

# Comisión Interamericana del Atún Tropical Inter-American Tropical Tuna Commission



## Vulnerability status and efficacy of potential conservation measures for the East Pacific leatherback turtle (*Dermochelys coriacea*) stock using the EASI-Fish approach

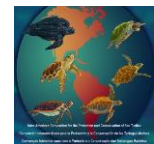
Shane Griffiths<sup>1</sup>, Bryan Wallace<sup>2,3,4</sup>, Yonat Swimmer<sup>5</sup>, Joanna Alfaro-Shigueto<sup>6,7</sup>, Jeffrey C. Mangel<sup>6,8</sup> & Ricardo Oliveros-Ramos<sup>1</sup>

<sup>1</sup>Inter-American Tropical Tuna Commission, <sup>2</sup>Ecolibrium, Inc., USA, <sup>3</sup>Duke University Marine Lab, USA, <sup>4</sup>Inter-American Convention for the Protection and Conservation of Sea Turtles, USA, <sup>5</sup>NOAA Fisheries, USA, <sup>6</sup>ProDelphinus, Perú, <sup>7</sup>Universidad Científica del Sur, Perú, <sup>8</sup>University of Exeter, UK.

IATTC Working Group on Bycatch, Informal Information Exchange, 4 June 2020 (Document BYC-10 INF-B)

# Outline

- IATTC responsibilities and progress to ensure ecological sustainability
- Need to assess vulnerability of eastern Pacific leatherback turtles
- A brief overview of the “EASI-Fish” model to quantify vulnerability
- Simulating conservation measures under IATTC Resolution C-19-04
- Future research

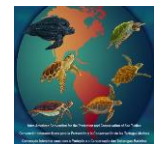


# IATTC responsibilities

- IATTC mandated to ensure ecological sustainability of its fisheries

## 1. Antigua Convention

- **Article II**, Objective: “...to ensure the long-term conservation and sustainable use of the fish stocks covered by this Convention.”
- **Article VII (f)** “...adopt, as necessary, conservation and management measures and recommendations for species belonging to the same ecosystem and that are affected by fishing...”





# IATTC responsibilities

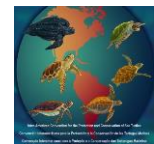
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## 2. IATTC Resolutions and Strategic Science Plan

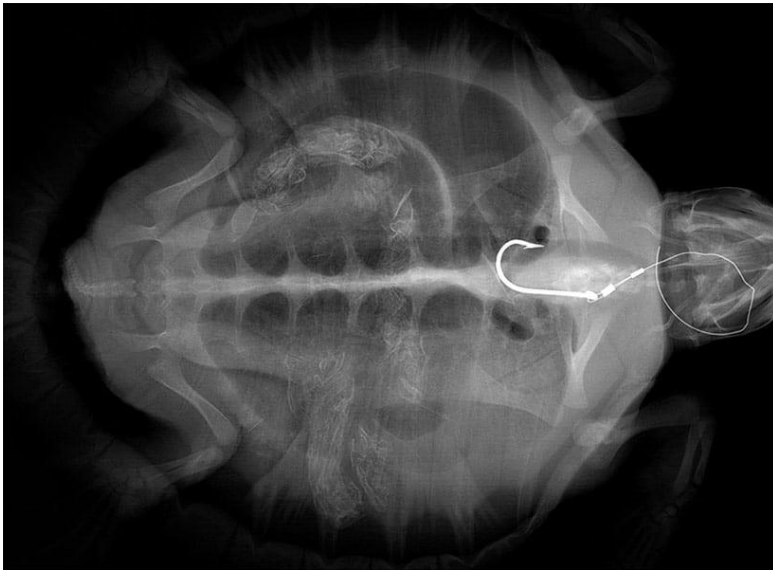
- Bycatch conservation since 2003 (C-03-08), elasmobranchs (C-05-03, C-11-10, C-15-04, C-16-05, C-19-05, C-19-06) and seabirds (C-10-02, C-11-02)
- Resolutions specific to sea turtles: 2003 (C-03-08), 2004 (C-04-07), 2008 (C-07-03), **2021 (C-19-04)**
- **C-19-04 approved in 2019 and will enter into force 1 January 2021**
- 5-year Strategic Science Plan (SSP): **Objective 4 - Ecological impacts of fisheries**



# Sea turtle resolution C-19-04

- C-19-04 mandates measures to mitigate bycatch and reduce post-capture mortality (PCM)
  - Use of only **large circle hooks** in shallow longline sets (to reduce deep hooking and PCM), OR

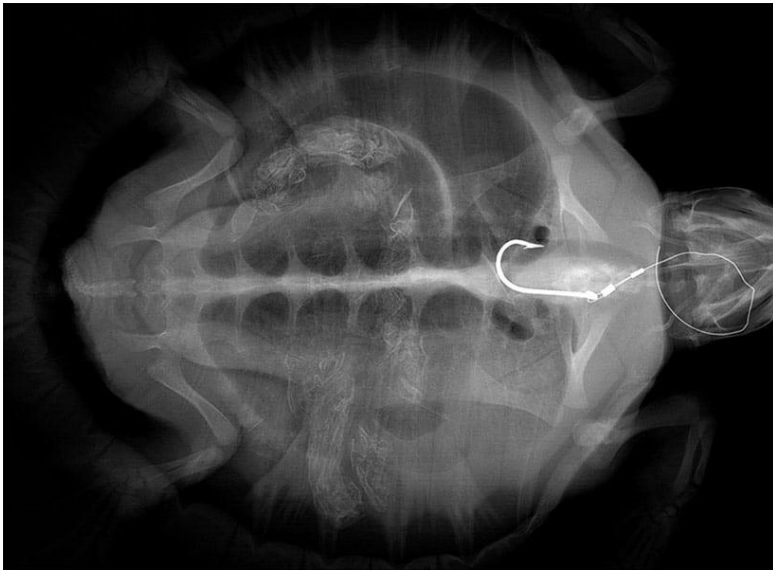
## Prohibition of using “J” hooks



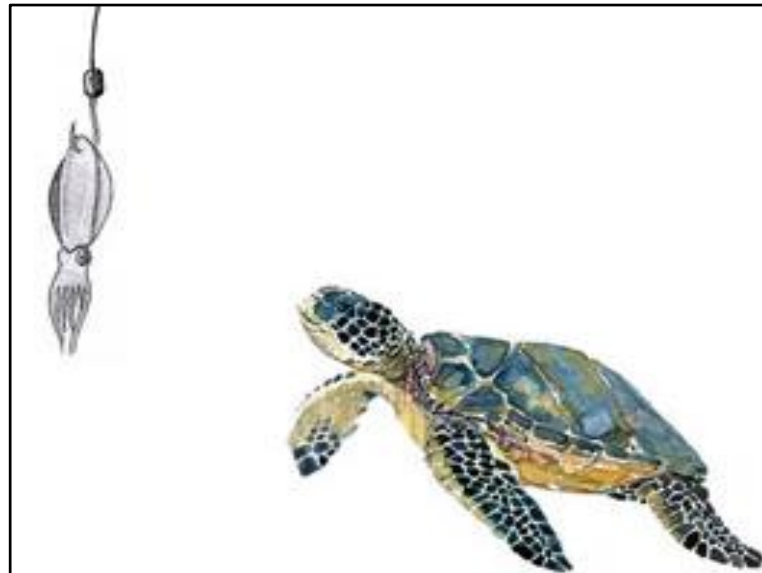
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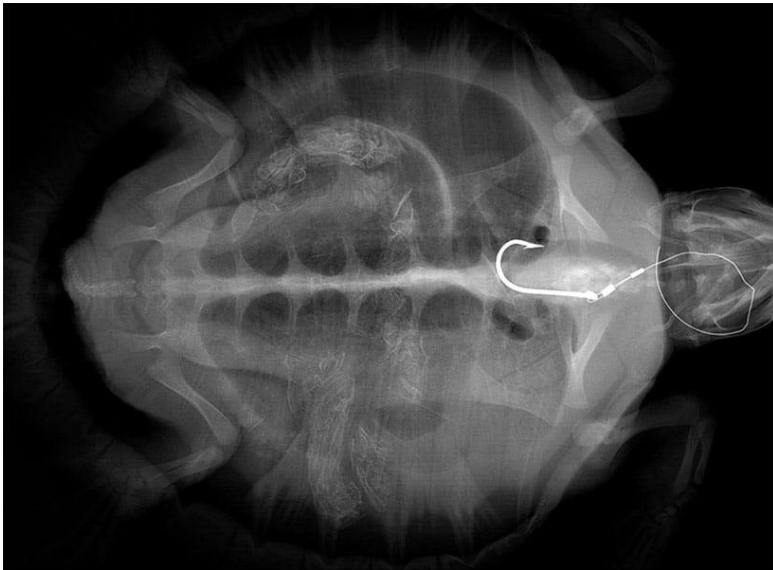
Prohibition of using squid baits



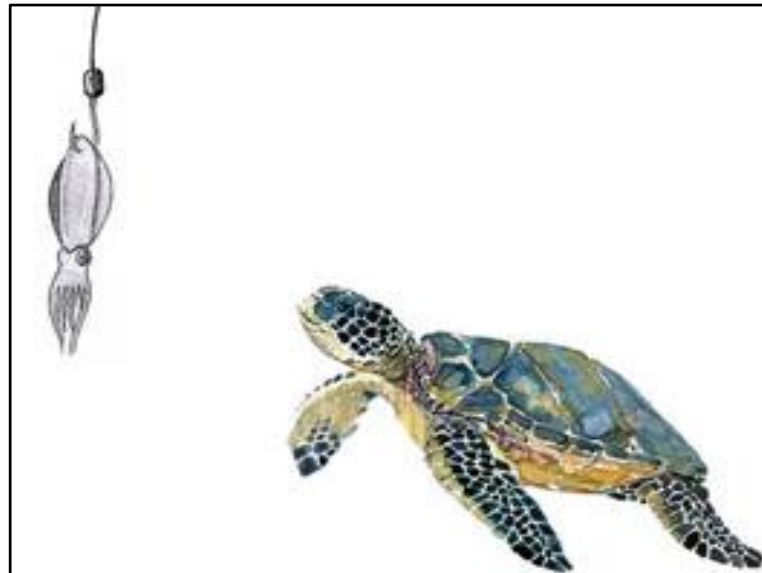
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Prohibition of using squid baits





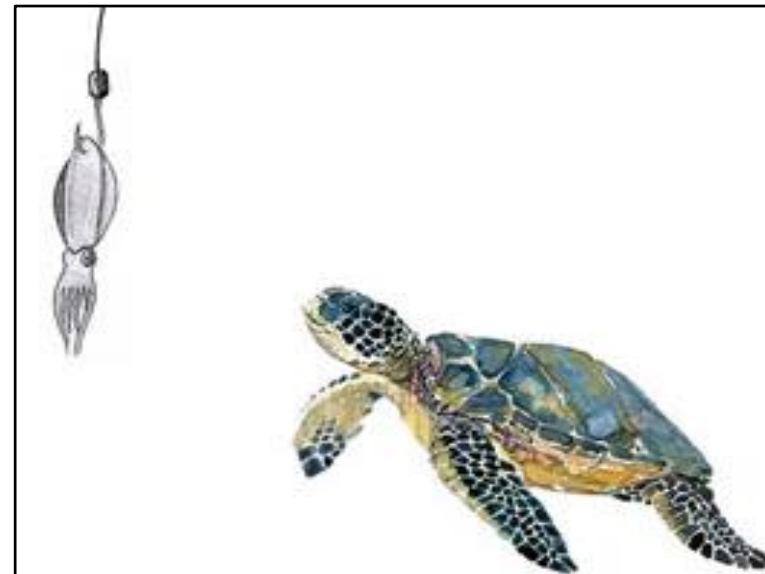
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  - Other **approved mitigation measures** (e.g., time-area closures), AND
  - Use of **best handling and release practices** in all fisheries targeting species under the Convention

Prohibition of using “J” hooks



Prohibition of using squid baits



Use of best handling and release practices





# Sea turtle resolution C-19-04

- A major focus on Eastern Pacific leatherbacks (*Dermochelys coriacea*)

Occupy oceanic and coastal waters



# Sea turtle resolution C-19-04

- A major focus on Eastern Pacific leatherbacks (*Dermochelys coriacea*)
- Caught in both industrial and artisanal fisheries (and egg collection)

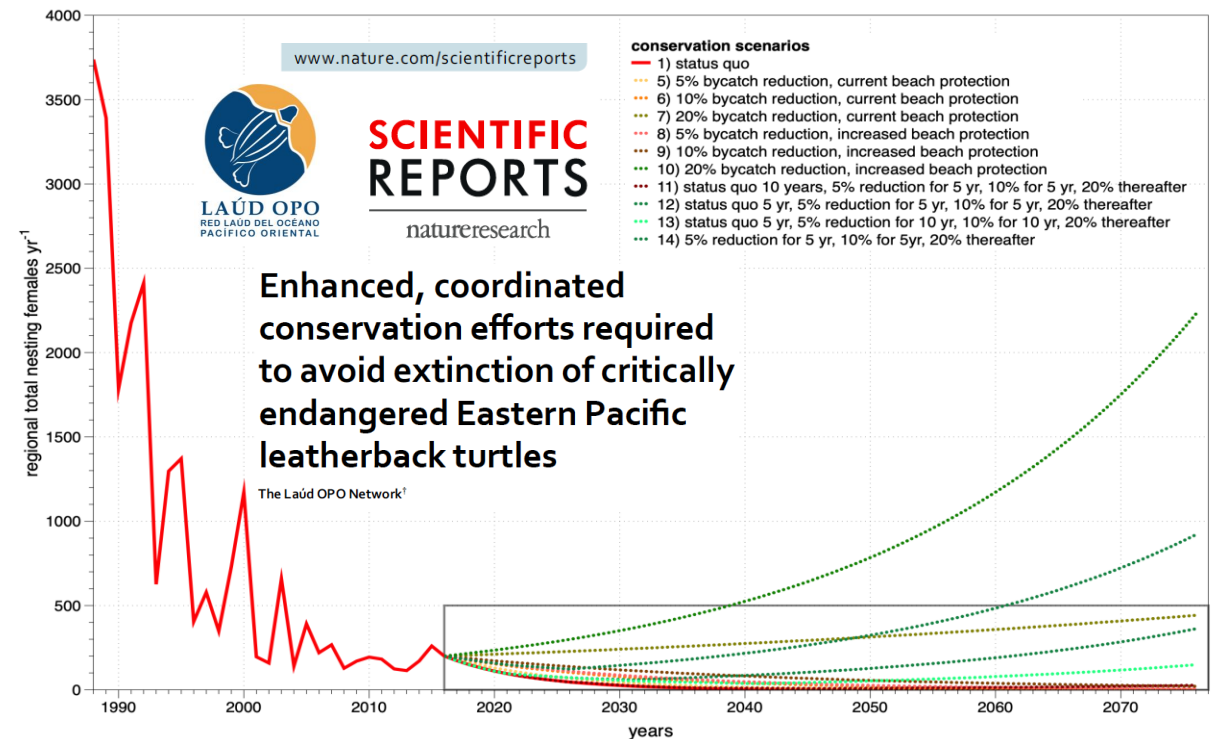
**Primarily caught in longline and gillnet fisheries**



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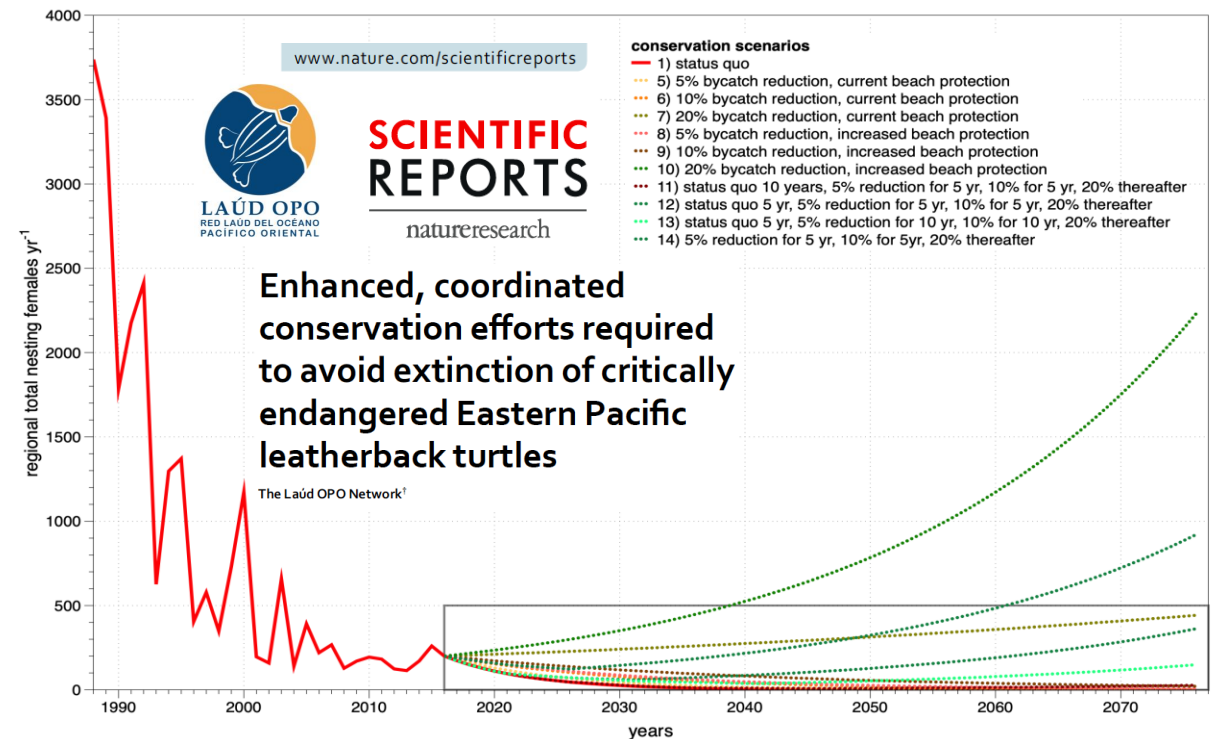




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- Caught in both industrial and artisanal fisheries (and egg collection)
- Slow growth, long-lived, low reproductive output led to a worrying decline
- Must reduce adult & subadult mortality by  $\geq 20\%$ , starting immediately

Primarily caught in longline and gillnet fisheries



# Collaborative research

- In 2019, IATTC BYC WG and SAC endorsed a collaborative project to assess vulnerability of leatherbacks, under the MoU between IATTC and IAC (*Leatherback Task Force*), with support from Red Laúd OPO



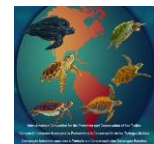
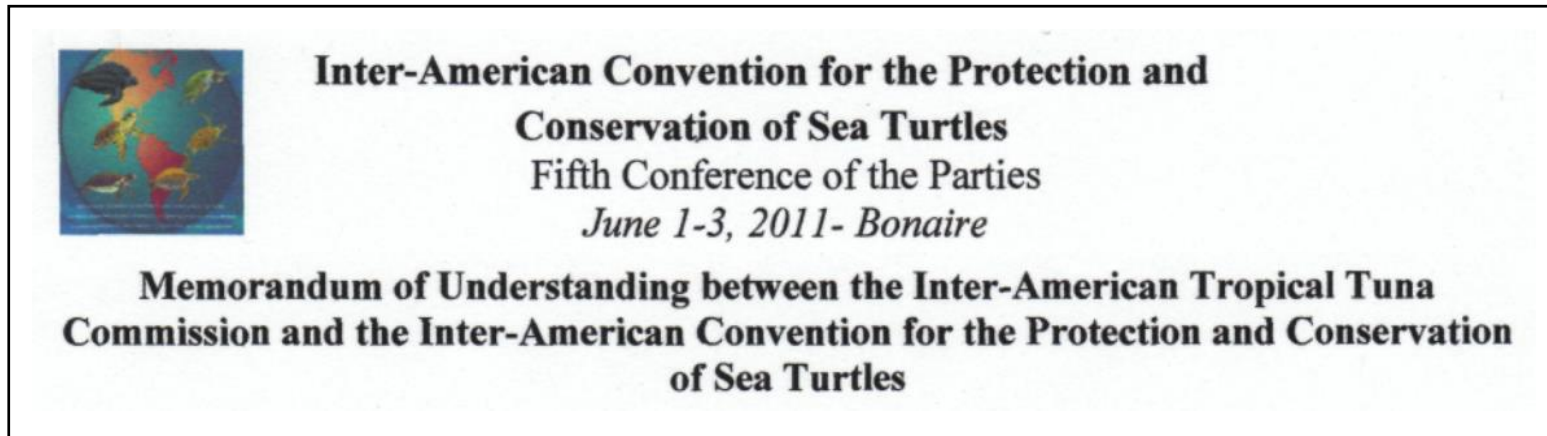
**Inter-American Convention for the Protection and  
Conservation of Sea Turtles**  
Fifth Conference of the Parties  
*June 1-3, 2011- Bonaire*

**Memorandum of Understanding between the Inter-American Tropical Tuna  
Commission and the Inter-American Convention for the Protection and Conservation  
of Sea Turtles**



# Collaborative research

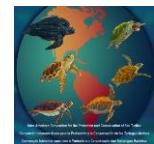
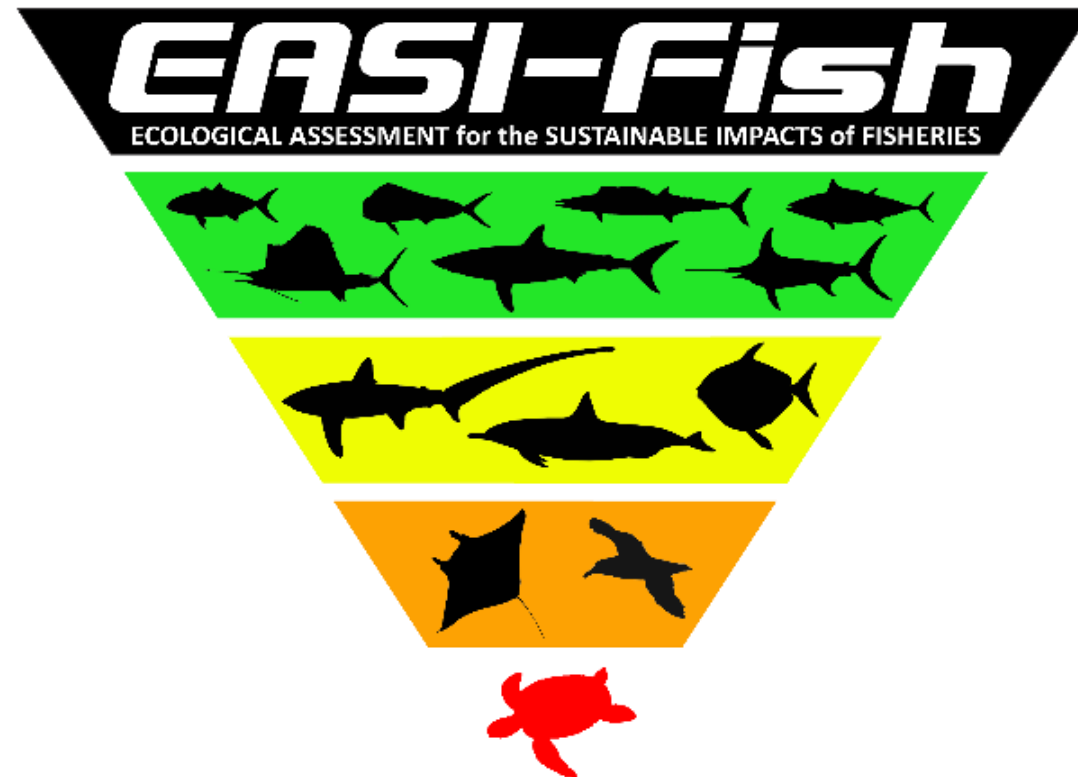
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- Project aim to determine current vulnerability status using ERA
- Also, to explore the potential efficacy of conservation measures detailed in **C-19-04** on vulnerability status
- Need to support implementation with viable options and resources





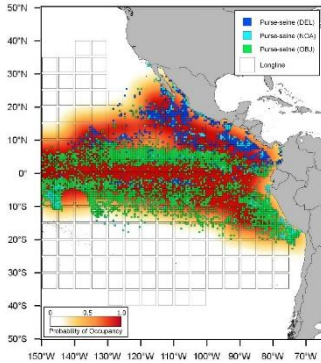
# Ecological Assessment of the Sustainable Impacts of Fisheries

## EASI-Fish

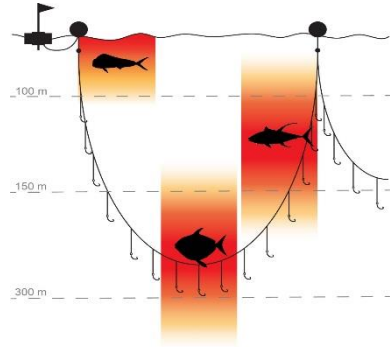


# EASI-Fish – an overview

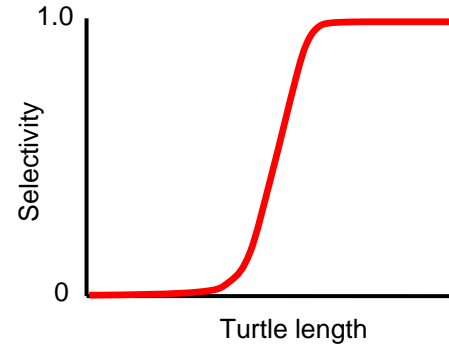
## Susceptibility - “Volumetric overlap”



**X**



**X**



**X**

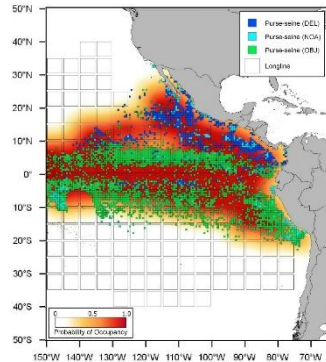
Post-Capture  
Mortality

**=**

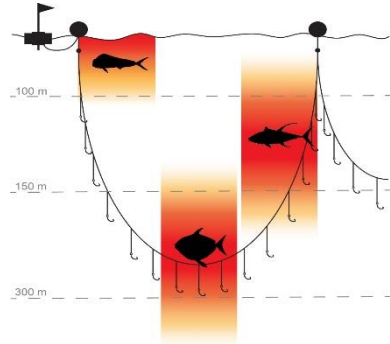
Fishing  
Mortality  
( $f \rightarrow F$ )

# EASI-Fish – an overview

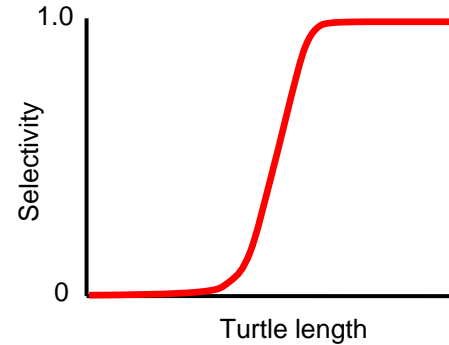
## Susceptibility - “Volumetric overlap”



X



X



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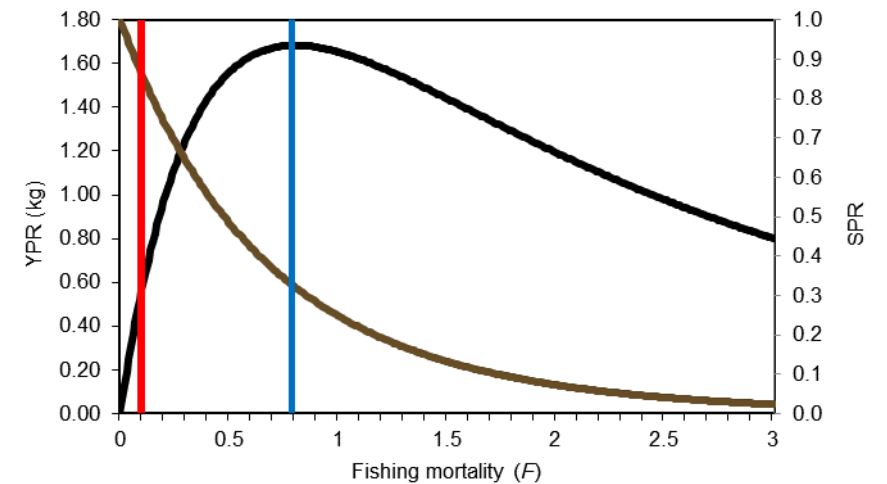
Post-Capture Mortality

=

Fishing Mortality ( $f \rightarrow F$ )



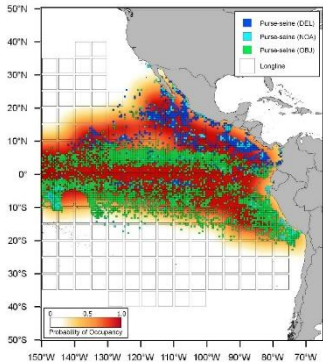
## Productivity - YPR



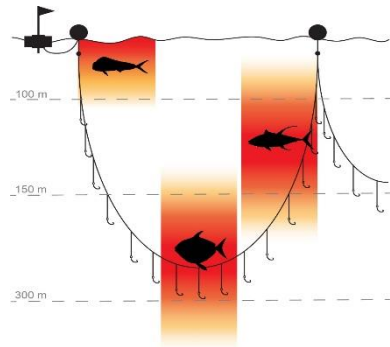


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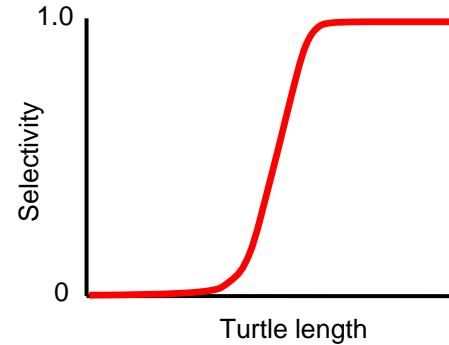
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X



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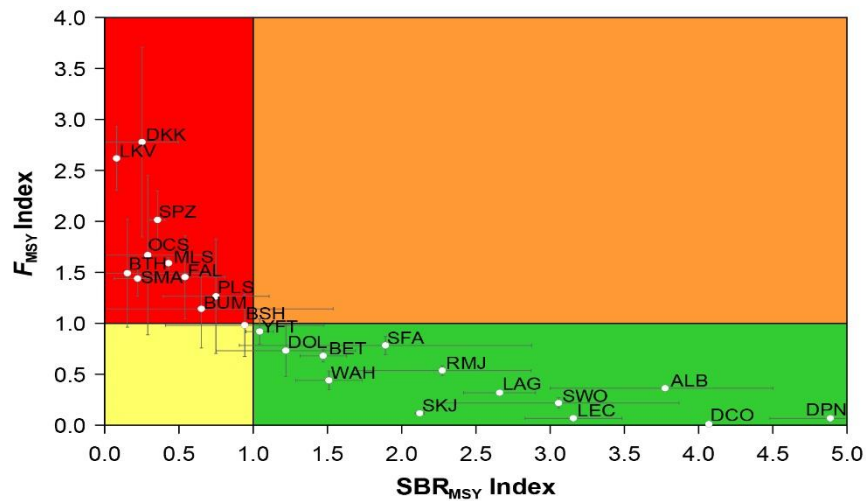
Post-Capture Mortality

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Fishing Mortality ( $f \rightarrow F$ )



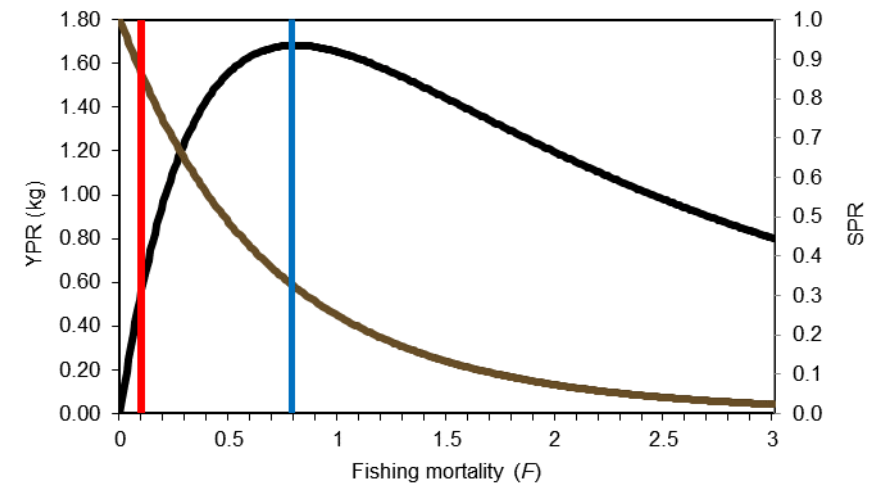
## Vulnerability status



Biological Reference Points (e.g.  $F_{MSY}$ )

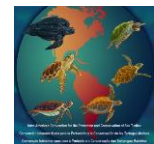
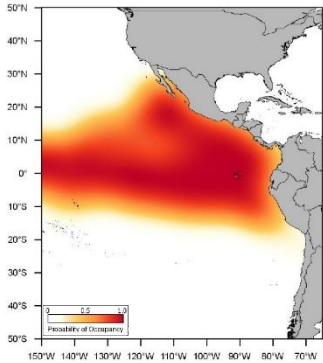


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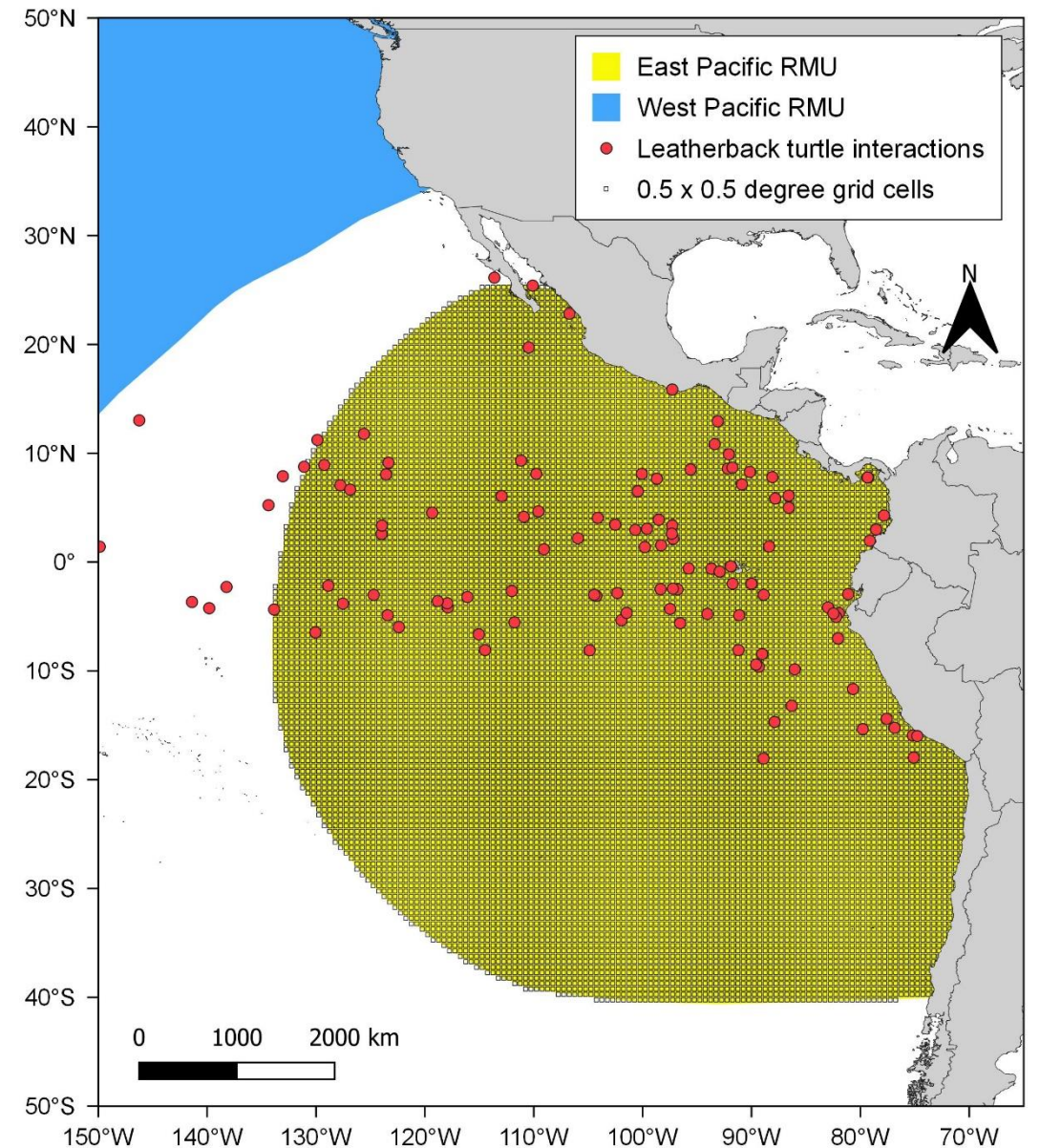
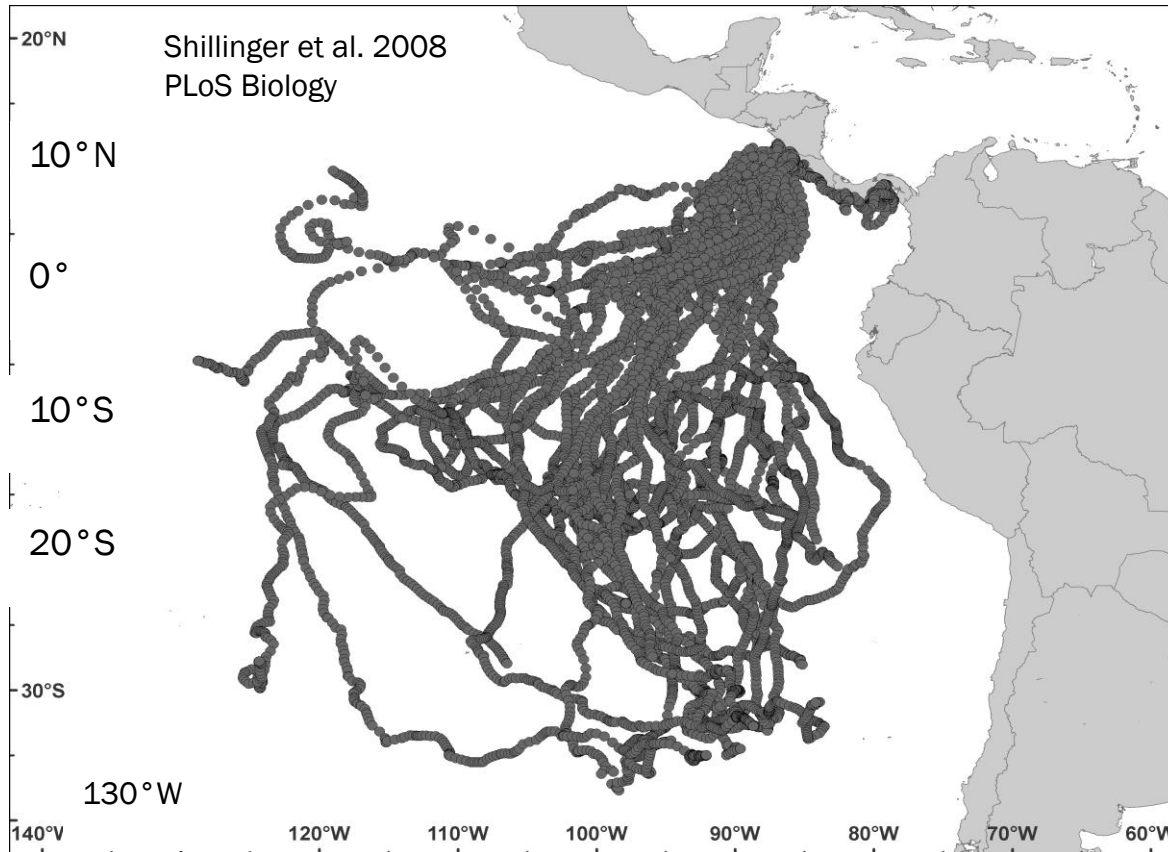
# Species distribution map

## Susceptibility - “Volumetric overlap”



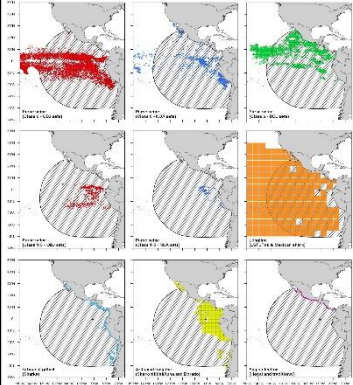
# Species distribution map

- Distribution models biased as tracking data unavailable from coastal areas
- Homogenous regional distribution assumed

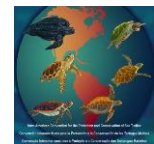


# Areal overlap of fishing effort

## Susceptibility - “Volumetric overlap”



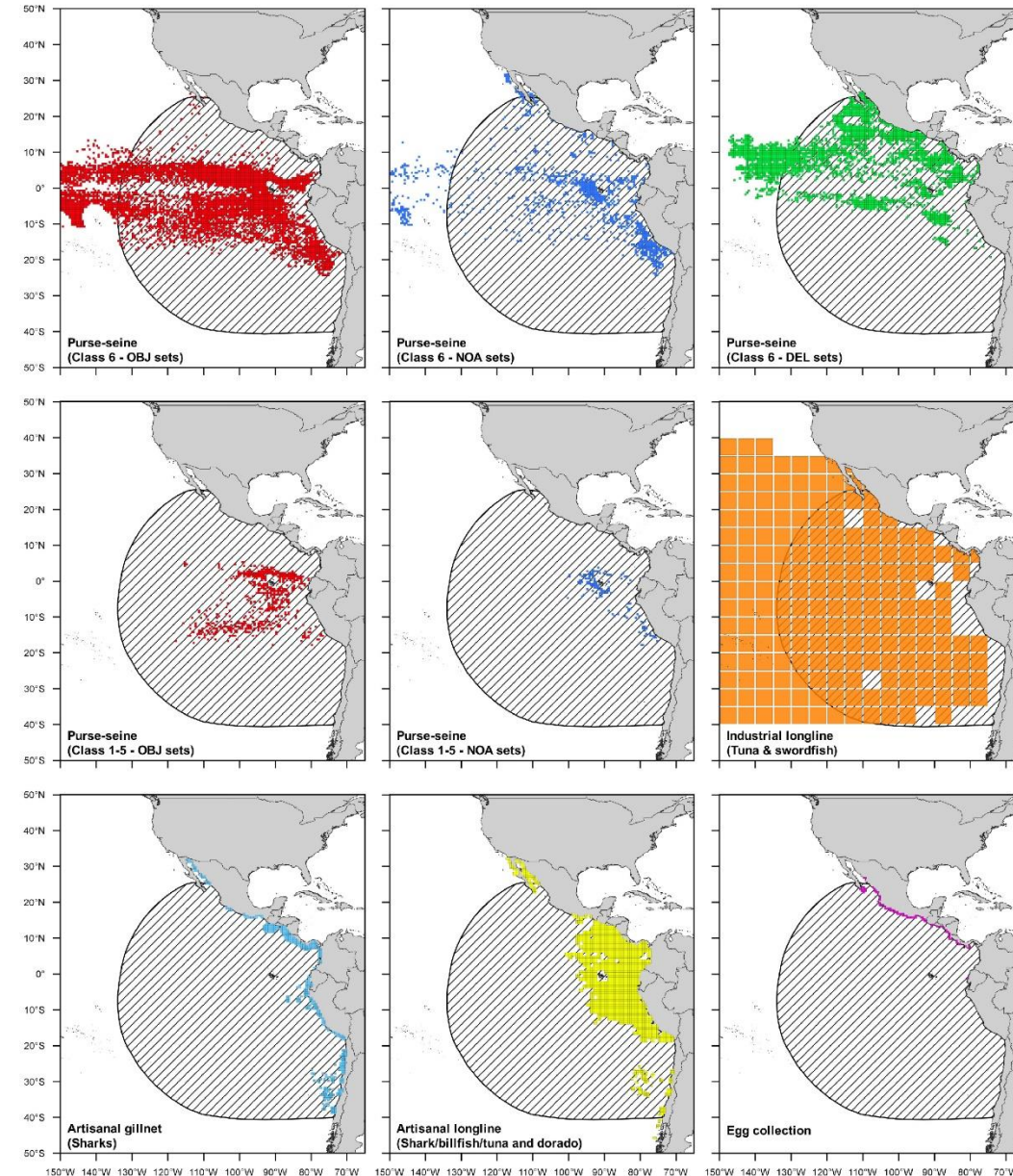
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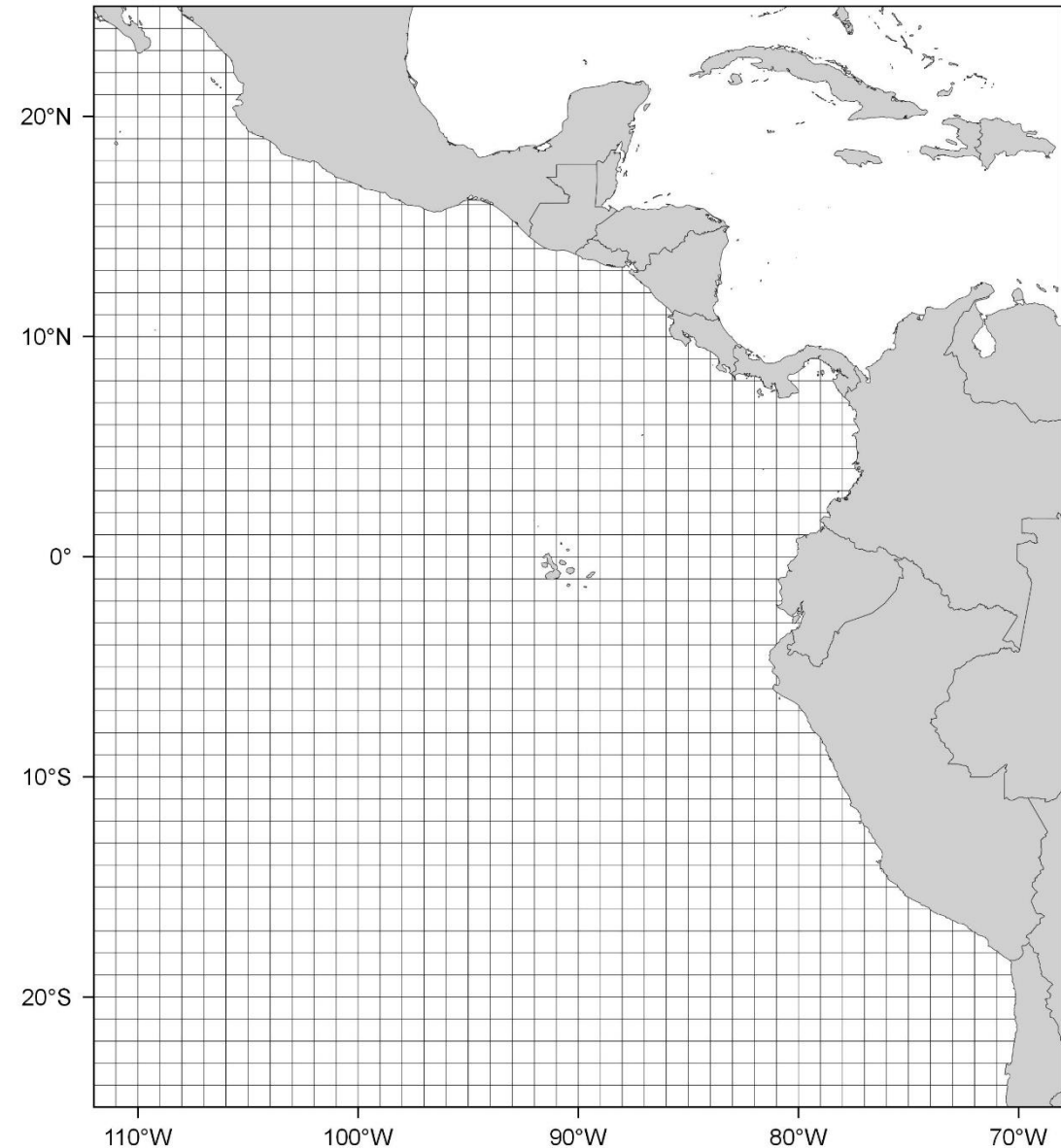
# Areal overlap of fishing effort

- Areal overlap of fishing effort and species distributions
  - no. grids occupied ( $G$ ) that are fished ( $G_x$ )



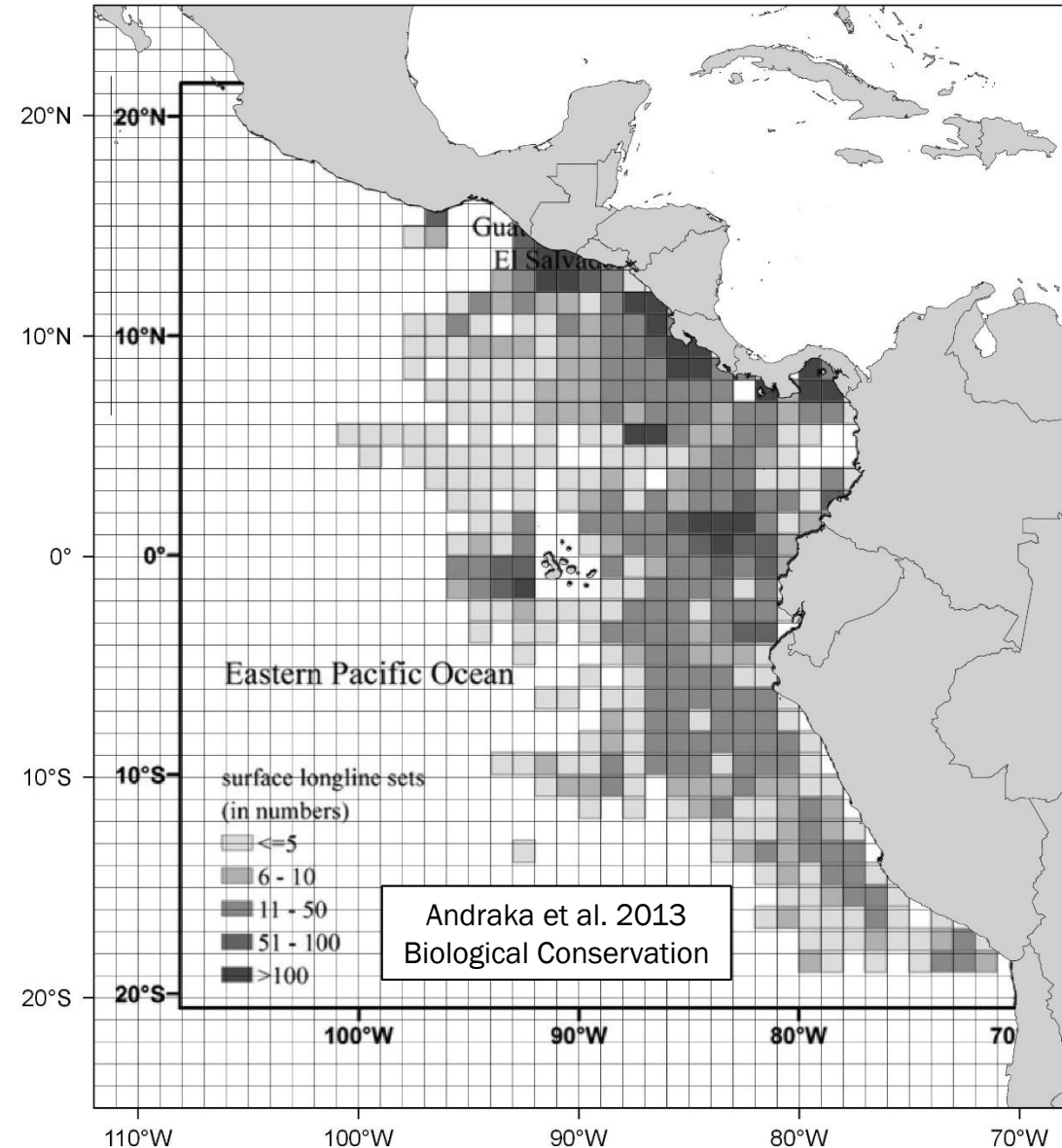
# Artisanal fishing effort

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- High catches in artisanal longline and gillnet fleets, but very little effort data



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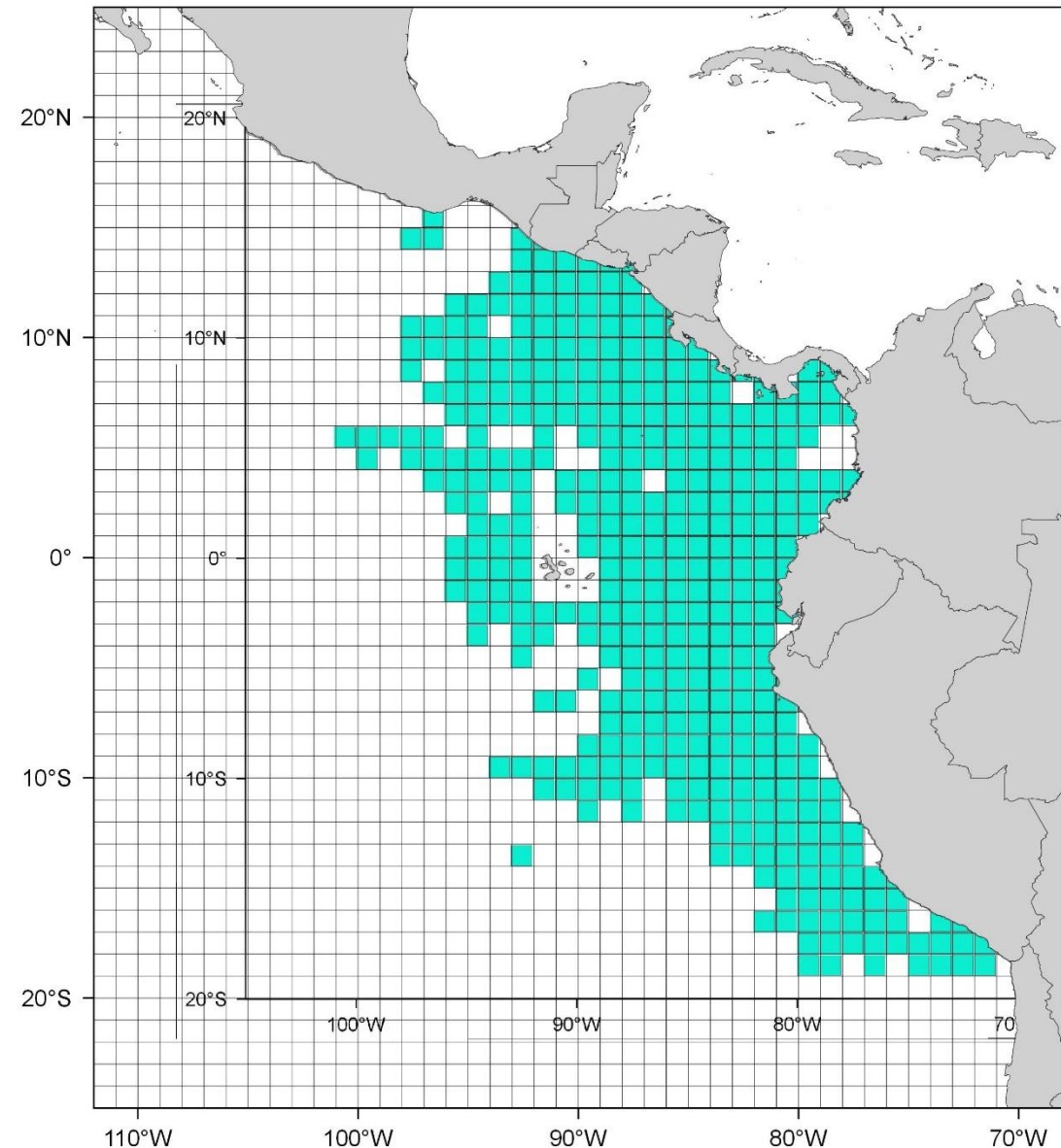
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# Artisanal fishing effort

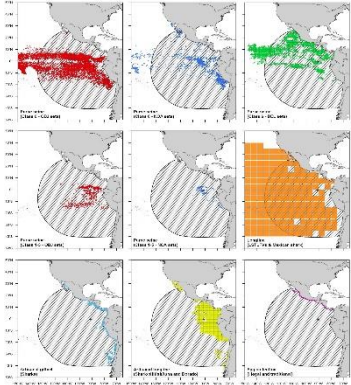
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- Where no effort data, cells surrounding known artisanal ports assumed to be fished



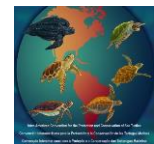
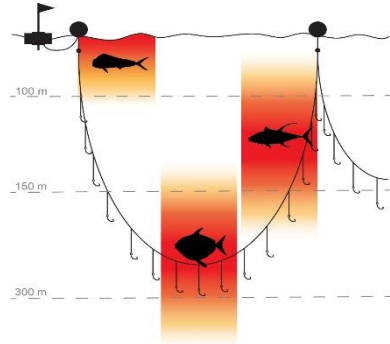


# Encounterability

## Susceptibility - “Volumetric overlap”

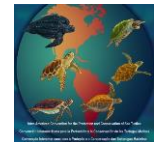
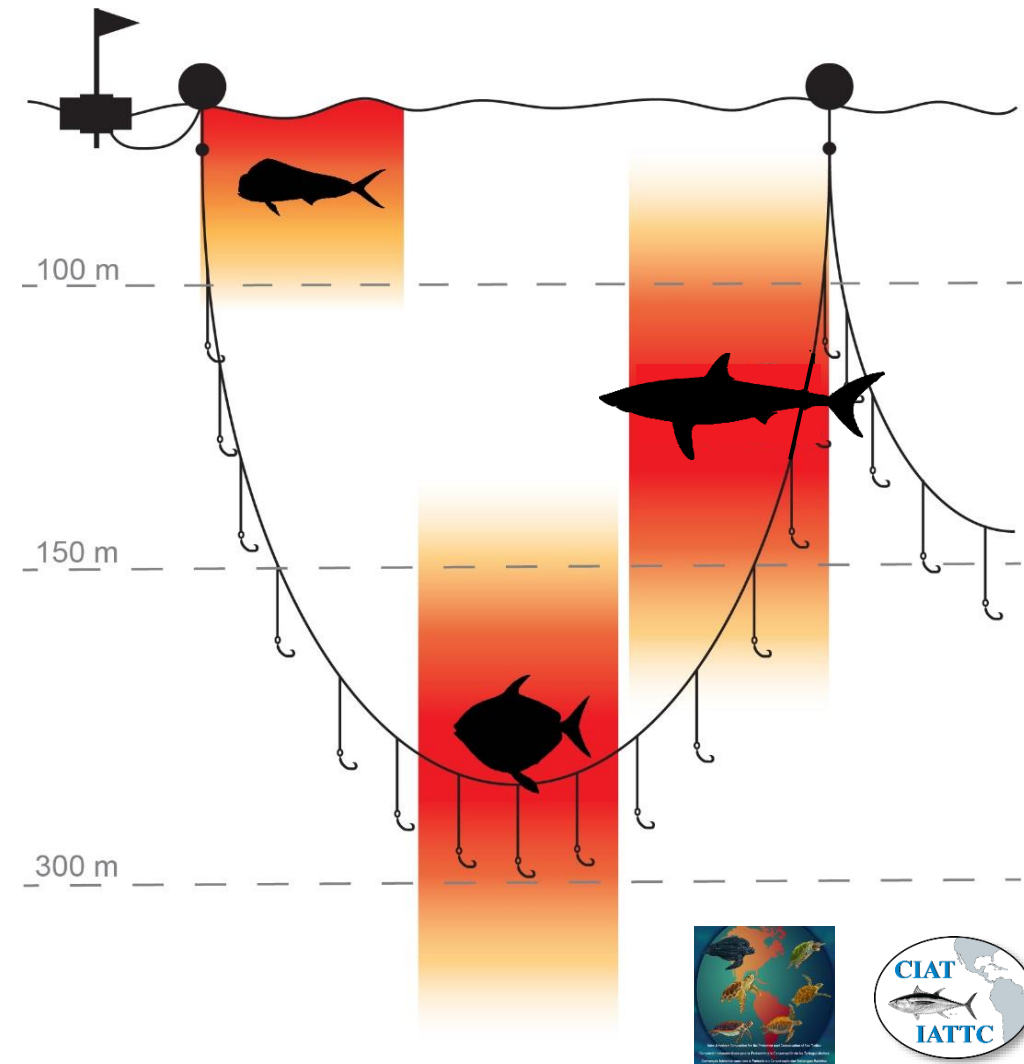
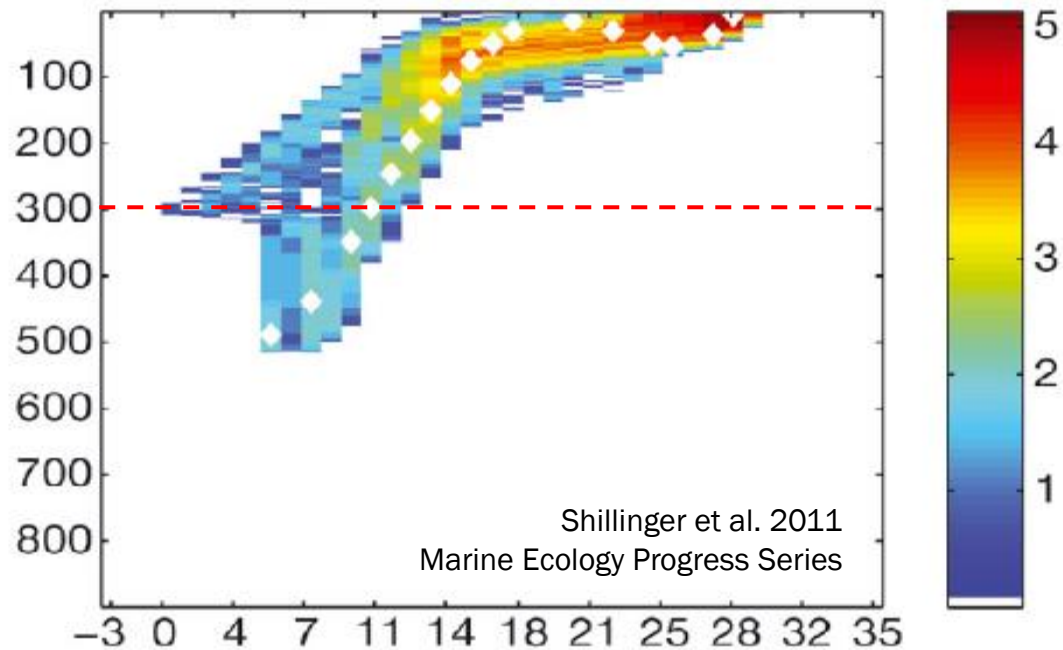


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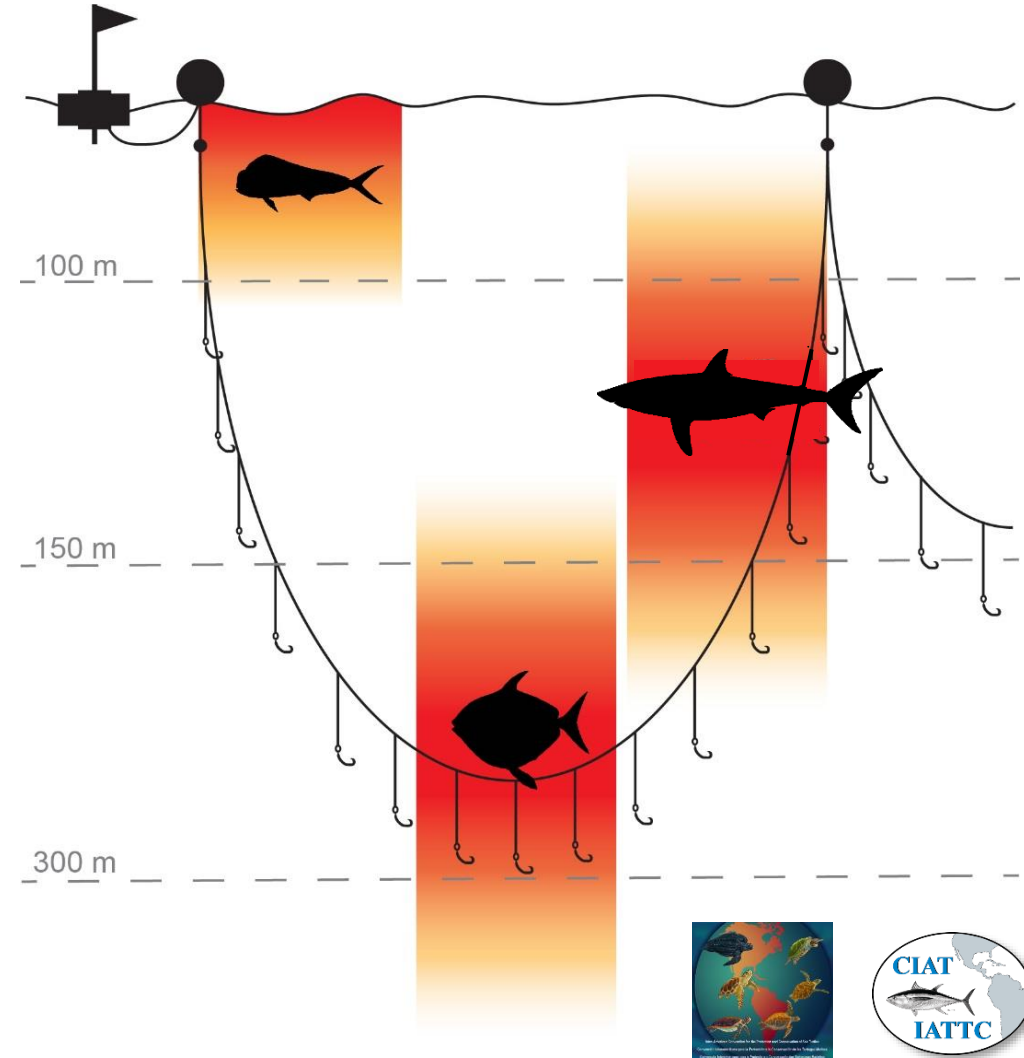
# Encounterability

- Despite high horizontal overlap, turtles may not encounter the gear
- Proportion of vertical distribution overlap
  - Electronic tagging studies
  - Expert opinion
- Leatherback depth range: 0–300 m



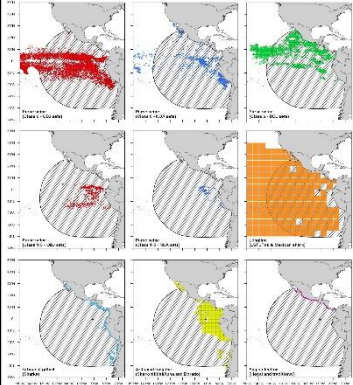
# Encounterability

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- Leatherback depth range: 0–300 m
- Defined gear depths:
  - Industrial longline “deep” sets (0–300 m)
  - Artisanal longline “shallow” sets (0–80 m)
  - Purse-seine sets (Class 6 vessels) (0–200 m)
  - Purse-seine sets (Class 1–5 vessels) (0–120 m)
  - Artisanal gillnet surface sets (0–80 m)

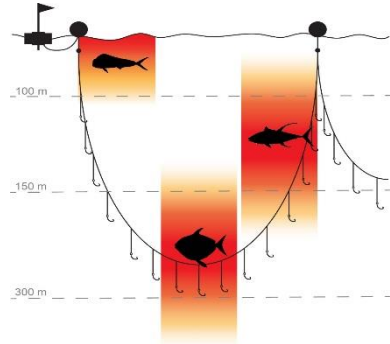


# Contact selectivity

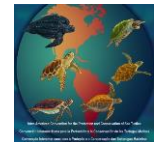
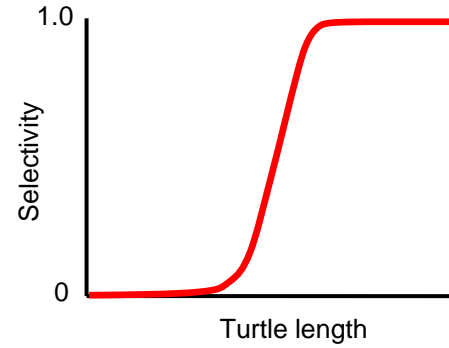
## Susceptibility - "Volumetric overlap"



X



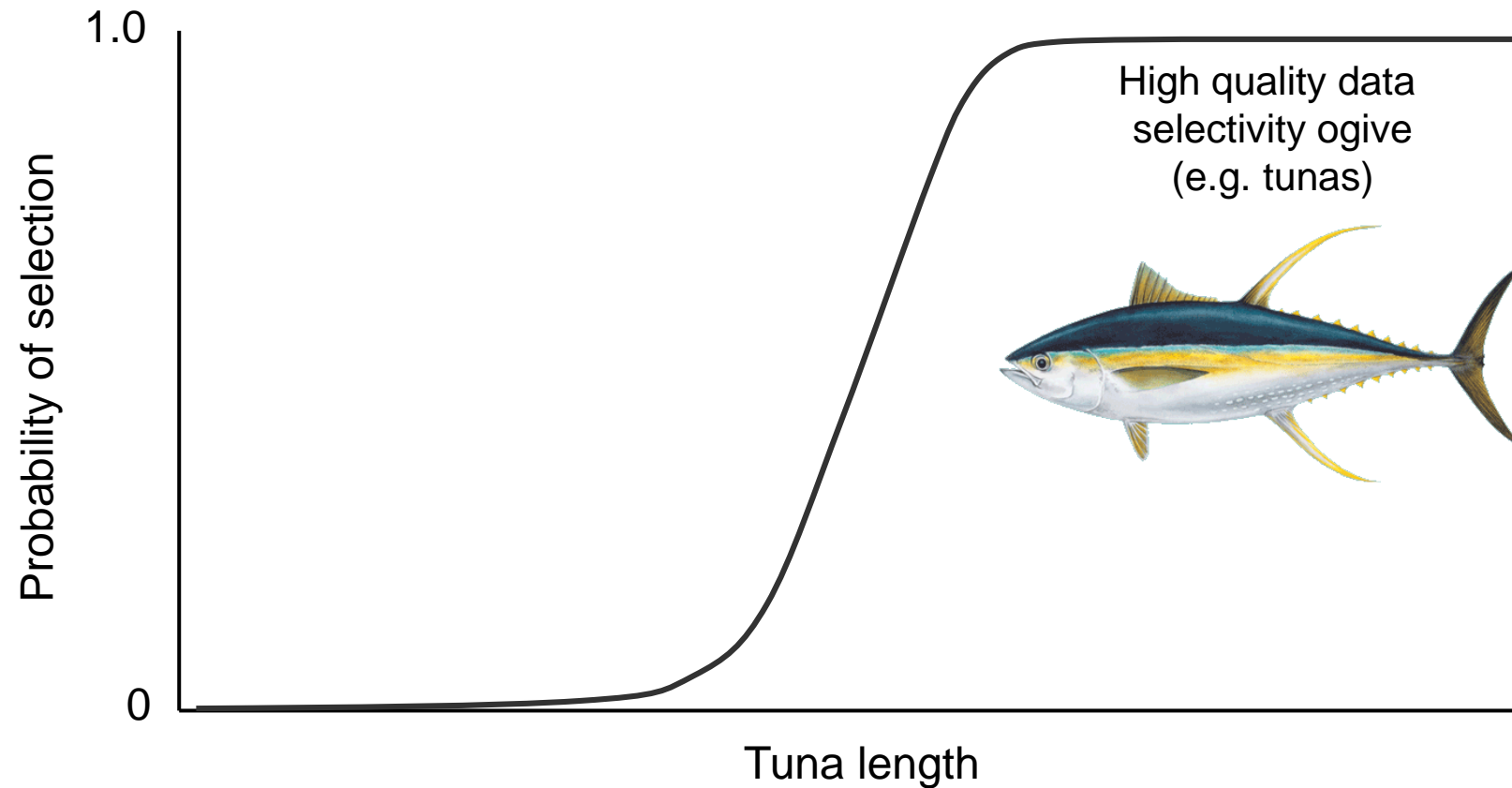
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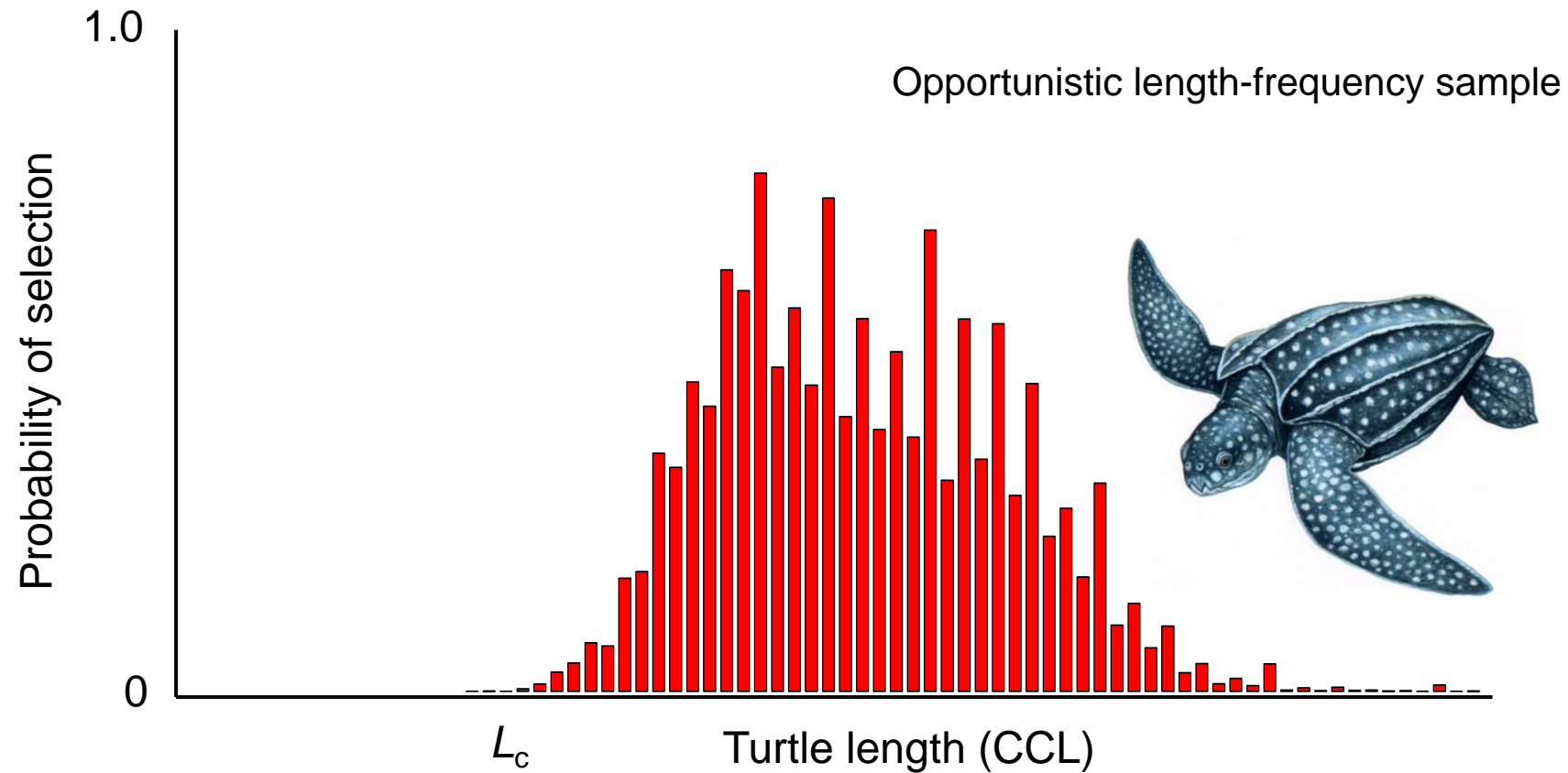
# Contact selectivity

- Selectivity function flexible depending on data availability



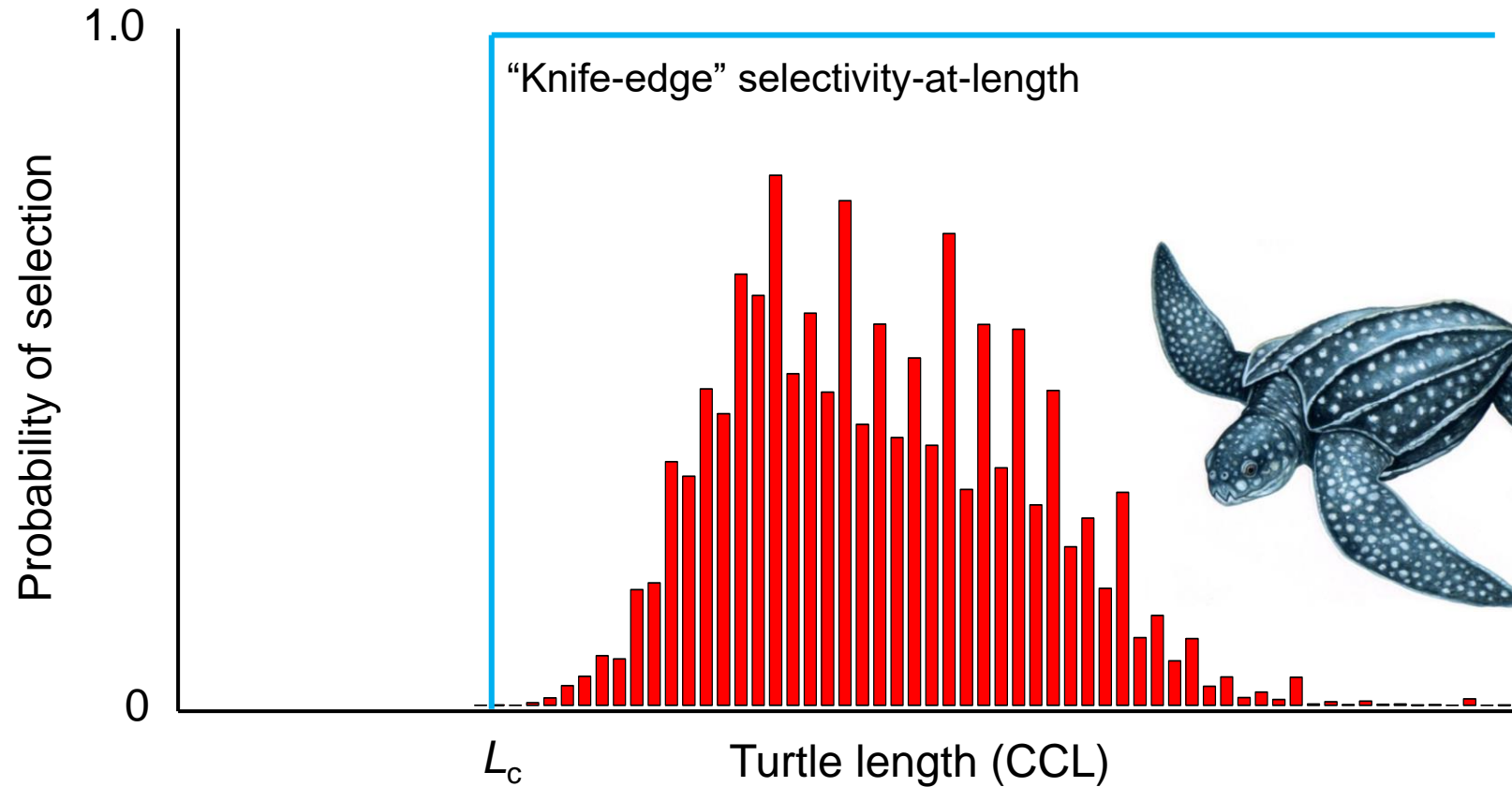
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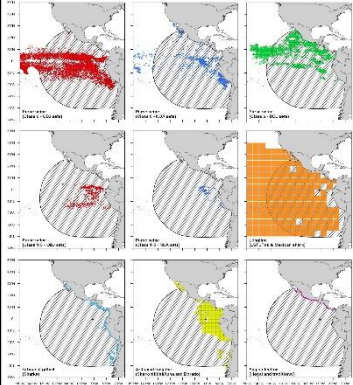


Used minimum observed length at first capture ( $L_c$ )

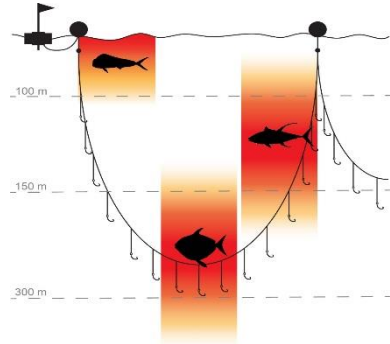
- 32 cm for purse-seine
- 40 cm all other fisheries

# Post-capture mortality (PCM)

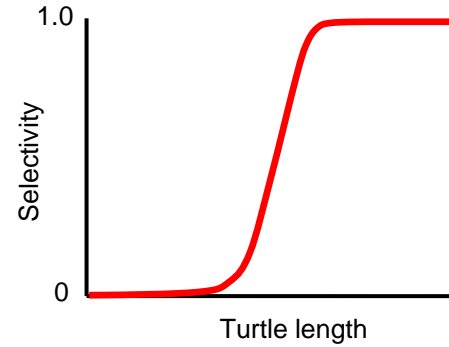
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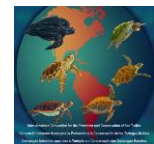


X



X

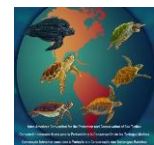
Post-Capture Mortality





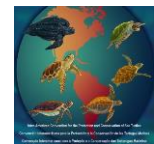
# Post-capture mortality (PCM)

- At-vessel mortality: between gear interaction and release (observed)
- Post-release mortality: mortality within 30 days of release (tagging)



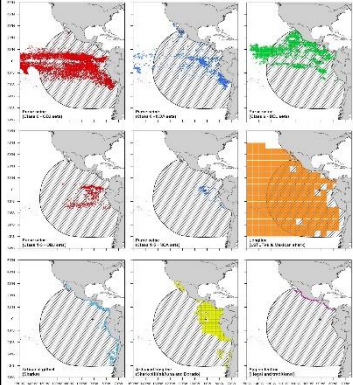
# Post-capture mortality (PCM)

- PCM values based on published values and expert review
- Value uncertainty captured in a triangular distribution used from minimum to maximum, and 'most probable' value
- Baseline values were:
  - Industrial longline: **0.4** (0.2 – 0.6)
  - Industrial purse seine: **0.05** (0.01 – 0.1)
  - Small-scale 'artisanal' longline: **0.25** (0.1 – 0.4)
  - Small-scale 'artisanal' gillnets: **0.5** (0.2 – 0.6)
  - Egg collection: **1.0**
- Estimated decreases in PCM due to conservation measures, **assuming 100% compliance, fleet-wide**

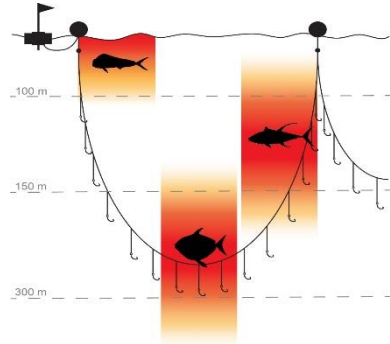


# EASI-Fish – an overview

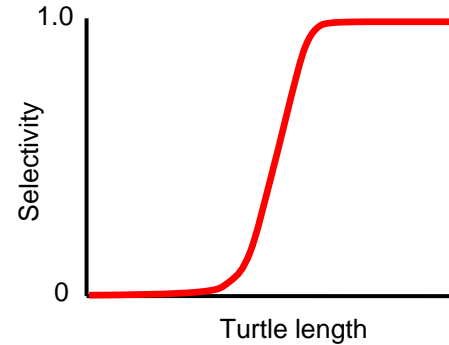
## Susceptibility - “Volumetric overlap”



**X**



**X**

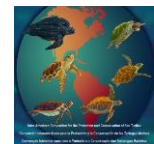


**X**

Post-Capture  
Mortality

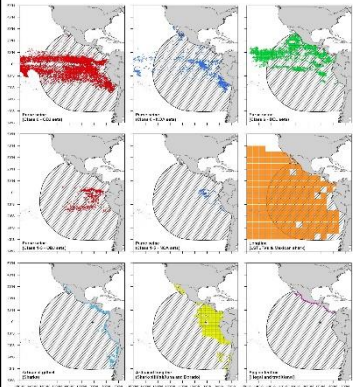
**=**

Fishing  
Mortality  
( $f \rightarrow F$ )

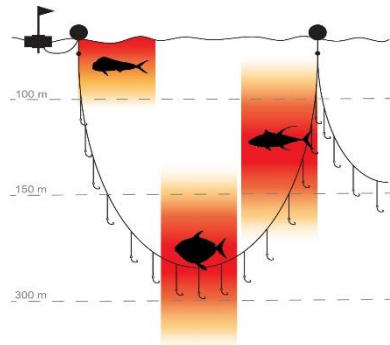


# EASI-Fish – an overview

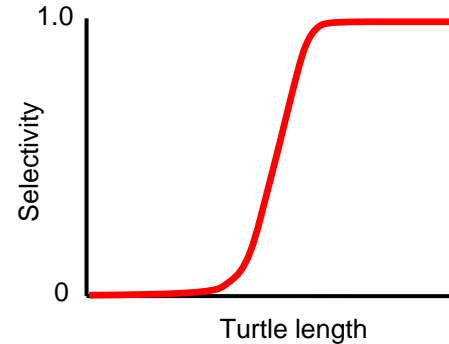
## Susceptibility - "Volumetric overlap"



X



X



X

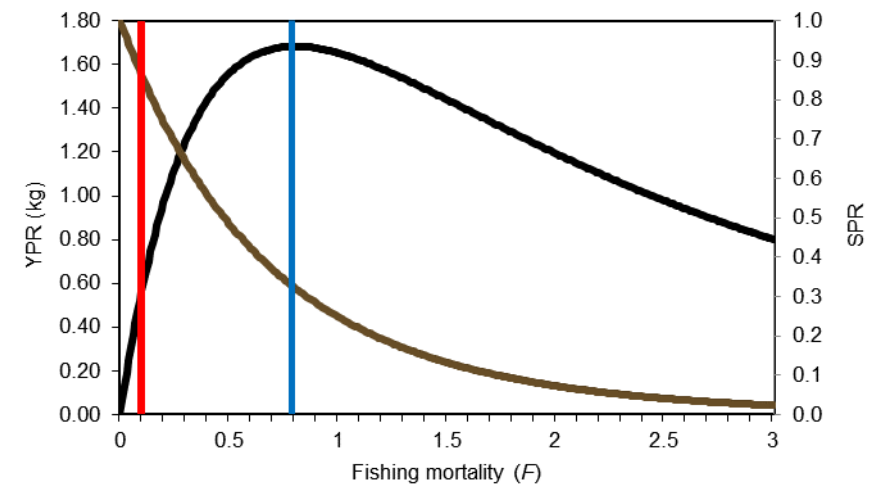
Post-Capture Mortality

=

Fishing Mortality ( $f \rightarrow F$ )



## Productivity - YPR





# Productivity – per-recruit models

## 1. Length-based yield per-recruit model (Chen and Gordon 1997)

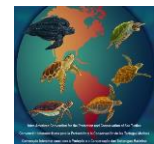
- Fishing mortality Biological Reference Points (BRPs)  $F_{2018}$  and precautionary  $F_{80\%}$  for leatherbacks

## 2. Corresponding breeding stock biomass-per recruit (BSR):

- Biomass-based BRPs  $BSR_{2018}$  and precautionary  $BSR_{80\%}$

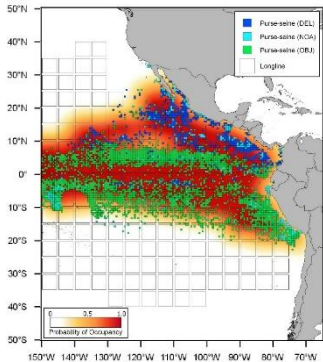
- Parameter uncertainty (e.g. PCM) - 10,000 Monte Carlo simulations

	$t_{\max}$ (yrs)	$L_{\inf}$ (yr <sup>-1</sup> )	$K$ (yr <sup>-1</sup> )	Length- weight $a$	Length- weight $b$	$L_{50}$ (cm)	$M$ (yr <sup>-1</sup> )
<b>Parameter value(s)</b>	48	147.6	0.286	0.0214	2.86	129.7	0.295–0.937
<b>Data source</b>	Jones et al. (2011)	Zug and Parham (1996)	Zug and Parham (1996)	Jones et al. (2011)	Jones et al. (2011)	Avens et al. (2020)	Santidrián Tomillo et al. (2017); The Laúd OPO Network (2020)

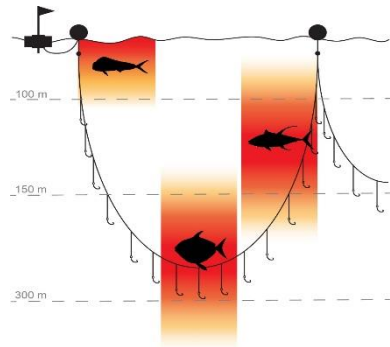


# Vulnerability status

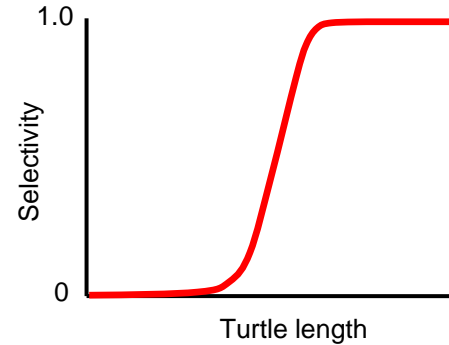
## Susceptibility - "Volumetric overlap"



X



X



X

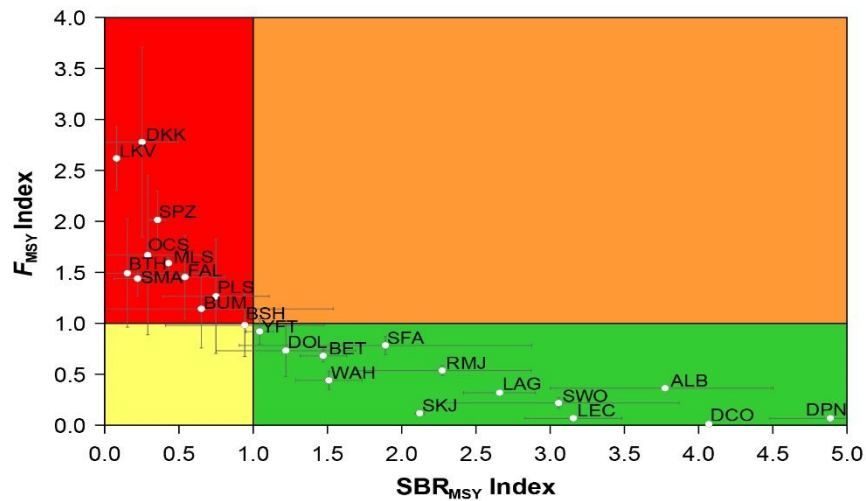
Post-Capture Mortality

=

Fishing Mortality ( $f \rightarrow F$ )



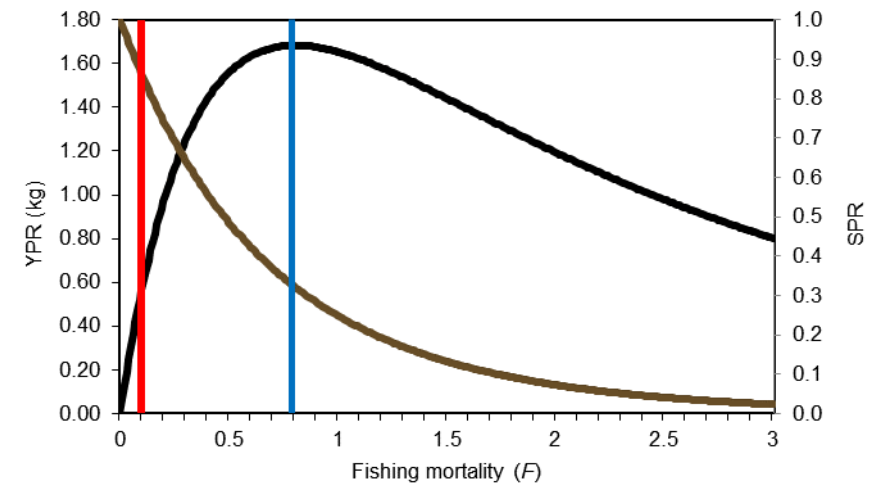
## Vulnerability status



BRP values

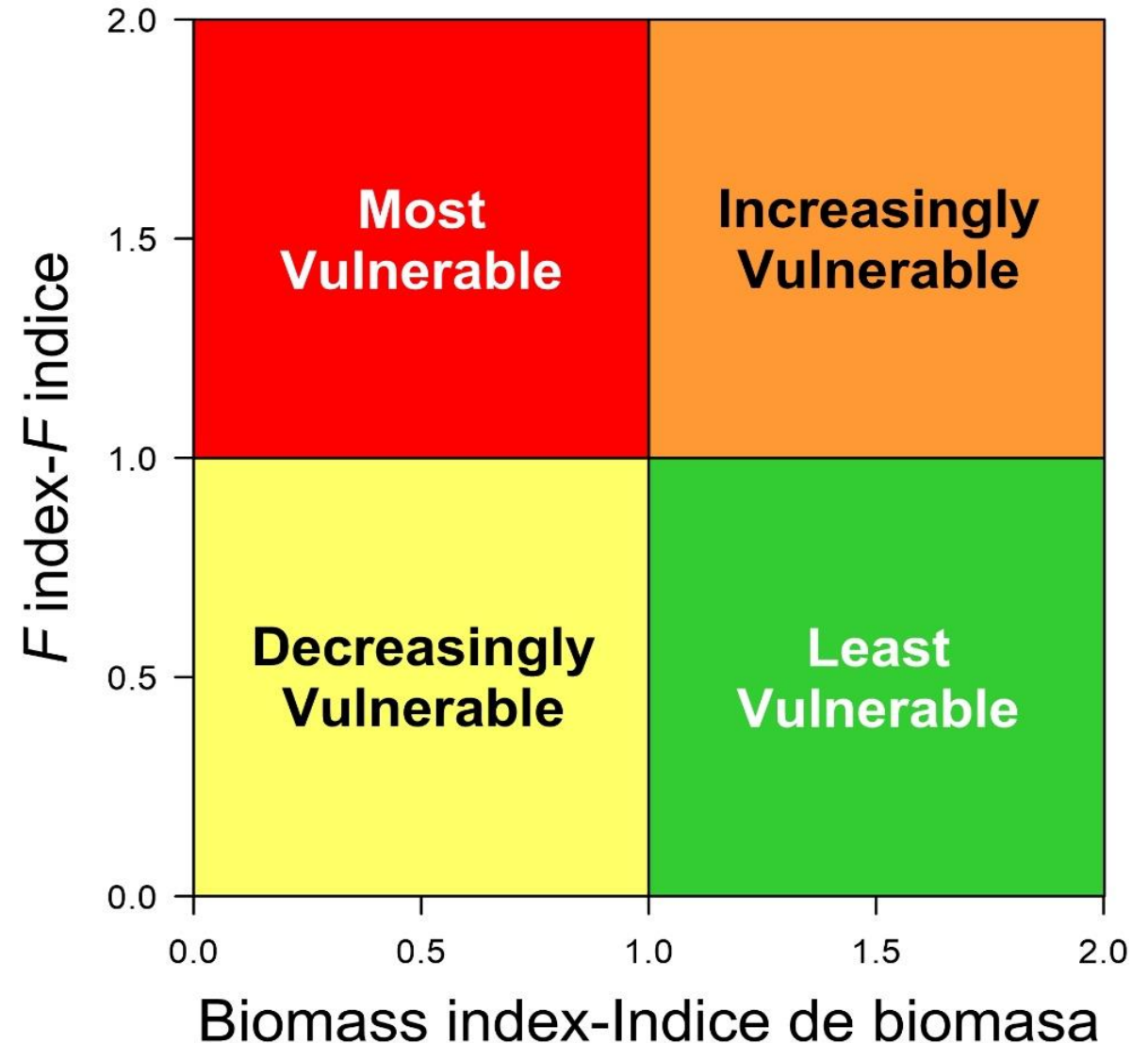


## Productivity - YPR

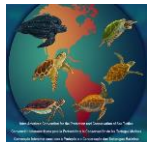


# Vulnerability status

- Traditional BRPs used to define vulnerability status
- EASI-Fish is not a stock assessment and does not define stock status



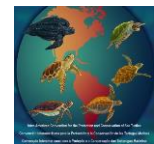
Using **EASI-Fish** to quantify vulnerability and to explore the potential efficacy of conservation and management measures in IATTC Resolution C-19-04





# Exploring CMMs to reduce vulnerability

- Because EASI-Fish is spatially explicit, specific CMMs (e.g. spatial closures) can be explored for reducing a species' vulnerability
- Examined several fisheries, effort data from IATTC, published studies
  - 'Industrial' longline fishery (Large scale tuna longline fishing vessels)
  - 'Industrial' purse-seine fishery (Class 6 vessels) – OBJ, NOA & DOL sets
  - Small purse-seine fishery (Class 1-5 vessels) – OBJ & NOA sets
  - Small-scale 'artisanal' longline (combined)
  - Small-scale 'artisanal' gillnets (combined)
  - Egg collection

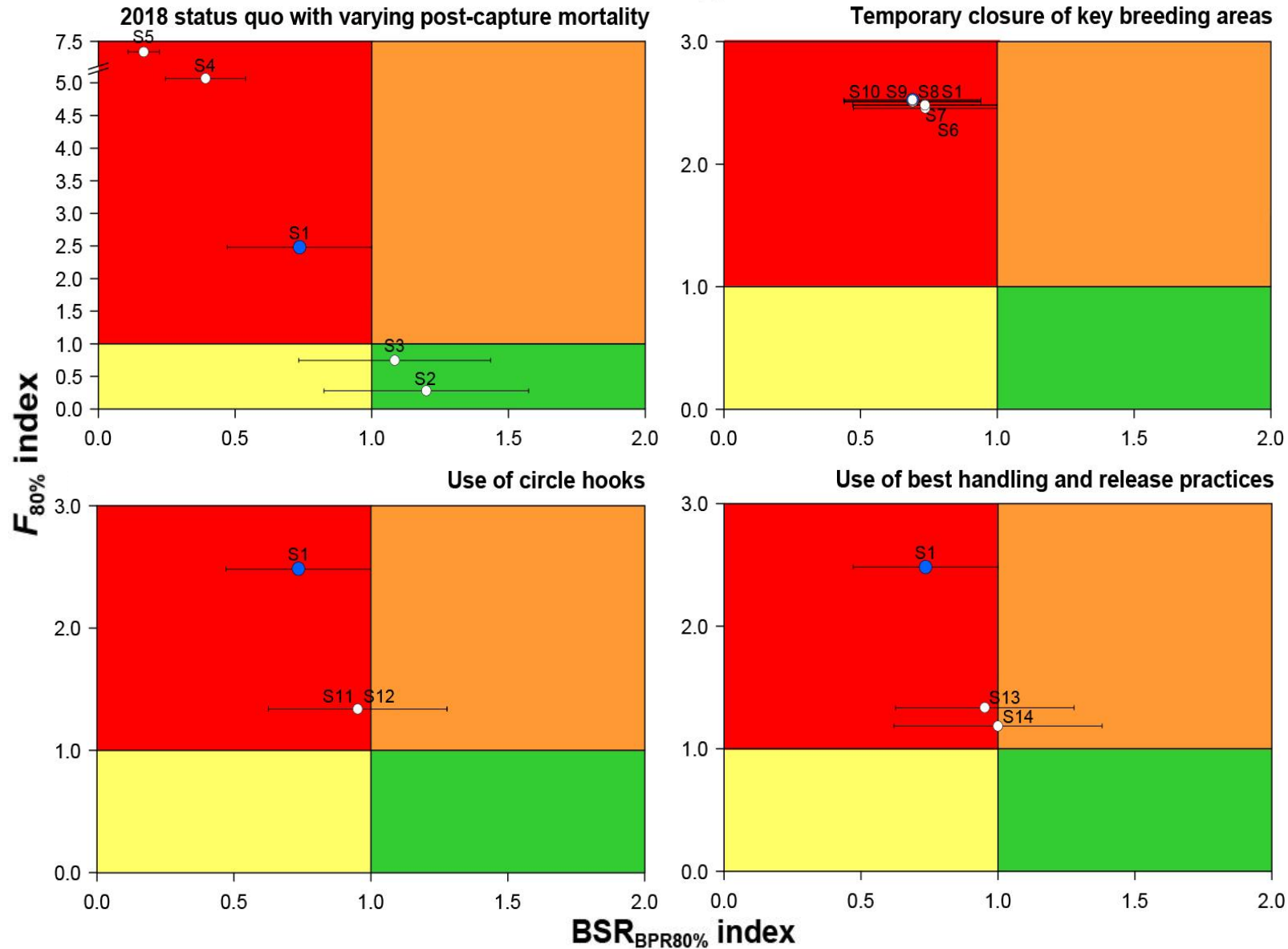


# Exploring CMMs to reduce vulnerability

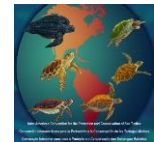
- Because EASI-Fish is spatially explicit, specific CMMs (e.g. spatial closures) can be explored for reducing a species' vulnerability
- 39 CMMs modeled including C-19-04 measures, and others:
  - The status quo vulnerability status for **2018**
  - Extending the current EPO-wide 72-day purse-seine fishery closure
  - Temporary closure of areas adjacent to nesting beaches
  - Reduction of PCM due to:
    - use of large circle hooks
    - use of best handling and release practices (e.g. FAO)
  - Combinations of the above scenarios in industrial fisheries only, in artisanal fisheries only, or across all fisheries



# CMM scenarios: breeding area closures, circle hooks, best practices

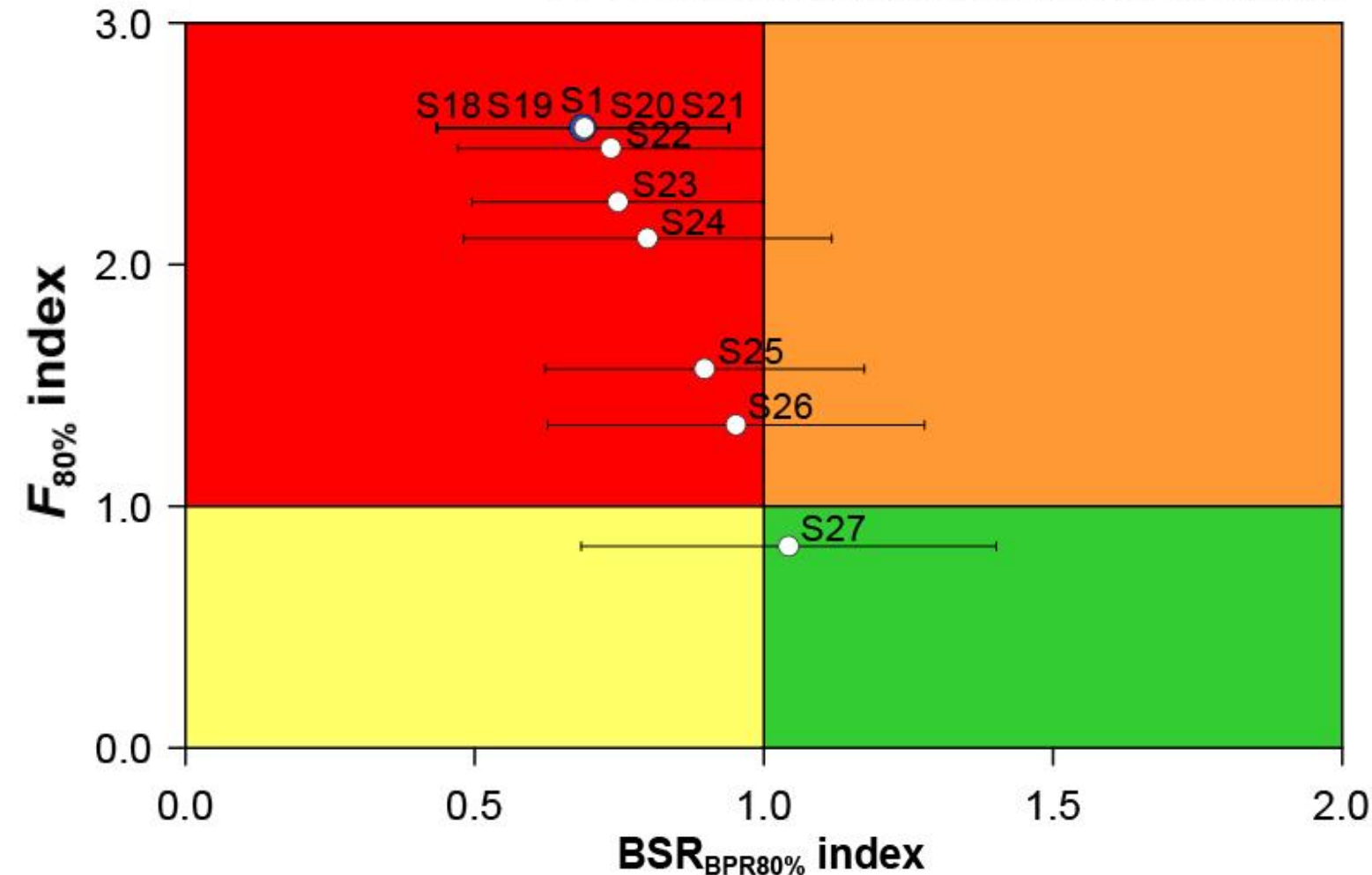


- PCM alone have a major effect compared to *Status quo* (S1 - blue dot)
- Breeding area closures alone have little effect
- Circle hooks and best practices each improve vulnerability, but not enough to change status

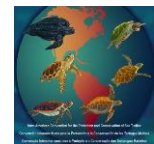


# CMM scenario: EPO-wide closures

EPO-wide closure to industrial fleets

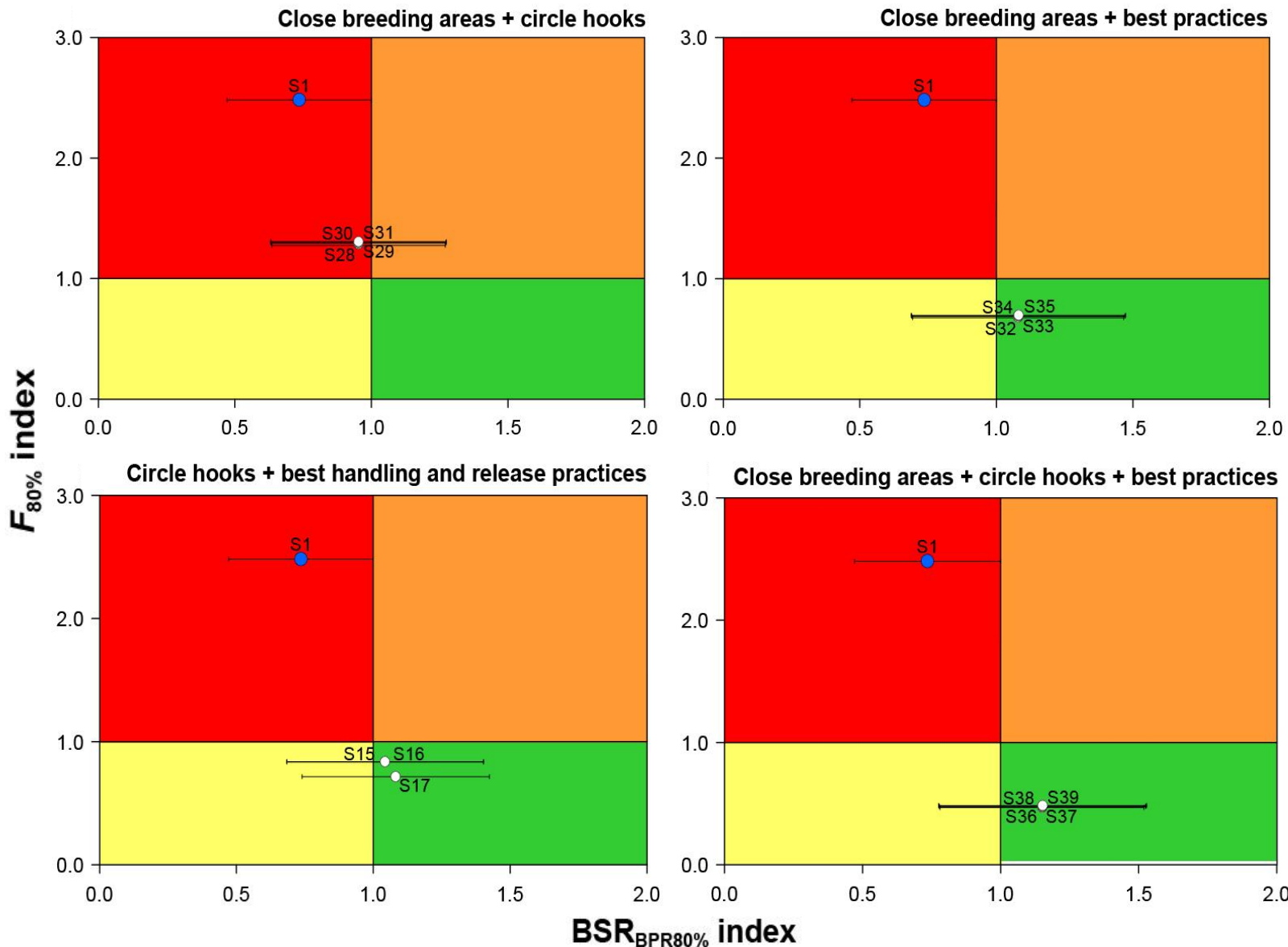


- EPO-wide industrial fleet closures decrease vulnerability with increasing duration, but only 270-day closure is sufficient

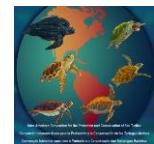




# CMM scenario: combinations of measures

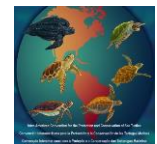


- Breeding area closures + circle hooks improve vulnerability, but not enough
- Breeding area closures + best practices = significant improvement
- Circle hooks + best practices = significant improvement
- Circle hooks + best practices + breeding area closures = largest improvements



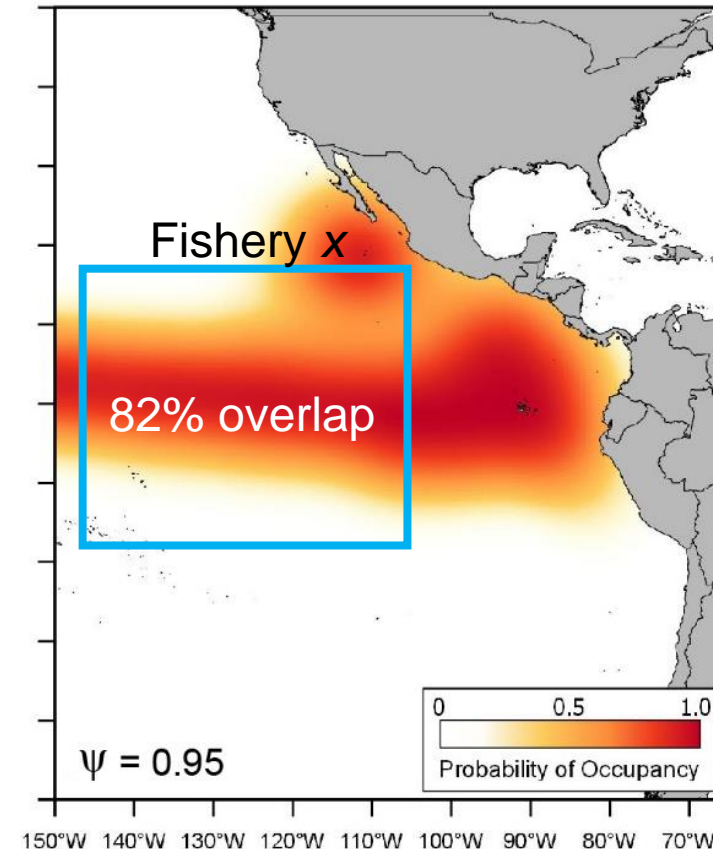
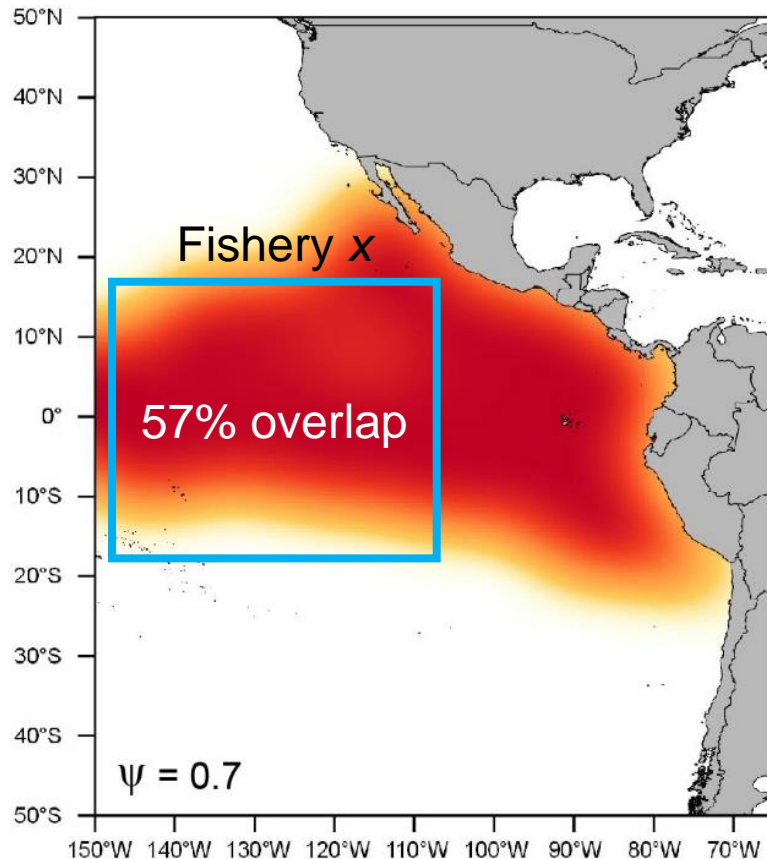
# Conclusions

- IATTC Resolution C-19-04 contains conservation measures that may significantly decrease vulnerability of leatherbacks to fishing
- Most single measures reduced vulnerability, but not sufficient (e.g. use of large circle hooks)
- But, combining multiple measures had the most positive benefits
- Reducing post-capture mortality is key, and is feasible
- Fishery closures ineffective due to small fishery footprint (lack of data?)
- EASI-Fish provided a first step towards understanding the potential efficacy of C-19-04 measures for data-limited bycatch species
- But there are several areas for model improvement



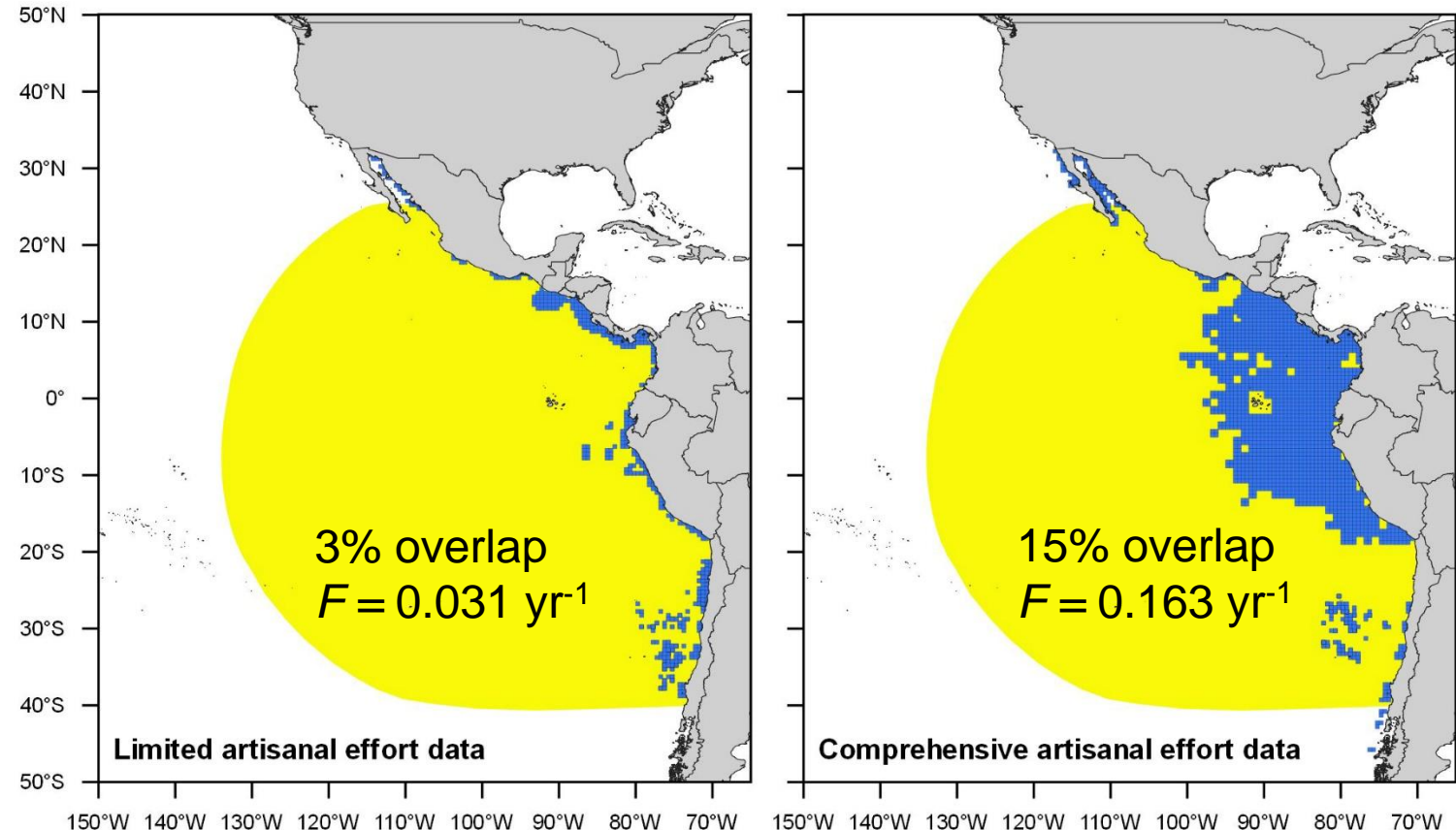
# Species distribution 'base map'

- Species distribution map heavily affects estimates of fishing mortality
- Larger spatial distribution = smaller relative fishery impact
- Annual distribution needs to include breeding/non-breeding areas



# Fishing effort distribution

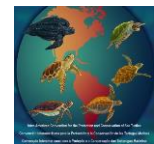
- Fishing effort distribution also affects estimates of fishing mortality
- Smaller fishery footprint (poor data) = smaller relative fishery impact
- Given high coastal bycatch, improved artisanal fishing effort data needed
  - IATTC Central America shark project
  - TUNACONS small purse-seine data
  - Several national programs

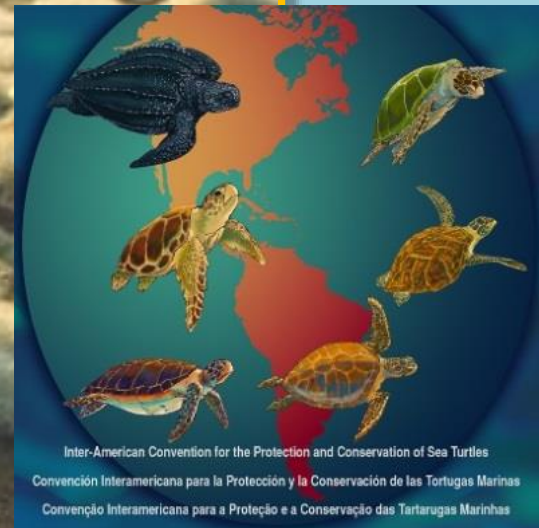




# Further considerations for future work

- Effectiveness of measures in small-scale fisheries vs. industrial
- Explore how different measures can be implemented (e.g., different types of spatial management)
- Compare effects of measures on target species (catch and economics)
- Improve collection of fishing effort data, observed and reported bycatch
  - IATTC CPCs now submitting set-by-set longline observer data from 2013
  - In 2022, C-19-04 will require **ALL non-observed sets** to record turtle interactions
- Include all EPO spatial and temporal closures inside/outside EEZs
  - EPO “Corralito”, Revillagigedo National Park (Mexico), Galápagos National Park (Ecuador)
  - Not included - Malpelo Sanctuary (Colombia), Cabo Blanco (Costa Rica)





Questions?



# 'Proof of concept' assessment

- 4 fisheries in an EASI-Fish 'proof of concept' assessment in 2018
  - EPO 'Industrial' longline and purse-seine (NOA, DEL, OBJ) fisheries
- 24 representative species
  - 6 target teleosts
  - 6 non-target teleosts
  - 6 sharks
  - 2 rays
  - 2 dolphins
  - 2 sea turtles

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## **Ecological Assessment of the Sustainable Impacts of Fisheries (EASI-Fish): a flexible vulnerability assessment approach to quantify the cumulative impacts of fishing in data-limited settings**

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# 'Proof of concept' assessment

- 4 fisheries in an EASI-Fish 'proof of concept' assessment in 2018
  - EPO 'Industrial' longline and purse-seine (NOA, DEL, OBJ) fisheries
- 24 representative species
  - 6 target teleosts
  - 6 non-target teleosts
  - 6 sharks
  - 2 rays
  - 2 dolphins
  - 2 sea turtles
- *Mobula* assessment in 2018

