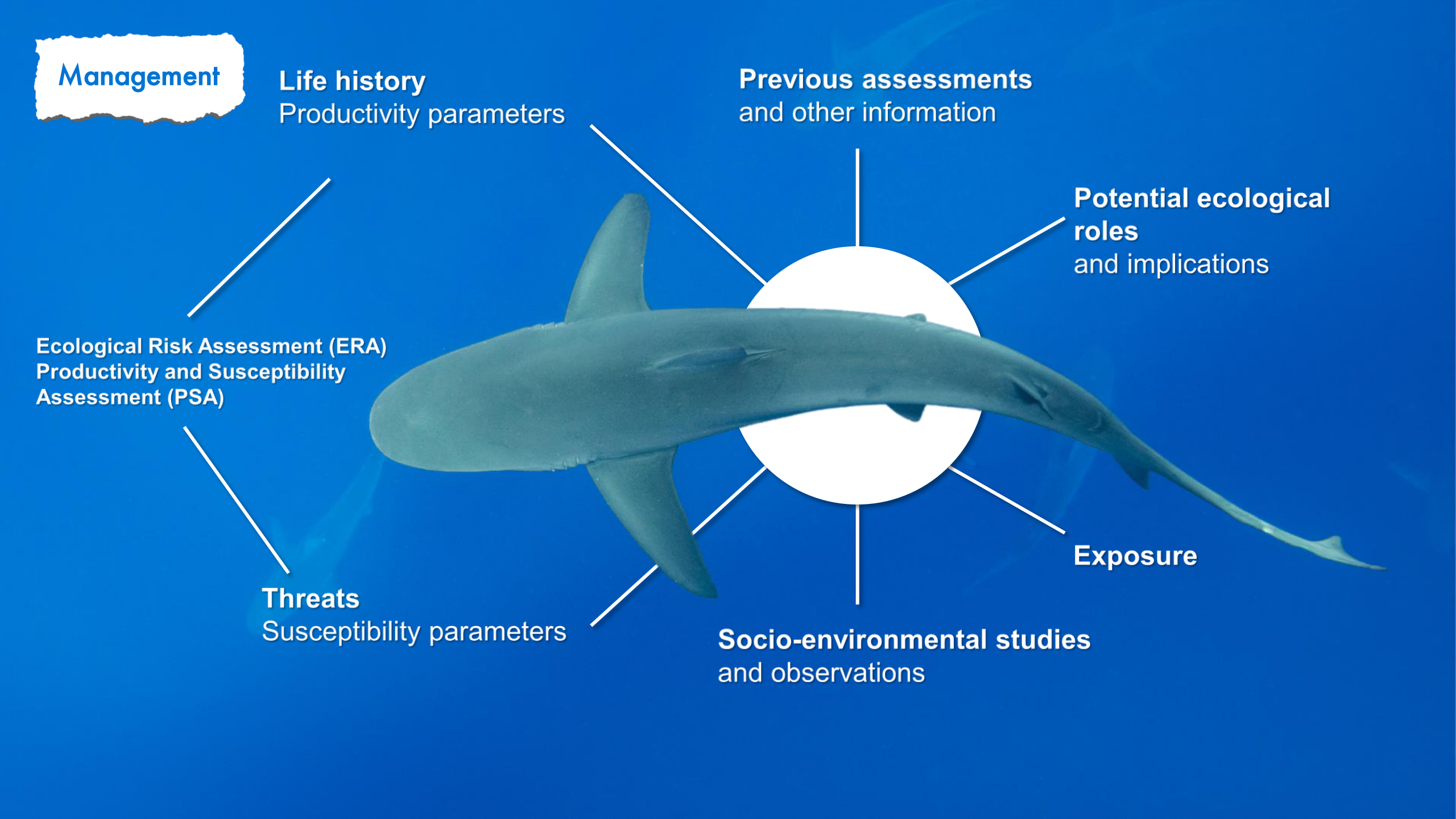
Exposure
- Size (larger sharks)
- Habitat range in relation to coast proximity (sharks closer to the coast)

Life history
- Low fecundities (few pups per litter)
- Infrequent litters (some bienial and trienial)
- Late maturing
- High longevity (long-lived)
- Long gestation periods

Poor or inadequate management
- Productivity & susceptibility



(Camhi *et al*., 1998; Cortés, 2000 ; Dulvy *et al*., 2014; Ferretti *et al*., 2010; Musick *et al*., 2000; Musick, 1999; Simpfendorfer *et al*., 2011; Stevens *et al*., 2000; Wilson *et al*., 2019)


Management
Life history
Productivity parameters
Previous assessments
and other information
Potential ecological roles
and implications
Ecological Risk Assessment (ERA)
Productivity and Susceptibility Assessment (PSA)
Exposure
Threats
Susceptibility parameters
Socio-environmental studies
and observations

Management

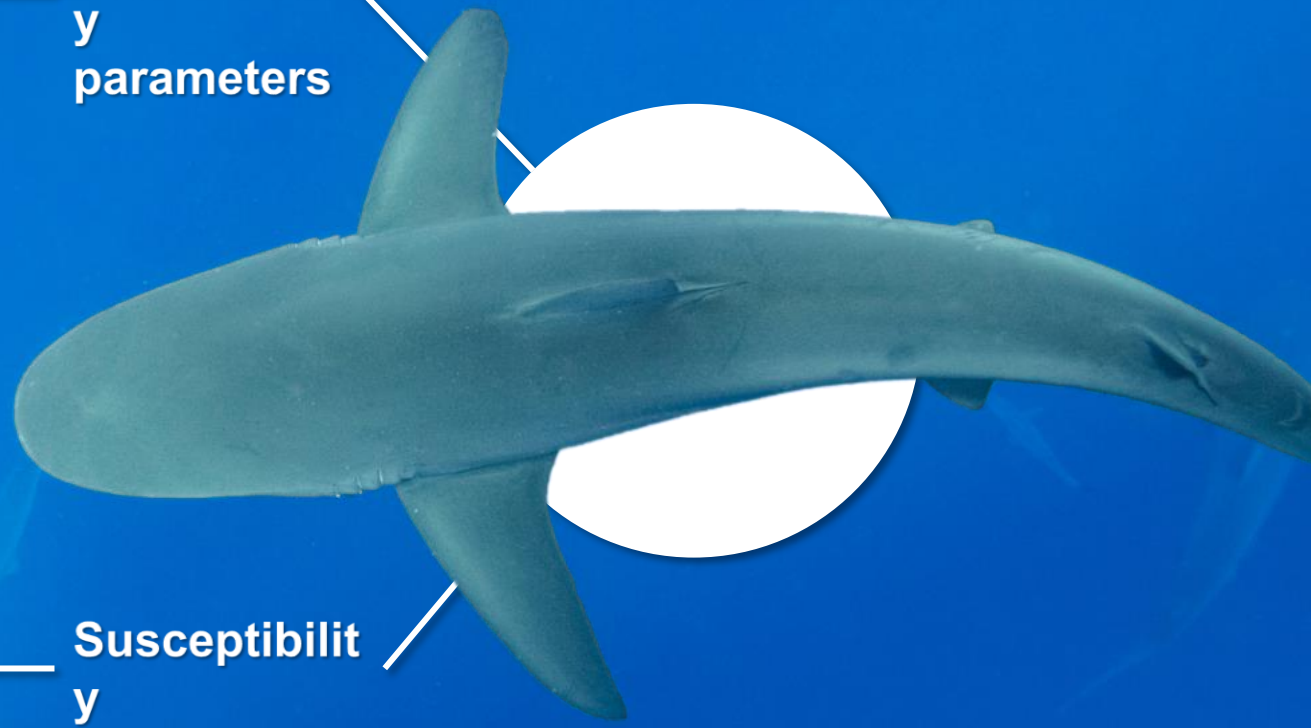
Productivity parameters

- ✓ **Population growth** (r)
- ✓ **von Bertalanffy growth coefficient** (k)
- ✓ **Age at maturity** (t_{mat})
- ✓ **Maximum age** (t_{max})
- ✓ **Maximum size** (L_{max})
- ✓ **Fecundity**
- ✓ **Breeding strategy**
- ✓ **Natural mortality rate** (M)
- ✓ **Mean trophic level**

Susceptibility parameters

E.g. Fishing

- ✓ **Overlap of stock and fishery** (horizontal and vertical)
- ✓ **Geographic concentration**
- ✓ **Behavior in response to fishing** (migrations, schooling, aggregations, etc.)
- ✓ **Desirability and value** (overfishing vs overfished, fishing effort vs product value)
- ✓ **Morphological characteristics affecting capture by fishing gear**
- ✓ **Management in place if any**
- ✓ **Fishing rate relative to M**
- ✓ **Biomass of spawners**
- ✓ **Survival after capture and release**
- ✓ **Fisheries impact on habitat** (e.g. EFH)



(Duffy & Griffiths, 2019; Patrick *et al.*, 2009)

Management

Previous assessments and other information

- Complicated baseline & catch history
- Abundance trends

E.g. Global Fin Print (GFP) initiative

- 2017-2018
- HJR Reefscaping & Florida International University
- Baited Remote Underwater Video (BRUV)
- Elasmobranch diversity and relative abundance
- South and west of Puerto Rico
- Coral reef habitat
- In sampled sites:
  - → In line with previous findings: low elasmobranch diversity and abundance in Caribbean coral reefs
  - → Low presence of large predatory sharks
  - → Suggesting low population sizes of large predatory sharks

(Pacoureau, 2023; Schärer-Umpierre *et al.*, 2020)

Management

Potential ecological roles and implications

Large predatory sharks

- Top predators/consumers of ocean food webs
- 10 feet or larger in tropical waters
- Predators
- Important ecological roles
    - → Top-down population control
    - → Weeding out the sick and the dead
    - → Other roles also performed by mesopredatory sharks
- Keystone species
- Loss of these sharks could lead to direct and indirect effects ecologically and economically

Exposure

High exposure

- Size: Large
- Proximity to coast: Inland and neritic environments

(Camhi *et al.*, 1998 ; Carrier *et al.*, 2022; Ferretti *et al.*, 2010; Gallagher *et al.*, 2012; Heithaus *et al.*, 2007)

Management

Socio-environmental studies and observations

Could bring insight on a group of species and their condition

May suggest what other efforts needed to be brought forth in order to complement management strategies

→ Educational methodologies (e.g. workshops)

→ Informative and educational resources

E.g. *Stakeholder analysis regarding sharks and stingrays in Puerto Rico*

- 2022-2023
- Emmanuel Maldonado, HJR Reefscaping and IslaMar
- Ethnographic assessment, interviews, social media analysis
- Stakeholders (fishers, conservationists, general public)
- 44 coastal municipalities

→ Lack of information = Negative perception

→ Knowledge = Positive perception

→ Interest in learning about sharks and rays

→ Need for species ID

→ Alternatives to shark fishing

(Maldonado-González *et al.*, 2023)

Where could we start?

Criteria

- ✓ Large sharks (10 ft or larger)
- ✓ Predators
  - Usually large prey carnivores and scavengers
- ✓ Possibly top consumers within habitat range
- ✓ Habitat range in promity to the coast
  - Inland and neritic habitat range
- ✓ Overall low productivity
- ✓ Susceptibility should be measured

Table 1. Large predatory sharks with overall low productivities and a habitat range in close proximity to the coast, for which suceptibility should be measured.

	Common name in English	Species name	Habitat range	Global status IUCN	Regulations & Protections
	Common thresher	*Alopias vulpinus*	Neritic & open ocean	Vulnerable	Regulated international trade - CITES Appendix II Fishing regulations in federal waters - HMS
	Bigeye thresher	*Alopias superciliosus*	Neritic & open ocean	Vulnerable	Regulated international trade - CITES Appendix II Protected in federal waters - HMS
	Shortfin mako	*Isurus oxyrinchus*	Neritic & open ocean	Endangered	Regulated international trade - CITES Appendix II Fishing regulations in federal waters - HMS
	Silky shark	*Carcharhinus falciformis*	Neritic & open ocean	Vulnerable	Regulated international trade - CITES Appendix II Fishing regulations in federal waters - HMS
	Oceanic whitetip shark	*Carcharhinus longimanus*	Neritic, open ocean & deepwater	Critically Endangered	Regulated international trade - CITES Appendix II Protected in PR territorial and federal waters– HMS, ESA, New Wildlife Act of Puerto Rico
	Dusky shark	*Carcharhinus obscurus*	Neritic & open ocean	Endangered	Regulated international trade - CITES Appendix II Protected in federal waters - HMS
	Caribbean reef shark	*Carcharhinus perezii*	Neritic & open ocean	Endangered	Regulated international trade - CITES Appendix II Protected in federal waters - HMS regulations)
	Bull shark	*Carcharhinus leucas*	Inland, neritic & open ocean	Vulnerable	Regulated international trade (CITES Appendix II); regulated in federal waters (HMS regulations
	Lemon shark	*Negaprion brevirostris*	Inland & neritic	Vulnerable	Regulated international trade (CITES Appendix II) Fishing regulations in federal waters - HMS
	Blue shark	*Prionace glauca*	Neritic & open ocean	Near Threatened	Regulated international trade CITES Appendix II) Fishing regulations in federal waters - HMS regulations
	Tiger shark	*Galeocerdo cuvier*	Inland, neritic, open ocean & deepwater	Near Threatened	Fishing regulations in federal waters - HMS
✓	Scalloped hammerhead	*Sphyrna lewini*	Inland, neritic, open ocean & deepwater	Critically Endangered	Regulated international trade - CITES Appendix II Protected in PR territorial and federal waters – HMS, ESA, New Wildlife Act of Puerto Rico
	Great hammerhead	*Sphyrna mokarran*	Inland, neritic & open ocean	Critically Endangered	Regulated international trade - CITES Appendix II Protected in federal waters - HMS
	Galapagos shark	*Carcharhinus galapagensis*	Neritic & open ocean	Least Concern	Regulated international trade - CITES Appendix II Protected in federal waters - HMS
	Sandbar shark	*Carcharhinus plumbeus*	Inland & neritic	Endangered	Regulated international trade - CITES Appendix II Fishing regulations in federal waters - HMS
	Nurse shark	*Ginglymostoma cirratum*	Neritic	Vulnerable	Protected in PR territorial waters - Puerto Rico Fisheries Law, Reglamento de Pesca de Puerto Rico Fishing regulations in federal waters (HMS regulations)

HMS – Highly Migratory Species regulations | ESA – Endangered Species Act (Castro, 2011; CITES, 2023; DNER-PR, 2004; Ebert *et al*., 2021; Gobierno de Puerto Rico, 2020; IUCN, 2023; NOAA Fisheries, 2023; Office of Sustainable Fisheries Atlantic Highly Migratory Species Management Division, 2023; Patrick *et al*., 2009)

Table 2. Large predatory sharks with a habitat range in close proximity to the coastand, particularly low productivities and no local (within territorial waters) regulations in place.

Common name in English	Species name	Habitat range	Global status IUCN	Regulations & Protections
Shortfin mako	*Isurus oxyrinchus*	Neritic & open ocean	Endangered	Regulated international trade - CITES Appendix II Fishing regulations in federal waters - HMS
Dusky shark	*Carcharhinus obscurus*	Neritic & open ocean	Endangered	Regulated international trade - CITES Appendix II Protected in federal waters - HMS
Great hammerhead	*Sphyrna mokarran*	Inland, neritic & open ocean	Critically Endangered	Regulated international trade - CITES Appendix II Protected in federal waters - HMS

HMS – Highly Migratory Species regulations (CITES, 2023; DNER-PR, 2004; Ebert *et al*., 2021; IUCN, 2023; NOAA Fisheries, 2023; Office of Sustainable Fisheries Atlantic Highly Migratory Species Management Division, 2023)

LARGE PREDATORY SHARKS

Shortfin mako *(Isurus oxyrinchus)*

Dusky shark *(Carcharhinus obscurus)*

Great hammerhead *(Sphyrna mokarran)*

WITH LOW PRODUCTIVITIES


Dusky shark
(Carcharhinus obscurus)


Dusky shark
(Carcharhinus obscurus)


Caribbean reef shark
(Carcharhinus perezii)


Silky shark
(Carcharhinus falciformis)


Galapagos shark
(Carcharhinus galapagensis)


Dusky shark
(Carcharhinus obscurus)


Silky shark
(Carcharhinus falciformis)

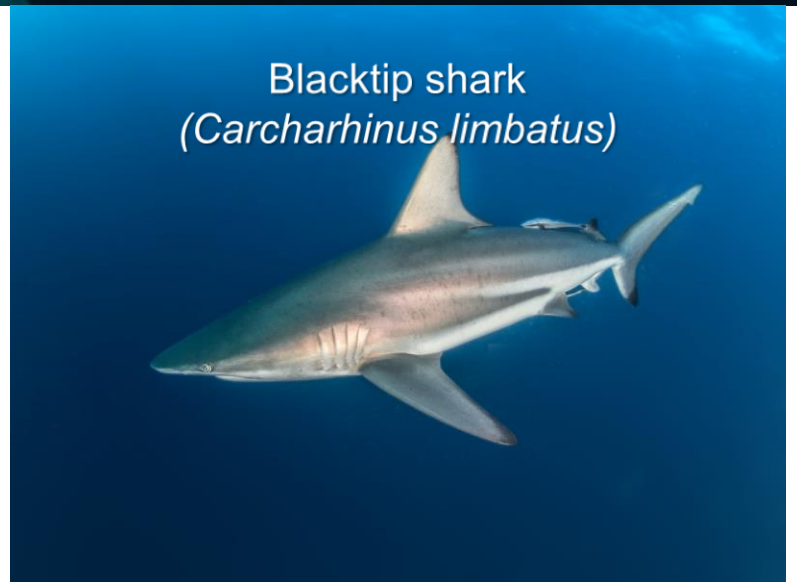

Galapagos shark
(Carcharhinus galapagensis)


Bull shark
(Carcharhinus leucas)


Dusky shark
(Carcharhinus obscurus)


Galapagos shark
(Carcharhinus galapagensis)


Bull shark
(Carcharhinus leucas)


Blacktip shark
(Carcharhinus limbatus)

Dusky shark
(Carcharhinus obscurus)

nsis)

Bull shark
(Carcharhinus leucas)

Blacktip shark
(Carcharhinus limbatus)

Caribbean reef shark
(Carcharhinus perezii)

Challenges

- ✓ Species identification
- ✓ Data collection on landings
- ✓ Data-poor species
- ✓ Not enough research
- ✓ Misinterpretation of current regulations
- ✓ Enforcement of current regulations

A way to move forward

- ✓ Photographic ID guide and workshops
- ✓ Improve data collection sheet (add discards and releases)
- ✓ Research in biology and ecology
- ✓ Incentivize students, develop courses and trainings, etc.
- ✓ Improve communication

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