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Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC)

By

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IOTC CALL

- Lack of information for quantitative stock assessment for all species of sharks in the IOTC area of responsibility
- **2011** Working Party on Ecosystem and Bycatch suggested ERA as a potential source of information for management advice
- 14th meeting of IOTC SC in **2011** strongly recommended that “Ecological Risk Assessment (ERA) is conducted for sharks”
- Preliminary results of ERA for LL gear are presented here
- Similar analysis for PS gear should be developed for the next session of SC (December **2012**)

BACKGROUND

• The Ecological Risk Assessment (ERA) for the effects of fishing framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk(level 1), through a more focused and semi-quantitative approach (level 2), to a highly focused and fully quantitative approach (level 3, (Hobday et al., 2006))

Level	What?	How?	Who?
1	Scale, intensity, consequence analysis	Perception	Stakeholder
2	**Productivity Susceptibility Analysis (PSA)**	**Semi quantitative analysis**	**Scientific basis**
3	Fully quantitative	Full stock assessment including uncertainty	Scientific basis

BACKGROUND

• Recently, there have been a few ERA applications to tuna and tuna like fisheries.

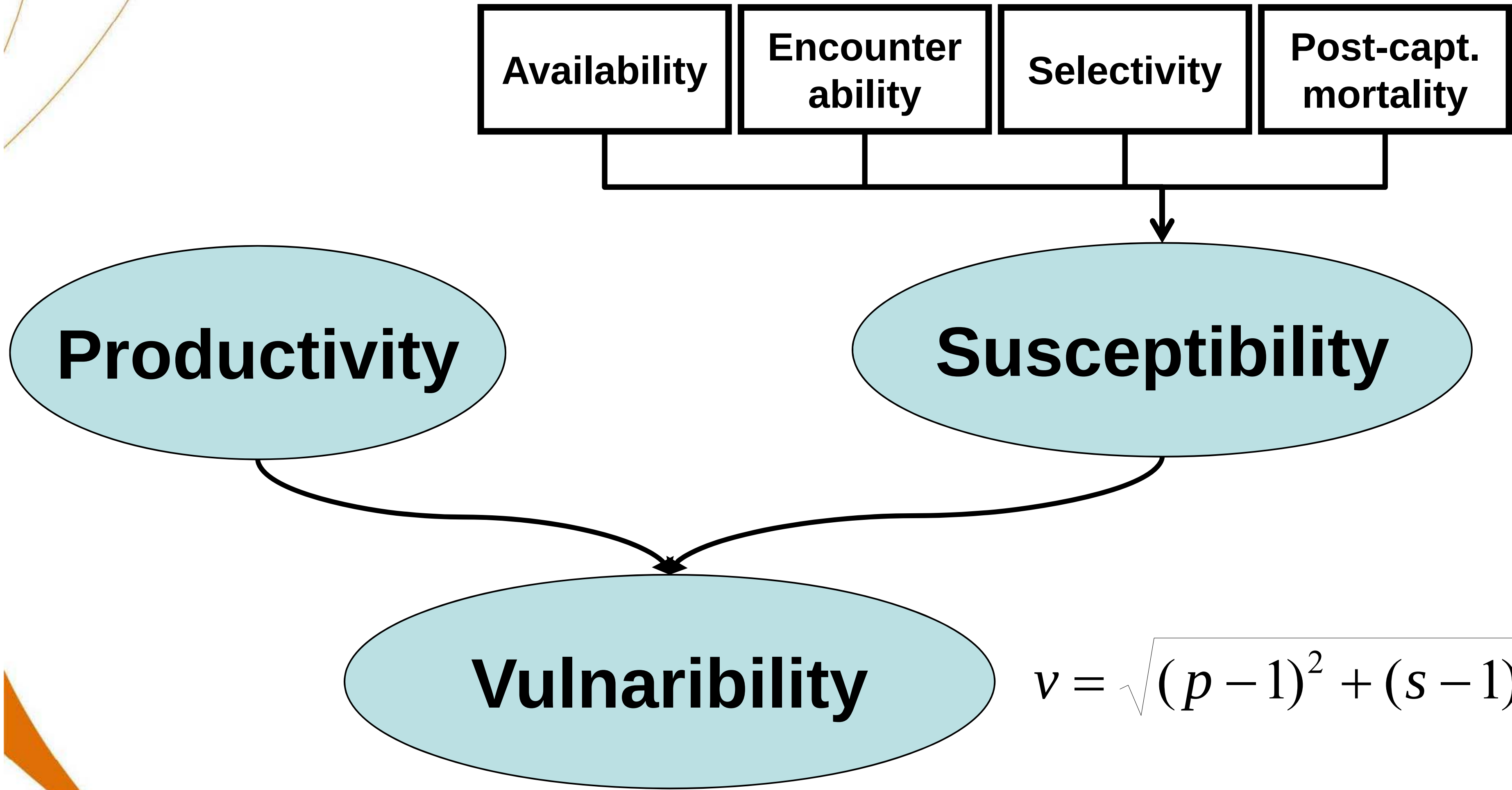
Reference	Where?	Fisheries?	Species?
Kirby (2006)	WCPO	Tuna	All
Cortés *et al.* (2010)	Atlantic	Longline	Pelagic elasmobranches
ICCAT Sub Com. on Ecosystems	Atlantic	Longline	Sea bird assessment
Arrizabalaga *et al.* (2009)	Atlantic	Tropical PS + USA LL	ALL
Murua *et al.* (2011)	Indian	Tropical PS + USSR, Taiwan, Reunión LL	ALL
Olson et al., 2011	East Pacific	PS	ALL

OBJECTIVES

Thus, the purpose of this work is to conduct a productivity susceptibility analysis, i.e. level 2 of an ERA analysis, for shark species caught in various fisheries targeting tuna and tuna-like species in the Indian Ocean.

MATERIAL & METHODS

A Cortes *et al.*, 2010 approach was used



$$v = \sqrt{(p-1)^2 + (s-1)^2}$$

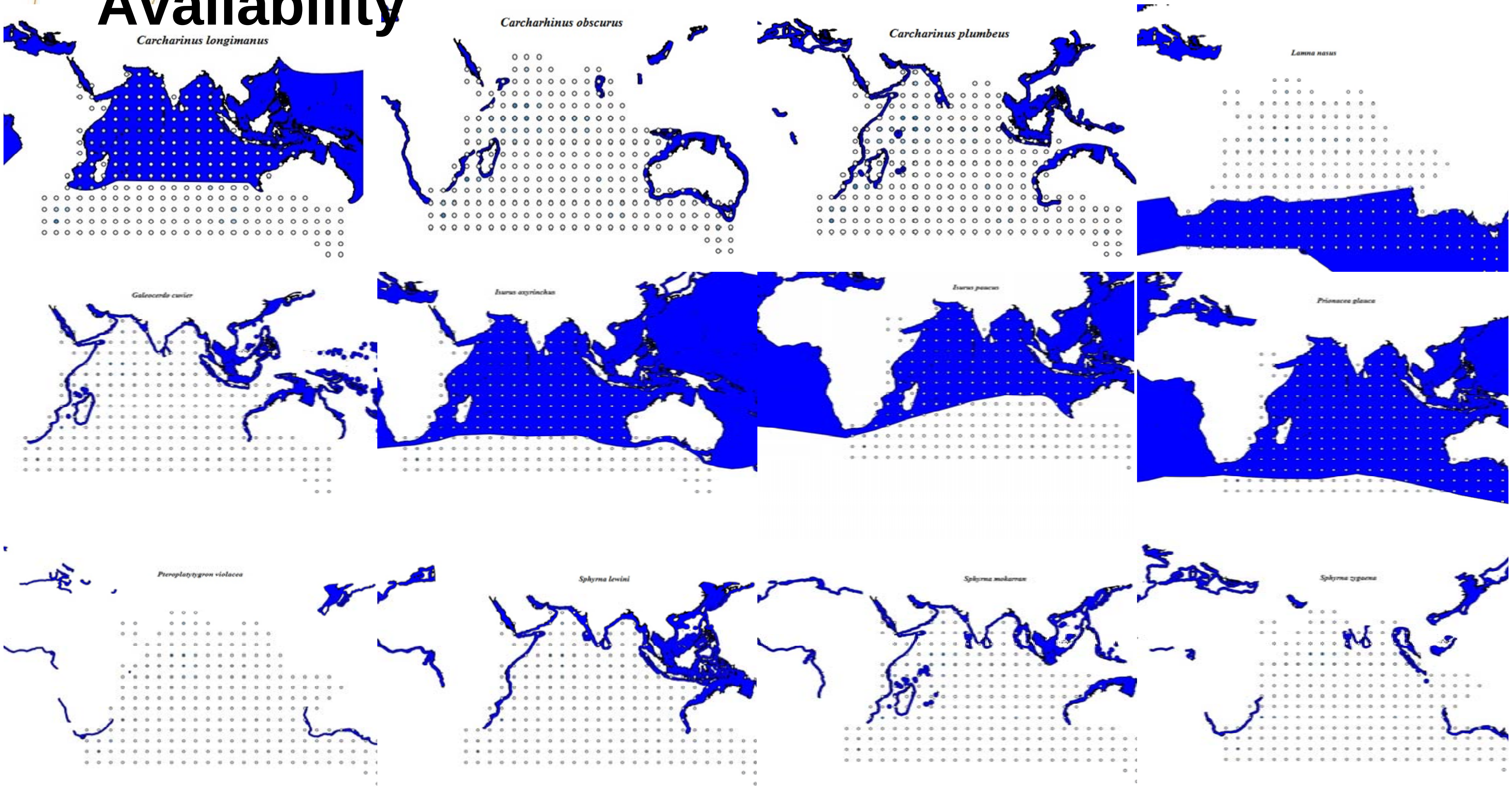
MATERIAL & METHODS

Productivities - Leslie matrices methods

- **Biological information needed (VB growth, fec., survivorship, longevity, maturity, etc…)**
- **Estimation of <u>Lambda (λ)</u> - Population finite growth rate - estimated with age-structured Leslie Matrices**
- **<u>Survivorship</u> parameters based on age-based mortalities calculated from indirect equations**
- **<u>Reproductive</u> parameters based on fecundity literature references, assuming a 1:1 sex ratio of the offspring, and accounting for the duration of the reproductive cycle**
- **<u>Uncertainties</u>: (MC-simulations based on 10,000 runs)**
  - **Survivorships & Fecundities**

MATERIAL & METHODS

Availability



RESULTS

Biological data

Species	Common name	Biological data region	Depth range (m)	Mean litter (n)	Reproductive periodicity (yr)	Female K (yr-1)	L∞ (cm FL)	t0	Median age at maturity (yr)	Female longevity (yr)	S0 (yr-1)	S1+(yr-1)
Alopias superciliosus (BTH)	Bigeye thresher	N Atlantic	*0-700*	3	1	0.06	293	102*	12.5	22	0.88	0.83-0.92
Alopias pelagicus (xxx)	Pelagic thresher	Pacific	*0-150*	2	1***	0.09	197	-7.67	8.5	28	0.89	0.82-0.97
Alopias vulpinus (ALV)	Common thresher	N Atlantic	*0-370*	4	1	0.11	483	121*	6	24	0.82	0.76-0.93
Carcharhinus falciformis (FAL)	Silky shark	Indian Ocean	*0-500*	7.2	2	0.057	320.4	81.1*	15	35.8	0.88	0.82-98
Carcharhinus longimanus (OCS)	Oceanic whitetip shark	N Atlantic	*0-152*	5.4	1	0.1	285	-3.39	6	17	0.82	0.78-0.90
Pseudocarcharias kamoharai (PSK)	Crocodile shark	N Atlantic	*0-590*	4	-	-	-	-	89 cm	122 cm	-	-
Carcharhinus obscurus (DUS)	Dusky shark	N Atlantic	*0-400*	7	3	0.04	421	-7.04	20	40	0.90	0.80-0.98
Carcharhinus plumbeus (CCP)	Sandbar shark	N Atlantic	*0-280*	8.4	2.5	0.12	181.15	-2.33	15.5	24	0.82	0.71-0.94
Galeocerdo cuvier (GAC)	Tiger shark	Indian Ocean	*0-140*	55	2	0.202	301	-1.11	11	29	0.77	0.56-0.99
Isurus oxyrinchus (SMA)	Shortfin mako	N Atlantic	*0-500*	15	2	0.054	432	70*	18	32	0.87	0.78-0.97
*Isurus paucus (LMA)***	Longfin mako	N Atlantic	*0-200*	4	2	0.054	432	70*	14	32	0.87	0.78-097
Lamna nasus (POR)	Porbeagle	N Atlantic	*0-700*	4	1	0.061	289	-5.9	14	26	0.88	0.81-0.93
Prionace glauca (BSH)	Blue shark	N Atlantic	*0-220*	38	1	0.15	375	-0.87	5	21	0.71	0.72-091
Pteroplatytrygon violacea (PLS)	Pelagic stingray	N Atlantic	*0-240*	6	0.5	0.2	116	17*	3	12	0.64	0.58-0.88
Sphyrna lewini (SPL)	Scalloped hammerhead	N Atlantic	*0-512*	17	2	0.09	303	-2.22	15	31	0.84	0.76-0.94
Sphyrna mokarran (SPM)	Great hammerhead	N Atlantic	*0-300*	28	2	0.13	286.7	-2.51	20	42	0.89	0.81-0.98
Sphyrna zygaena (SPZ)	Smooth hammerhead	N Atlantic	*0-200*	33	1	0.07	285	-7.3	9	18	0.85	0.85-0.90
Rhincodon typus	Whale shark	Indian Ocean	*0-250*	55	-	0.032	1496	0.85	30 yr (males)	1900 cm	-	-
Carcharodon carcharias	Great white shark	Indian Ocean	*0-250*	10	2	0.07	660	-2.33	9.5	36	0.80	0.71-0.99

RESULTS

Observer data

			Susceptivility			
FAO Code	Species/Stock	Common name	Availability	Encounterability	Selectivity	Post-capture mortality
CCP	*Carcharhinus plumbe*	Sandbar shark	All	All	Korea	Korea
DUS	*Carcharhinus*	Dusky shark	All	All	Korea (2 specimens)	Korea
LMA	*Isurus paucus*	Longfin mako	All	All	Portugal/Japan/Korea/USSR	Portugal
BTH	*Alopias superciliosus*	Bigeye thresher	All	All	Portugal/Japan/USSR	Portugal/Korea
POR	*Lamna nasus*	Porbeagle	All	All	Japan/Korea	Portugal/Korea
SMA	*Isurus oxyrinchus*	Shortfin mako	All	All	Portugal/Japan/Korea/USSR	Portugal/Reunion/Korea
SPL	*Sphyrna lewini*	Scalloped hammerh	All	All	Korea (4 specimens)	Portugal/Reunion/Korea
FAL	*Carcharhinus falcifo*	Silky shark	All	All	Portugal/Japan/Korea/USSR	Portugal/Reunion/Korea
PTH	*Alopias pelagicus*	Pelagic thresher	All	All	Japan/Korea	Korea
SPM	*Sphyrna mokarran*	Great hammerhead	All	All	n/a	Portugal
WSH	*Carcharodon carcha*	Great white shark	All	All	n/a	n/a
GAC	*Galeocerdo cuvier*	Tiger shark	All	All	Portugal/Korea	Portugal/Korea
ALV	*Alopias vulpinus*	Common thresher	All	All	Japan	n/a
OCS	*Carcharhinus longim*	Oceanic whitetip sh	All	All	Portugal/Japan/Korea/USSR	Portugal/Reunion/Korea
PLS	*Pteroplatytrygon viol*	Pelagic stingray	All	All	China/Korea (few specimens)	Portugal/Reunion/Korea
SPZ	*Sphyrna zygaena*	Smooth hammerhea	All	All	Portugal/Japan/Korea	Portugal/Korea
BSH	*Prionace glauca*	Blue shark	All	All	Portugal/Japan/Korea/China/USSR	Portugal/Reunion/Korea

RESULTS

Productivity

- **Species sorted from lowest to highest productivities**

FAO Code	Species/Stock	Lambda	95%CI (low)	95%CI (upp)
CCP	*Carcharhinus plumbeus*	0.978	0.950	1.005
DUS	*Carcharhinus obscurus*	1.027	1.009	1.044
LMA	*Isurus paucus*	1.029	1.007	1.049
BTH	*Alopias superciliosus*	1.033	1.017	1.047
POR	*Lamna nasus*	1.041	1.024	1.057
SMA	*Isurus oxyrinchus*	1.061	1.040	1.081
SPL	*Sphyrna lewini*	1.062	1.039	1.083
FAL	*Carcharhinus falciformis*	1.075	1.057	1.093
SPM	*Sphyrna mokarran*	1.097	1.079	1.115
PTH	*Alopias pelagicus*	1.098	1.075	1.119
WSH	*Carcharodon carcharias*	1.117	1.077	1.155
GAC	*Galeocerdo cuvier*	1.147	1.078	1.211
ALV	*Alopias vulpinus*	1.148	1.114	1.181
OCS	*Carcharhinus longimanus*	1.162	1.132	1.192
PLS	*Pteroplatytrygon violacea*	1.242	1.156	1.323
SPZ	*Sphyrna zygaena*	1.281	1.257	1.303
BSH	*Prionace glauca*	1.483	1.414	1.546

RESULTS

Susceptibility

- **Species sorted from highest to lowest susceptibilities**

			SUSCEPTIBILITY				
FAO Code	**Species/Stock**	**Common name**	**Availability**	**Encounterability**	**Selectivity**	**Post-capture mortality**	**Susceptibility**
PTH	*Alopias pelagicus*	Pelagic thresher	0.974	1.000	0.997	1.000	**0.971**
BSH	*Prionace glauca*	Blue shark	0.952	1.000	0.996	0.984	**0.933**
SMA	*Isurus oxyrinchus*	Shortfin mako	0.963	1.000	0.970	0.994	**0.929**
BTH	*Alopias superciliosus*	Bigeye thresher	0.968	1.000	0.968	0.970	**0.909**
SPZ	*Sphyrna zygaena*	Smooth hammerhead	0.909	1.000	0.997	0.997	**0.904**
FAL	*Carcharhinus falciformis*	Silky shark	0.961	1.000	0.925	0.990	**0.880**
OCS	*Carcharhinus longimanus*	Oceanic whitetip shark	0.961	1.000	0.939	0.974	**0.880**
POR	*Lamna nasus*	Porbeagle	0.796	1.000	0.885	0.905	**0.638**
SPM	*Sphyrna mokarran*	Great hammerhead	0.925	1.000	0.622*	1.000	**0.575**
LMA	*Isurus paucus*	Longfin mako	0.956	1.000	0.600	0.992	**0.569**
GAC	*Galeocerdo cuvier*	Tiger shark	0.923	1.000	0.521	0.903	**0.434**
PLS	*Pteroplatytrygon violacea*	Pelagic stingray	0.941	1.000	0.758	0.370	**0.264**
DUS	*Carcharhinus obscurus*	Dusky shark	0.943	1.000	0.245	1.000	**0.231**
SPL	*Sphyrna lewini*	Scalloped hammerhead	0.942	1.000	0.246	0.875	**0.203**
CCP	*Carcharhinus plumbeus*	Sandbar shark	0.935	1.000	0.172	1.000	**0.161**
ALV	*Alopias vulpinus*	Common thresher	0.970	1.000	0.562	0.180**	**0.098**
WSH	*Carcharodon carcharias*	Great white shark	0.974	1.000	n/a	n/a	**n/a**

RESULTS

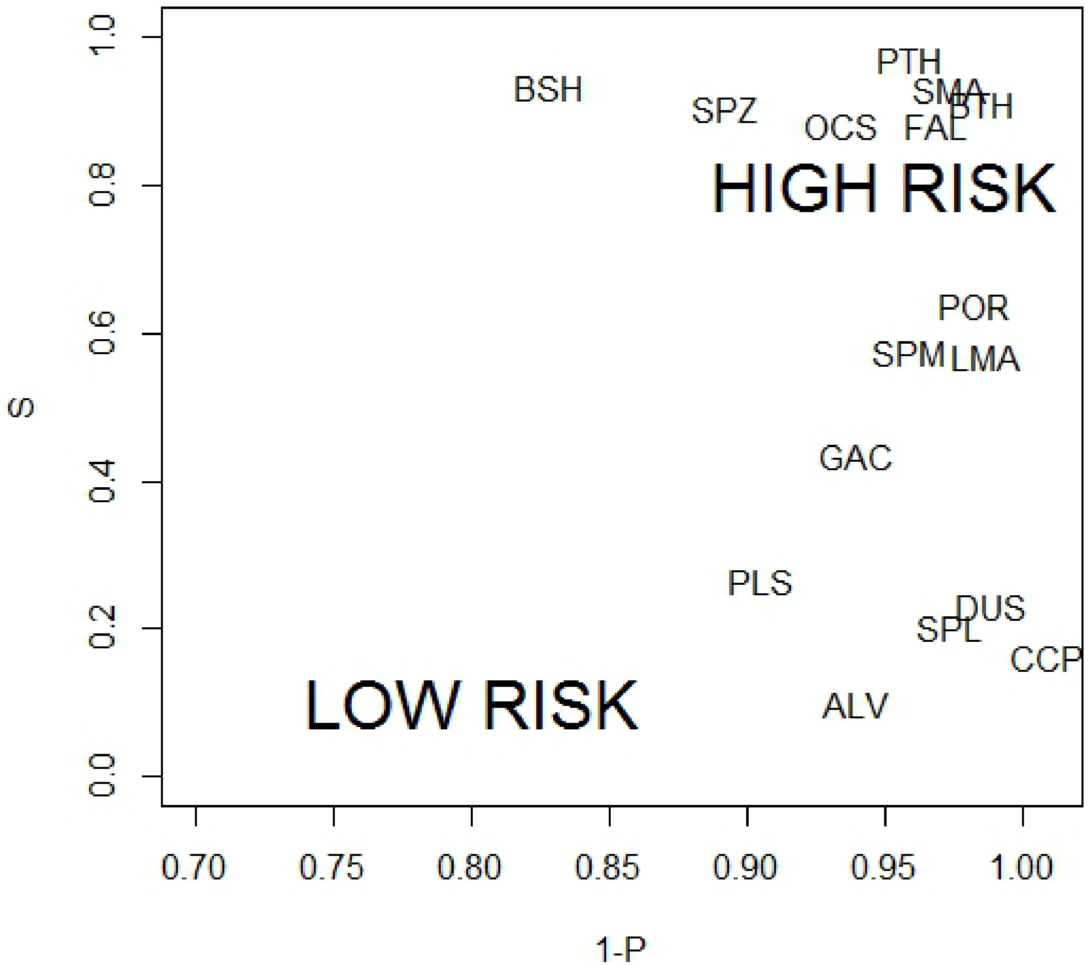
Vulnerability:

- **Species rank from highest to lowest susceptibilities**

FAO Code	Species/Stock	Common name	Productivity	Susceptibility	Vulnerability	RANK
SMA	*Isurus oxyrinchus*	Shortfin mako	1.061	0.929	**0.094**	**1**
BTH	*Alopias superciliosus*	Bigeye thresher	1.033	0.909	**0.097**	**2**
PTH	*Alopias pelagicus*	Pelagic thresher	1.098	0.971	**0.102**	**3**
FAL	*Carcharhinus falciformis*	Silky shark	1.075	0.880	**0.142**	**4**
OCS	*Carcharhinus longimanus*	Oceanic whitetip shark	1.162	0.880	**0.202**	**5**
SPZ	*Sphyrna zygaena*	Smooth hammerhead	1.281	0.904	**0.298**	**6**
POR	*Lamna nasus*	Porbeagle	1.041	0.638	**0.364**	**7**
LMA	*Isurus paucus*	Longfin mako	1.029	0.569	**0.432**	**8**
SPM	*Sphyrna mokarran*	Great hammerhead	1.098	0.575	**0.436**	**9**
BSH	*Prionace glauca*	Blue shark	1.483	0.933	**0.489**	**10**
GAC	*Galeocerdo cuvier*	Tiger shark	1.147	0.434	**0.585**	**11**
DUS	*Carcharhinus obscurus*	Dusky shark	1.027	0.231	**0.770**	**12**
PLS	*Pteroplatytrygon violacea*	Pelagic stingray	1.242	0.264	**0.775**	**13**
SPL	*Sphyrna lewini*	Scalloped hammerhead	1.062	0.203	**0.799**	**14**
CCP	*Carcharhinus plumbeus*	Sandbar shark	0.978	0.161	**0.840**	**15**
ALV	*Alopias vulpinus*	Common thresher	1.148	0.098	**0.914**	**16**
WSH	*Carcharodon carcharias*	Great white shark	1.117	n/a	**n/a**	**n/a**

RESULTS

Productibility and Susceptibility



CONCLUSIONS I

- **PSA is a tool focused on assessment of large numbers of species in order to identify potentially vulnerable species, which then might be subject to more detailed and rigorous analyses**

- **PSA also helps identify data gaps and immediate research priorities**

- **Lack of biological parameters specific to Indian Ocean for most of the sharks as well as limited length frequency and post-capture mortality data from observes may affect the results of this analysis. *Therefore, it is strongly recommended that shark biological information specific to the Indian Ocean as well as observer data compilation is improved.***

CONCLUSIONS II

• **The present study ranks the vulnerability or relative risk to overexplotation of different shark species harvested by the longline fleet in the Indian Ocean. However, the current PSA study does not evaluate the status of the stocks because it does not estimate the fishing mortality neither the biomass in relation to their biological reference points.**

• **Nevertheless, it is a step in the right direction to identify most vulnerable species, which needs more attention (e.g. data collection, surveys, assessment, etc…)**

•**It would also be important to expand the analysis to other large scale IOTC fisheries, such as gillnet fisheries. However data availability for these fisheries is primary issue.**

THANK YOU FOR YOUR ATTENTION!!!