



SAC-08-07d

A preliminary ecological risk assessment of the large-scale tuna longline fishery in the eastern Pacific Ocean using Productivity-Susceptibility Analysis

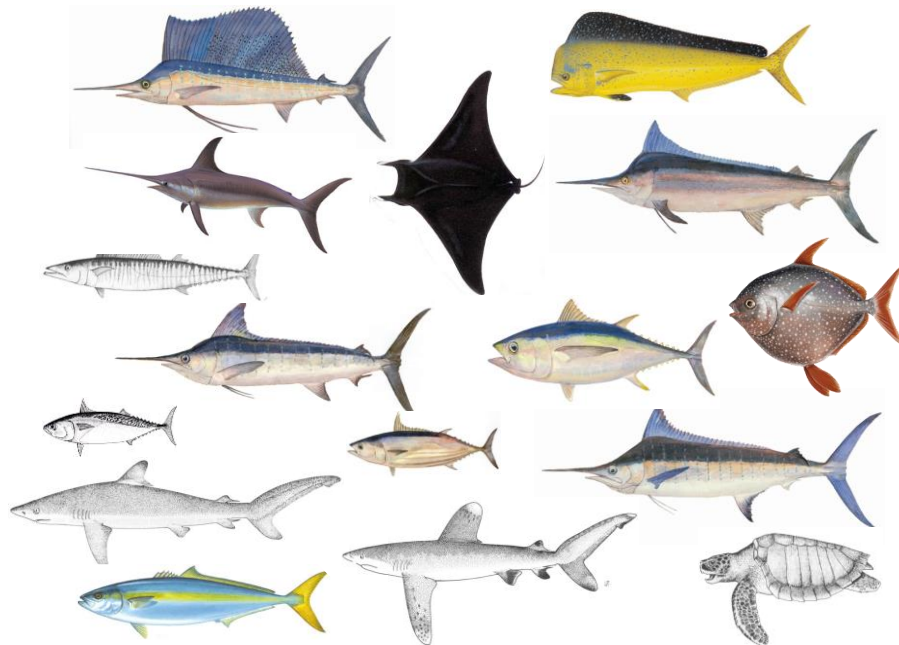
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8<sup>a</sup> Reunión del Comité Científico Asesor  
8<sup>th</sup> Meeting of the Scientific Advisory Committee

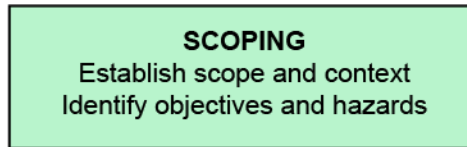
# Ecological sustainability

- IATTC committed to ensuring EPO fisheries are ecologically sustainable
  - Antigua Convention, specific IATTC Resolutions
- Metadata review of the EPO Large Scale Tuna Longline Fishery showed it interacts with many species – target, byproduct, bycatch, species of conservation concern (e.g. silky shark)
- Many species have little economic value and biological and catch data
- PSA is a flexible ERA method designed for data-limited species



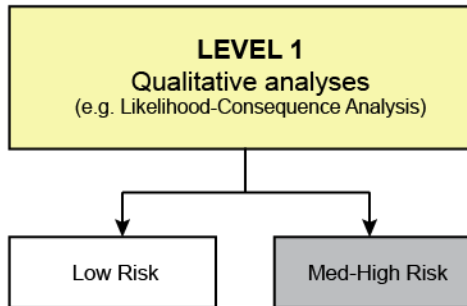
# ERAEF Framework

**Analysis:**  
Fishery/subfishery/gear type



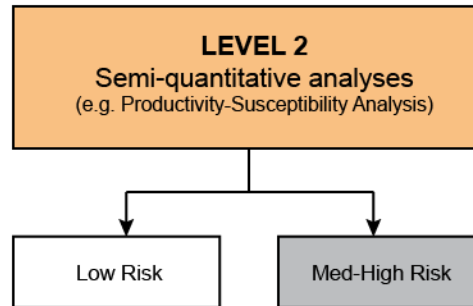
**Analysis:**  
Most vulnerable units in each component (species, habitat, community)

**Screen out:**  
Low consequence activities affecting components

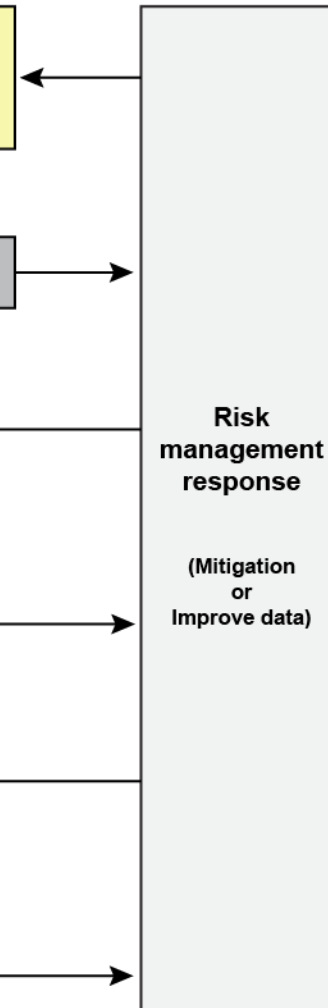
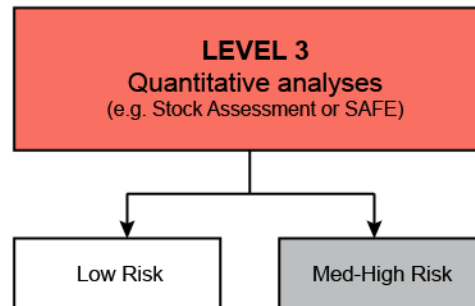


**Analysis:**  
All units in each component

**Screen out:**  
Low risk units



**Analysis:**  
Individual units/stocks, with spatial and temporal dynamics



# Methods

- Includes only the Large Scale Tuna Longline Fishery
  - Excludes 'artisanal' longline fishery (FAO-GEF)
- Only elasmobranchs and teleosts assessed
  - Taxonomic aggregations omitted (e.g. "Elasmobranchii")
- Seabirds, sea turtles and marine mammals interactions have not been reported to the IATTC
  - Resolutions require monitoring by CPCs - data should be sufficient for "Level 3" quantitative population models
- List of species from IATTC database and CPC observer reports
- Biological, ecological and fishery information from IATTC data > literature for the EPO > Pacific Ocean > other similar fisheries > FishBase

# Productivity-Susceptibility Analysis

- **Vulnerability:** potential for the productivity of a stock to be diminished by direct and indirect fishing pressure. A combination of a stock's productivity and its susceptibility to the fishery.
- **Productivity** – capacity to recover if stock is depleted (function of life history characteristics)
  - 5 attributes ranked from 1 (least productive) to 3 (most productive)

Stobutzki, I.C., Miller, M.J., and Brewer, D.T. 2001. Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. *Environmental Conservation* 28: 167-181.

Patrick, W.S., P. Spencer, J. Link, J. Cope, J. Field, D. Kobayashi, P. Lawson, T. Gedamke, E. Cortés, O. Ormseth, K. Bigelow, and W. Overholtz. 2010. Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. *Fish. Bull.* 108: 305-322.

# Productivity attributes

Productivity attribute	Ranking		
	Low (1)	Moderate (2)	High (3)
<b>Maximum size (cm)</b>			
Maximum recorded size of a species, in cm.	> 350	> 200, ≤ 350	≤ 200
<b>von Bertalanffy growth coefficient (<math>K \text{ yr}^{-1}</math>)</b>			
The Brody growth rate coefficient describing the rate at which a population approaches the average length of an individual if fish lived indefinitely ( $L_{\infty}$ ).	< 0.1	0.1–0.3	> 0.3
<b>Fecundity</b>			
The total number of viable offspring (or oocytes) that a fish produces annually.	< 10	10–200,000	> 200,000
<b>Breeding strategy</b>			
The relative investment by a species in the wellbeing of early stages of its offspring's life; assessed by Winemiller's index of parental investment (0–14).	≥ 4	1 - 3	0
<b>Age at maturity (years)</b>			
The age (in years) at which 50% of the population is mature ( $A_{50}$ ).	≥ 7.0	≥ 2.7, < 7.0	< 2.7

- Precautionary approach, absence of reliable data = score of 1

# Productivity-Susceptibility Analysis

- **Vulnerability:** potential for the productivity of a stock to be diminished by direct and indirect fishing pressure. A combination of a stock's productivity and its susceptibility to the fishery.
- **Productivity** – capacity to recover if stock is depleted (function of life history characteristics)
  - 5 attributes ranked from 1 (least productive) to 3 (most productive)
- **Susceptibility** – propensity of species to be captured by, and incur mortality from, a fishery.
  - 6 attributes ranked from 1 (least susceptible) to 3 (most susceptible)

Stobutzki, I.C., Miller, M.J., and Brewer, D.T. 2001. Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. *Environmental Conservation* 28: 167-181.

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# Susceptibility attributes

Susceptibility attribute	Ranking		
	Low (1)	Moderate (2)	High (3)
<b>Areal overlap</b>			
Extent of geographic overlap of the fishery with the primary distribution of the species	Species reported to be caught in <2 high-effort areas in the IATTC Convention Area.	Species reported to be caught in 2-3 high-effort areas in the IATTC Convention Area.	Species reported to be caught in >3 high-effort areas in the IATTC Convention Area.
<b>Seasonal availability</b>			
The proportion of a year that a species is available for potential interaction with the fishery.	Low availability due to the species being present in the IATTC Convention Area for less than 3 months of the year.	Medium availability due to the species being present in the IATTC Convention Area for 3-6 months of the year.	High availability due to the species being present in the IATTC Convention Area for more than 6 months of the year.
<b>Aggregation behavior</b>			
The degree to which a species normally aggregates, either naturally or in relation to gear type (e.g. attraction to bait)	Solitary species, and/or not attracted to baits on longlines.	Normally found in loose aggregations, and/or has some attraction to baits on longlines.	Normally schooling species, and/or highly attracted to baits on longlines.

- Precautionary approach applied
- Data based on CPC data submissions suggests a “shallow set” fishery (< 150 m)

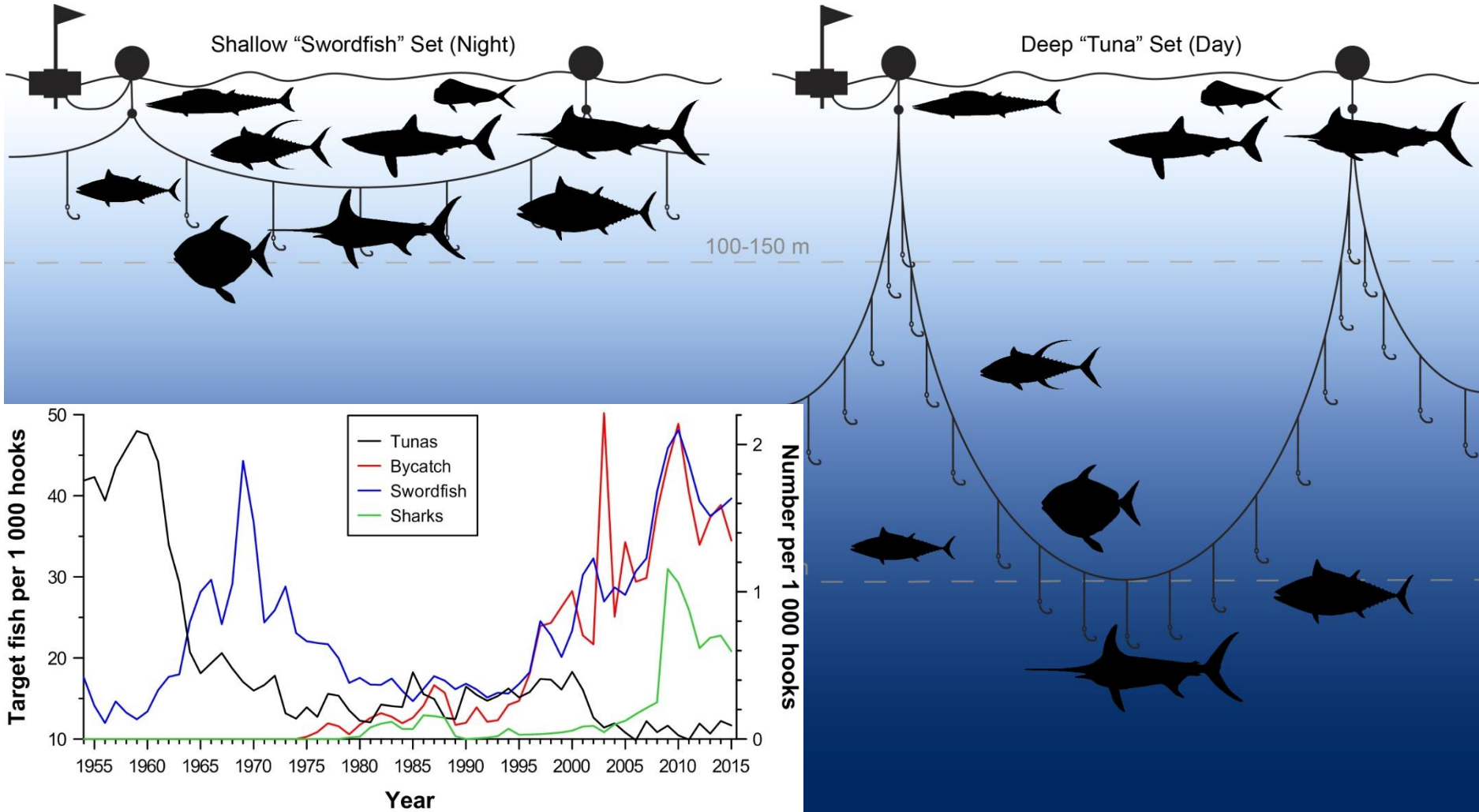


# Susceptibility attributes

Susceptibility attribute	Ranking		
	Low (1)	Moderate (2)	High (3)
<b>Encounterability</b>			
The position of the species within the water column relative to the fishing depth of the gear.	Low overlap with fishing gear. Majority of the stock distributed above or below the normal depth of the gear.	Medium overlap with fishing gear. A reasonable portion of the stock distributed within the normal depth of the gear.	High overlap with fishing gear. Majority of the stock distributed within the normal depth of the gear. Default score for target species (P1)
<b>Gear selectivity</b>			
Potential for the gear to retain a species once an interaction has taken place.	Small proportion of the stock that encounters the gear is hooked.	Medium proportion of the stock that encounters the gear is hooked.	Large proportion of the stock that encounters the gear is hooked. Default score for target species (P1).
<b>Post-capture survival</b>			
Potential for a species to survive after being caught and released.	Highly robust species, with high potential for post-capture survival.	Reasonably robust species, with some potential for post-capture survival.	Delicate species, with low potential for post-capture survival due to trauma, scale loss, etc.

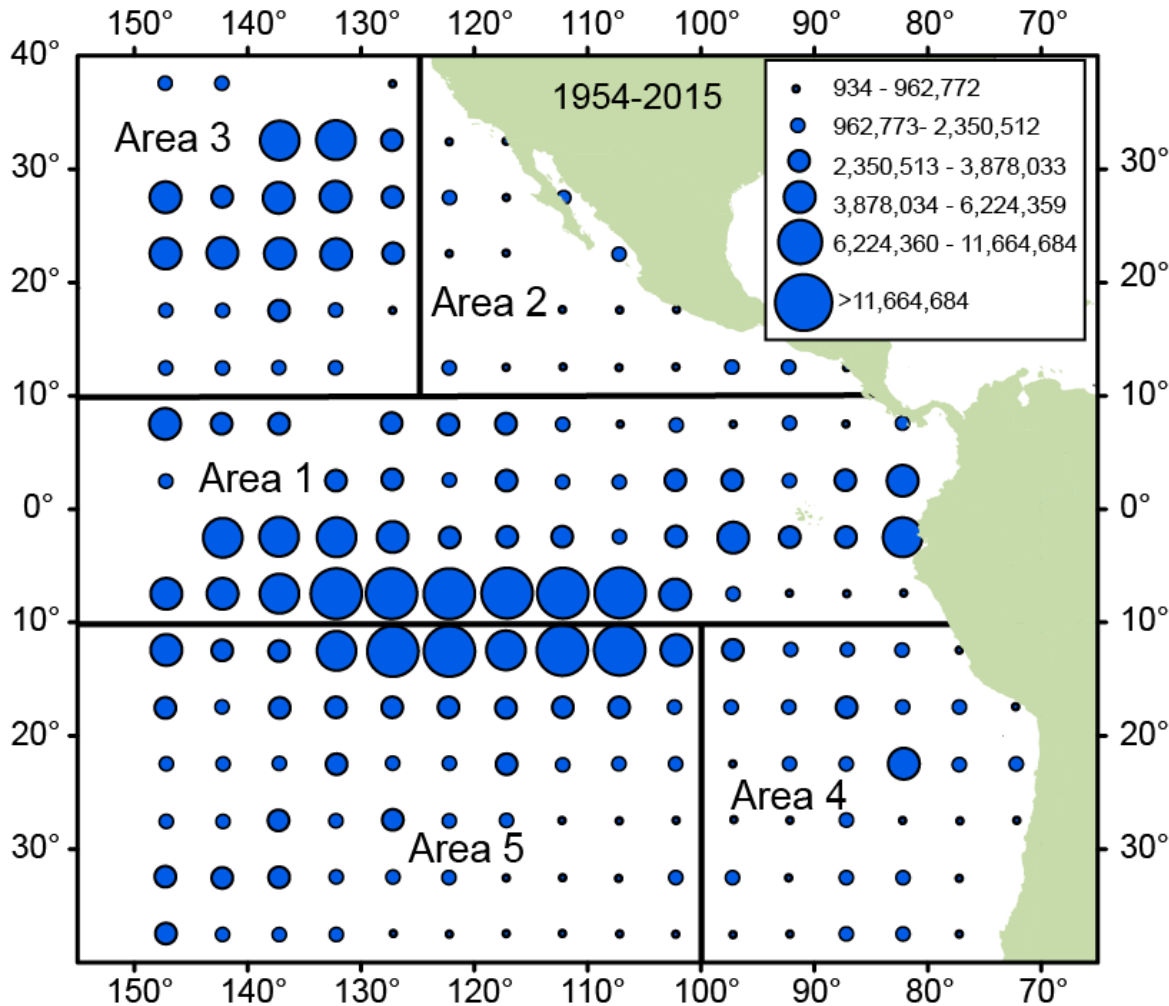
- Precautionary approach applied
- Absence of reliable data = score of 3

# Encounterability – assumption of set type



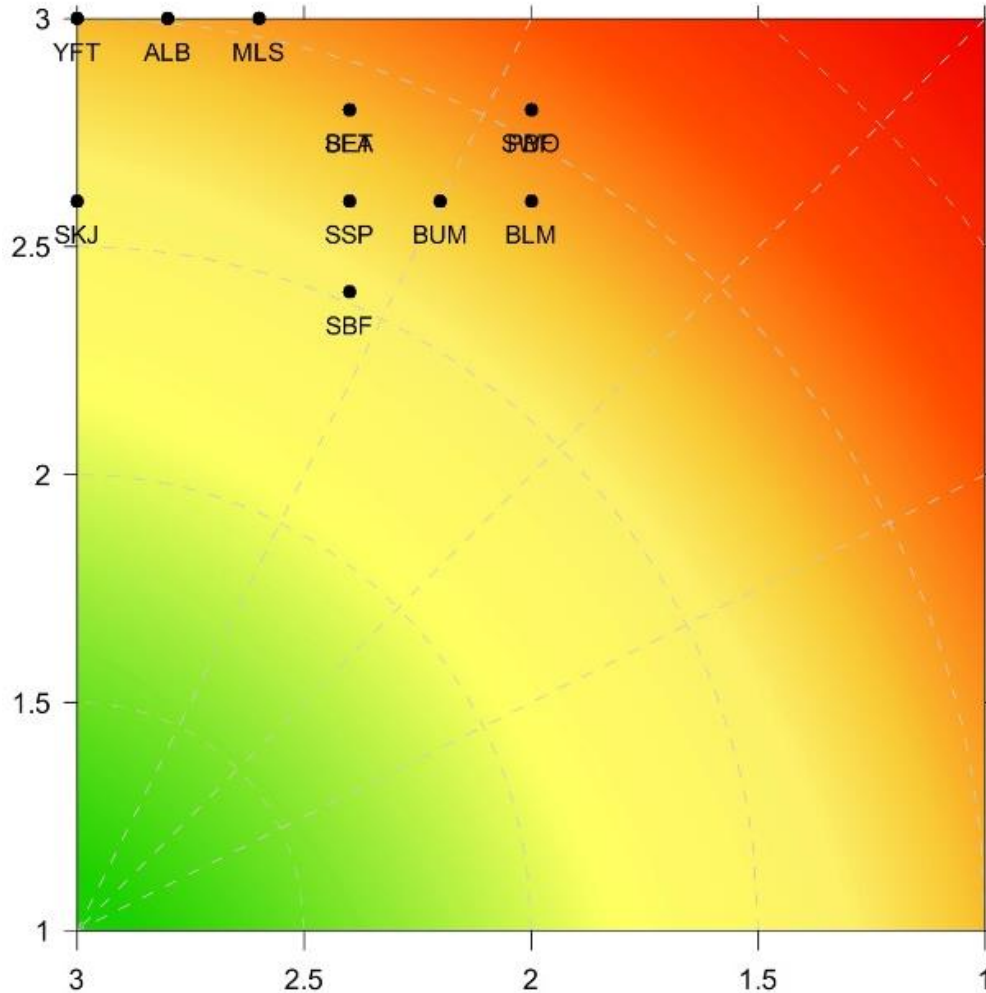
- Precautionary approach based on CPC data submissions
  - Appears to be "Shallow set" fishery (< 150 m) in absence of gear configuration data

# Spatial extent of the EPO longline effort



- Extent of the fishery defined as any grid receiving any effort since 1954
- Longline effort recorded in almost every EPO grid
  - 100% overlap = score 3
- Hinton (2003) suggested 5 sub fishery areas
- Potential fishery impact
  - 1 areas (low)
  - 2-3 areas (moderate)
  - 4-5 areas (high)

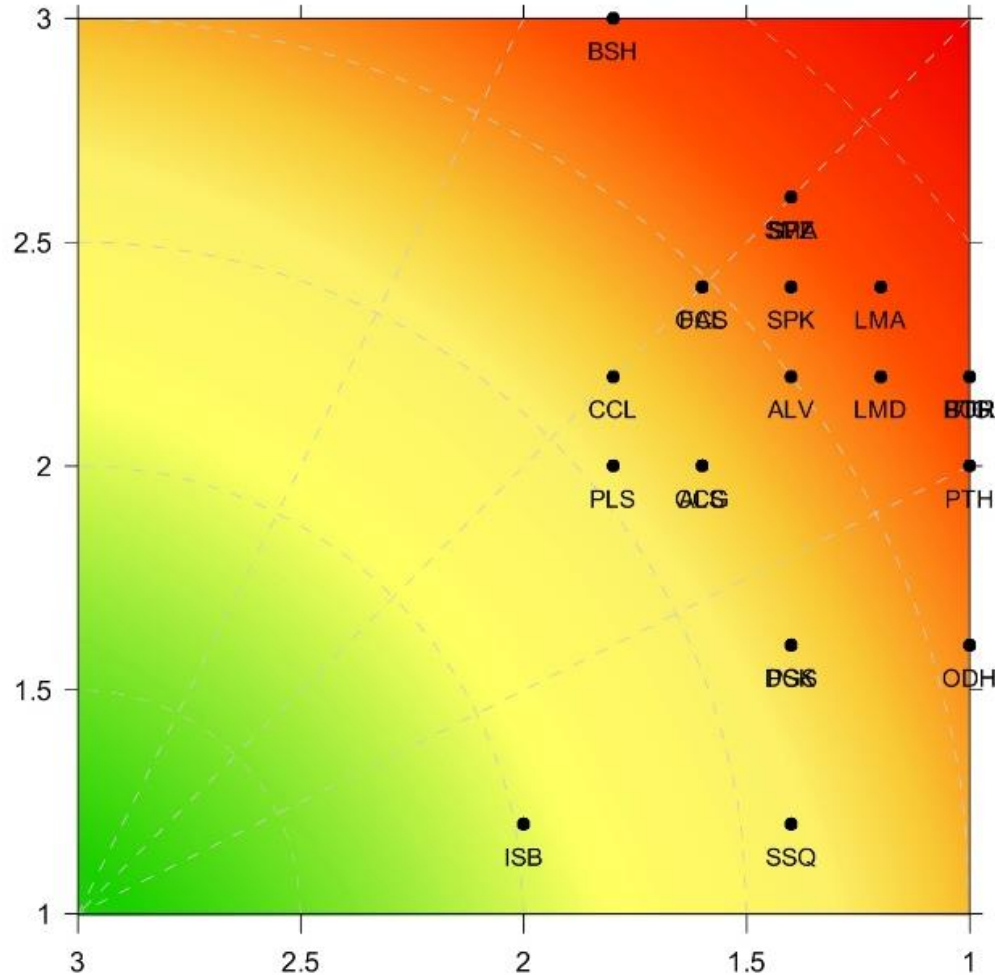
# Results – Tunas and billfishes



Group	FAO code	Common name	v
Billfishes	SWO	Swordfish	2.06
	MLS	Striped marlin	2.04
	SFA	Indo-Pacific sailfish	1.90
	BLM	Black marlin	1.89
	BUM	Blue marlin	1.79
	SSP	Shortbill spearfish	1.71
Tunas	PBF	Pacific bluefin tuna	2.06
	ALB	Albacore tuna	2.01
	YFT	Yellowfin tuna	2.00
	BET	Bigeye tuna	1.90
	SKJ	Skipjack	1.60
	SBF	Southern bluefin tuna	1.52



# Results - Elasmobranchs

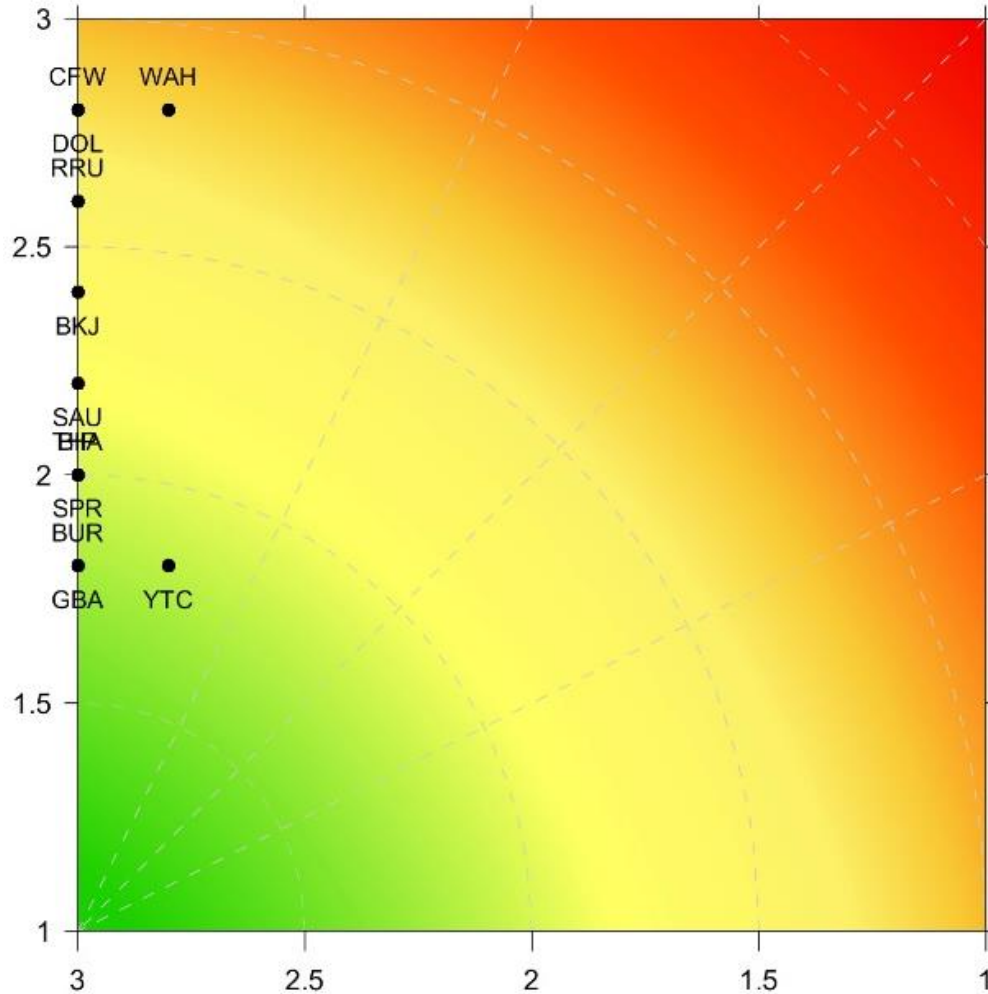


Group	FAO code	Common name	v
Elasmobranchs	BTH	Bigeye thresher shark	2.33
	TIG	Tiger shark	2.33
	POR	Porbeagle	2.33
	BSH	Blue shark	2.33
	LMA	Longfin mako shark	2.28
	SMA	Short fin mako shark	2.26
	SPL	Scalloped hammerhead shark	2.26
	SPZ	Smooth hammerhead	2.26
	PTH	Pelagic thresher	2.24
	LMD	Salmon shark	2.16
	SPK	Great hammerhead	2.13
	ODH	Bigeye sand tiger shark	2.09
	ALV	Common thresher shark	2.00
	FAL	Silky shark	1.98
	OCS	Oceanic whitetip shark	1.98
	ALS	Silvertip shark	1.72
	CCG	Galapagos shark	1.72
	PSK	Crocodile shark	1.71
	DGS	Spiny dogfish	1.71
	CCL	Blacktip shark	1.70
	SSQ	Velvet dogfish	1.61
	PLS	Pelagic stingray	1.56
	ISB	Cookie cutter shark	1.02





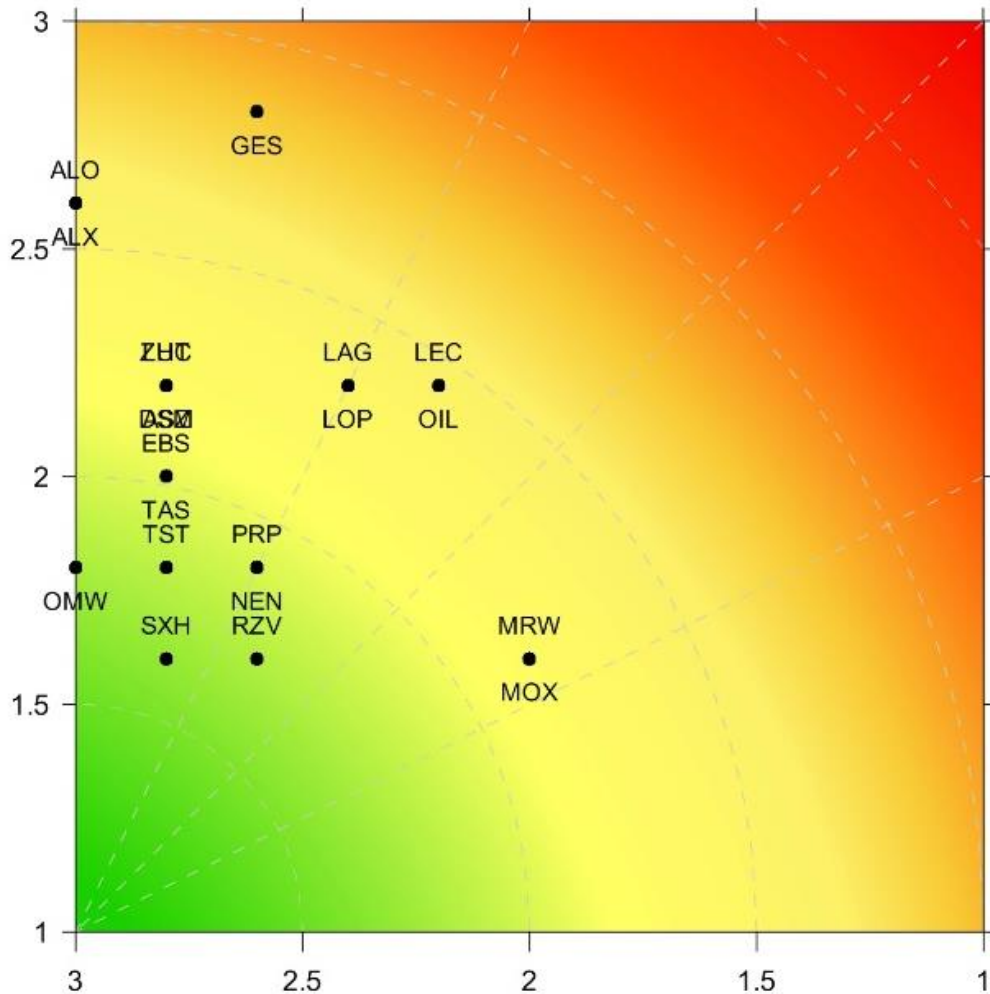
# Results – Tuna-like species



Group	FAO code	Common name	v
Tuna-like species	WAH	Wahoo	1.81
	CFW	Pompano dolphinfish	1.80
	DOL	Common dolphinfish	1.80
	RRU	Rainbow runner	1.60
	BKJ	Black skipjack	1.40
	SAU	Atlantic saury	1.20
	THA	Atlantic thread herring	1.00
	SPR	European sprat	1.00
	BIP	Striped bonito	1.00
	YTC	Yellowtail amberjack	0.82
	BUR	Sompat grunt	0.80
GBA	Great barracuda	0.80	



# Results – Mesopelagic fishes



Group	FAO code	Common name	v
	GES	Snake mackerel	1.84
	ALO	Short snouted lancetfish	1.60
	ALX	Long snouted lancetfish	1.60
	LEC	Escolar	1.44
	OIL	Oilfish	1.44
	LAG	Opah	1.34
	LOP	Crestfish	1.34
	DSM	Polka-dot ribbonfish	1.22
	ZUC	Scalloped ribbonfish	1.22
<b>Mesopelagic fishes</b>	ASZ	Razorback scabbardfish	1.22
	LHT	Tapertail ribbonfish	1.22
	MRW	Sharptail mola	1.17
	MOX	Sunfish	1.17
	EBS	Brilliant pomfret	1.02
	TAS	Rough pomfret	1.02
	NEN	Black gemfish	0.89
	PRP	Roudi escolar	0.89
	TST	Sickle Pomfret	0.82
	OMW	Omosudid (Hammerjaw)	0.80
	RZV	Slender sunfish	0.72
	SXH	Longfin escolar	0.63



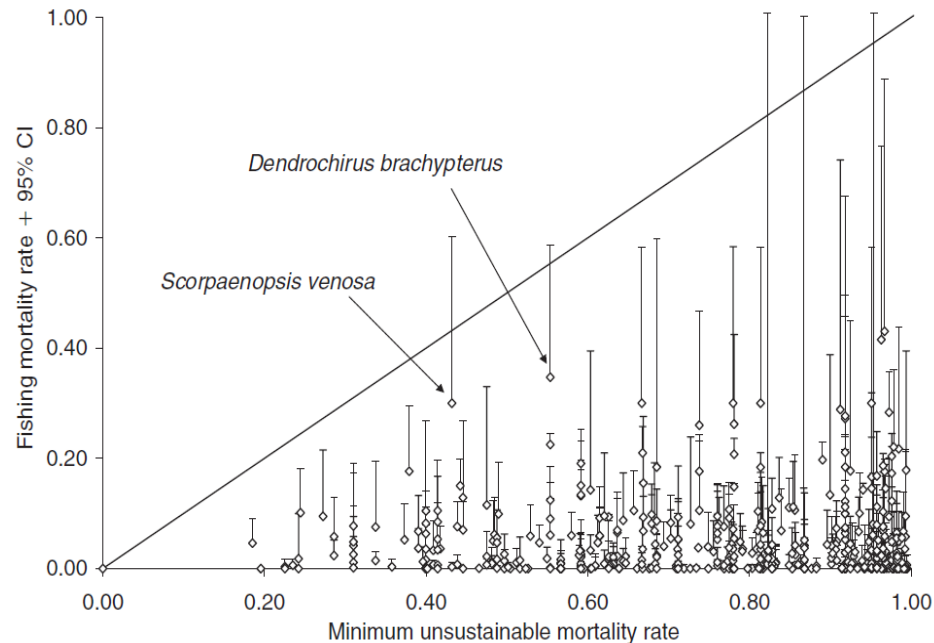
# Conclusions

- Preliminary PSA for the large-scale tuna longline fishery showed:
  - 18 species at high risk – mostly sharks (threshers, makos, blue)
  - 38 species at moderate risk – many mesopelagic fish with little data (e.g. escolar)
  - 12 species at low risk
- PSA allows prioritization of species for further investigation in our current stage of limited data and funding
  - Improved CPC reporting of sharks, billfish and large fishes (e.g. escolar)
  - Better determine ecounterability with set-by-set data with gear configurations
- But, PSA only produces a relative ranking of risk
  - Potential for false negatives despite a precautionary approach
- Also does not consider cumulative impacts by multiple fisheries
  - Bigeye thresher also highest risk species in purse-seine PSA



# Future work

- We propose to undertake PSA for other EPO fisheries
  - Artisanal (FAO-GEF), Purse-seine (Class 1-5), Recreational
- Explore methods to assess cumulative impacts of EPO fisheries
- Feasibility of Sustainability Assessment for Fishing Effects (SAFE)
  - Quantitative indicator of risk (with uncertainty) using biological reference points
  - High reliance on fine-scale species distribution overlap with fishing effort



## Summary of *Ecosystem Considerations* papers

- Our 4 “ecosystem considerations” papers provided a strategy to address ecological sustainability.
  - 1) Identified the need for ecological research to meet IATTC mandates and to demonstrate EPO fisheries are fishing responsibly.
  - 2) Proposed ERAEF framework to guide future work and ERA methods
  - 3) Completed longline metadata analysis to assess data quality for ERA
  - 4) Improved PSA method by reducing biases and input data requirements
  - 5) Identified data gaps and species requiring urgent attention for ERA
  - 6) Proposed future work to improve reliability of ERA to meet IATTC mandates



Questions