SAC-07-07b
Ecosystem considerations in the eastern Pacific Ocean

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7ª Reunión del Comité Científico Asesor
7th Meeting of the Scientific Advisory Committee

Summary: update of ecosystem considerations

Trophic interactions

- Global analysis of yellowfin, bigeye and albacore trophic patterns (international collaboration: CLIOTOP WG3[1])

Aggregate indicators

- Mean trophic level of organisms taken by the purse-seine fisheries in the EPO

Ecological risk assessment (ERA)

- Ecosystem Specialist to join IATTC staff in August 2016
- Review modifications made to the Productivity and Susceptibility Assessment (PSA) in 2015 – proof of concept
- Summarize available data for fisheries operating in the EPO (SAC-07-INF C(d)

[1] Climate Impacts on Oceanic Top Predators, Working Group 3: Trophic Pathways in Open-Ocean Ecosystems

Food-web structure and function

- Ecological research at the IATTC largely focused on the structure and function of the pelagic food web in the EPO

- Effects of tuna fisheries on ecosystem
  - Direct effects: e.g. bycatches of non-target species (some sensitive)
  - Indirect effects: e.g. predator-prey connections and competition via the food web

- Anticipating changes induced by fishing requires understanding of food web structure and function

- Diet studies are necessary for investigating pathways of energy flow in exploited ecosystems

- Knowledge of trophic position and linkages is essential for informing ecosystem models

- Knowledge of <u>pelagic</u> food webs is still rudimentary, in many aspects

Trophic interactions

- A new book chapter reviews current understanding of bioenergetics and feeding dynamics of tunas on a world-wide scale: "Bioenergetics, trophic ecology, and niche separation of tunas"

- Novel classification tree methodology developed for analyzing complex diet data

> To date: 4 papers have been published using this approach and another paper was recently submitted to Deep-Sea Research II

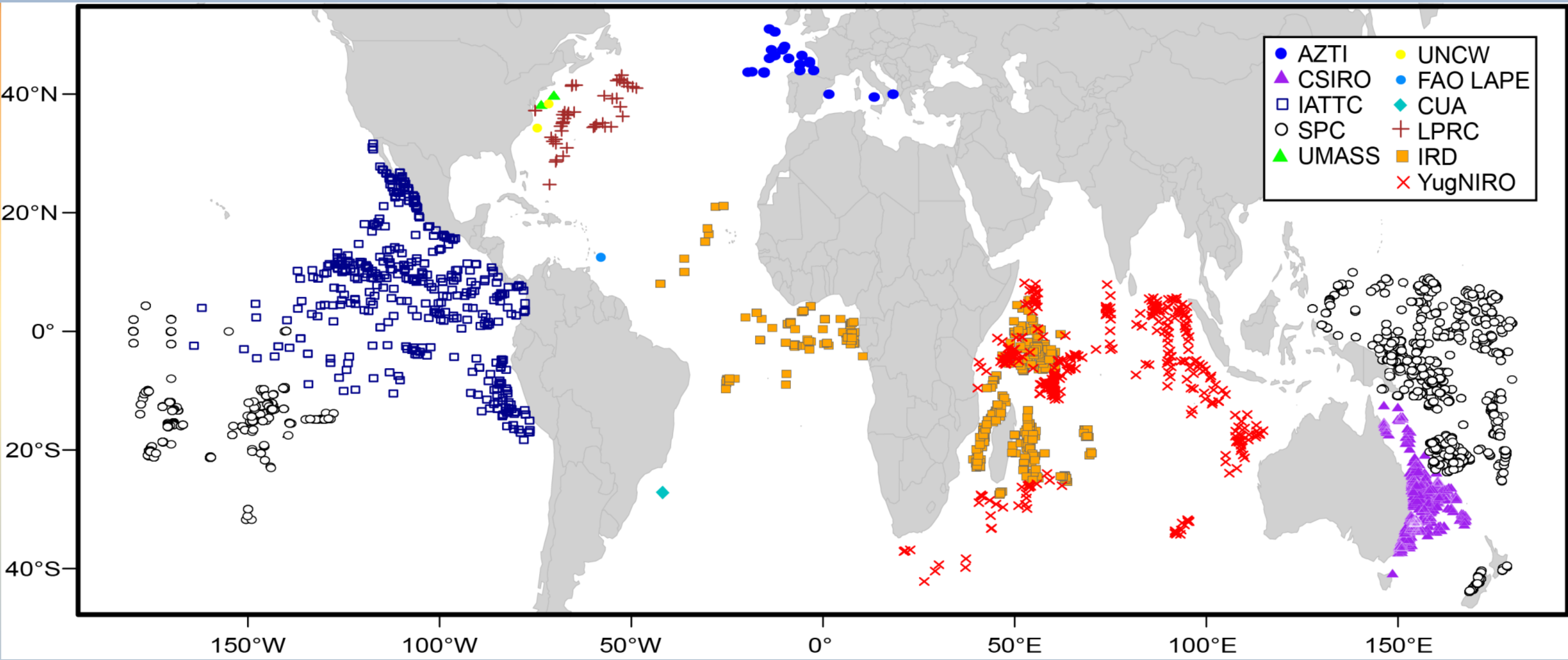
- CLIOTOP[1] Working Group 3 (WG3): Trophic pathways in open-ocean ecosystems – Companion papers

  - Global trophic ecology of yellowfin, bigeye and albacore tunas: can spatial analyses be used to hypothesize predation changes in a warming ocean?

  - Global comparative analysis of marine trophodynamics inferred by stable isotopes in yellowfin, bigeye and albacore tunas

[1] Climate Impacts on Oceanic Top Predators

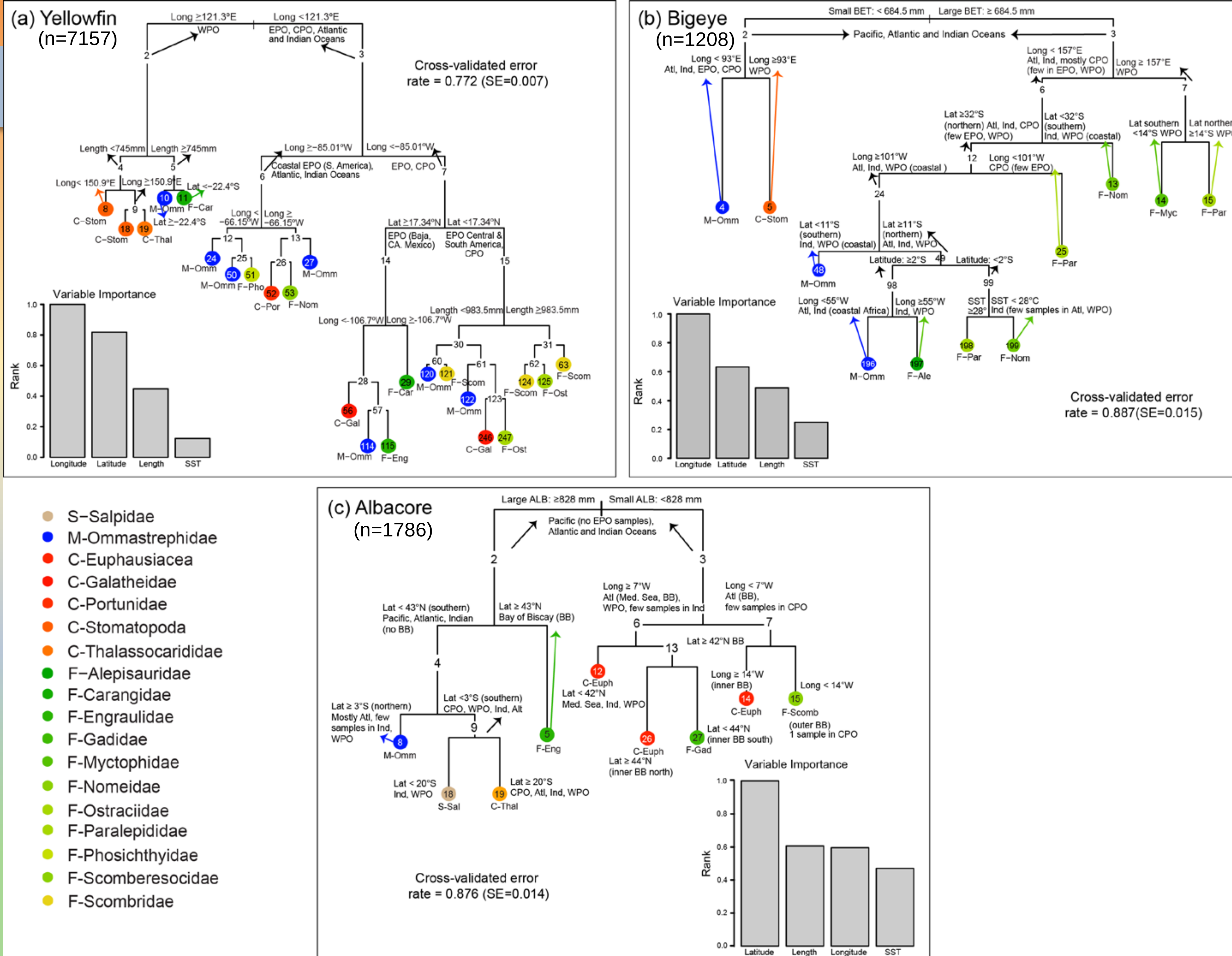
Trophic interactions: global tuna-diet study (CLIOTOP WG3)



Data compiled for 14,185 yellowfin, bigeye and albacore tunas

Objectives:

- Examine the importance of spatial, biological, and environmental variables on diet composition and diet diversity
- Can any variables be used as a proxy to predict the effects of long-term ocean climate variability on pelagic food webs



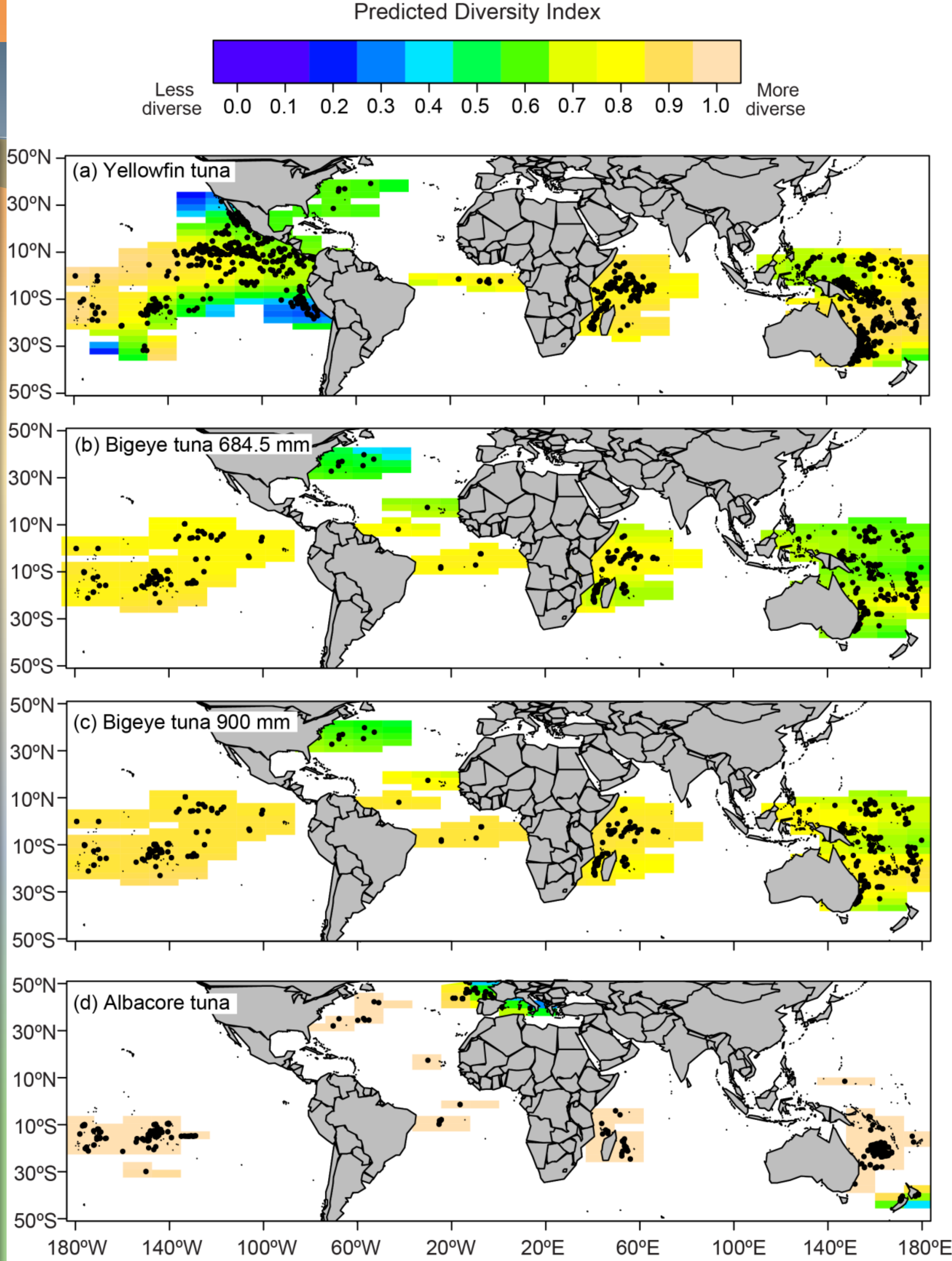
(a) Yellowfin
(n=7157)
Long ≥121.3°E
Long <121.3°E
WPO
EPO, CPO, Atlantic and Indian Oceans
Cross-validated error rate = 0.772 (SE=0.007)
Length <745mm
Length ≥745mm
Long ≥-85.01°W
Long <-85.01°W
Coastal EPO (S. America), Atlantic, Indian Oceans
EPO, CPO
Long< 150.9°E
Long ≥150.9°E
Lat <-22.4°S
Lat ≥-22.4°S
C-Stom
C-Thal
M-Omm
F-Car
Long < -66.15°W
Long ≥ -66.15°W
Lat ≥17.34°N
Lat <17.34°N
EPO (Baja, CA. Mexico)
EPO Central & South America, CPO
F-Pho
C-Por
F-Nom
Length <983.5mm
Length ≥983.5mm
Long <-106.7°W
Long ≥-106.7°W
C-Gal
F-Eng
F-Scom
F-Ost
Variable Importance
Rank
Longitude
Latitude
Length
SST
(b) Bigeye
(n=1208)
Small BET: < 684.5 mm
Large BET: ≥ 684.5 mm
Pacific, Atlantic and Indian Oceans
Long < 93°E
Atl, Ind, EPO, CPO
Long ≥93°E
WPO
Long < 157°E
Atl, Ind, mostly CPO (few in EPO, WPO)
Long ≥ 157°E
WPO
Lat ≥32°S (northern) Atl, Ind, CPO (few EPO, WPO)
Lat <32°S (southern) Ind, WPO (coastal)
Lat southern <14°S WPO
Lat northern ≥14°S WPO
Long ≥101°W
Atl, Ind, WPO (coastal)
Long <101°W
CPO (few EPO)
F-Nom
F-Myc
F-Par
M-Omm
C-Stom
Lat <11°S (southern) Ind, WPO (coastal)
Lat ≥11°S (northern) Atl, Ind, WPO
Latitude: ≥2°S
Latitude: <2°S
Long <55°W
Atl, Ind (coastal Africa)
Long ≥55°W
Ind, WPO
SST ≥28°
SST < 28°C
Ind (few samples in Atl, WPO)
F-Ale
Variable Importance
Cross-validated error rate = 0.887(SE=0.015)
(c) Albacore
(n=1786)
Large ALB: ≥828 mm
Small ALB: <828 mm
Pacific (no EPO samples), Atlantic and Indian Oceans
Lat < 43°N (southern)
Pacific, Atlantic, Indian (no BB)
Lat ≥ 43°N
Bay of Biscay (BB)
Long ≥ 7°W
Atl (Med. Sea, BB), WPO, few samples in Ind
Long < 7°W
Atl (BB), few samples in CPO
Lat ≥ 42°N BB
Lat < 42°N
Med. Sea, Ind, WPO
C-Euph
Long ≥ 14°W (inner BB)
Long < 14°W
F-Scomb (outer BB) 1 sample in CPO
Lat ≥ 3°S (northern) Mostly Atl, few samples in Ind, WPO
Lat <3°S (southern) CPO, WPO, Ind, Alt
F-Eng
Lat < 44°N (inner BB south)
F-Gad
Lat ≥ 44°N (inner BB north)
Lat < 20°S Ind, WPO
S-Sal
Lat ≥ 20°S CPO, Atl, Ind, WPO
C-Thal
Variable Importance
Cross-validated error rate = 0.876 (SE=0.014)
S–Salpidae
M-Ommastrephidae
C-Euphausiacea
C-Galatheidae
C-Portunidae
C-Stomatopoda
C-Thalassocarididae
F–Alepisauridae
F-Carangidae
F-Engraulidae
F-Gadidae
F-Myctophidae
F-Nomeidae
F-Ostraciidae
F-Paralepididae
F-Phosichthyidae
F-Scomberesocidae
F-Scombridae

Generalized Additive Models

YFT best fitting model	*p* value	DE%
s(Fork length)+	< 2e-16 ***	
te(Longitude, Latitude)+	< 2e-16 ***	
s(SST) +	3.07e-09 ***	
s(Chla)+	0.00796 **	65.9
s(M_{B50})+	5.72e-15 ***	
s(MLD)+	< 2e-16 ***	
s(Oxygen)	< 2e-16 ***	

BET best fitting model	*p* value	DE%
s(Fork length)+	< 2e-16 ***	
te(Longitude, Latitude)+	< 2e-16 ***	
s(SST) +	1.62e-11 ***	
s(Chla)+	2.03e-10 ***	82
s(MLD)+	0.01421 *	
s(Oxygen)+	0.00618 **	
s(EKE)	0.00730 **	

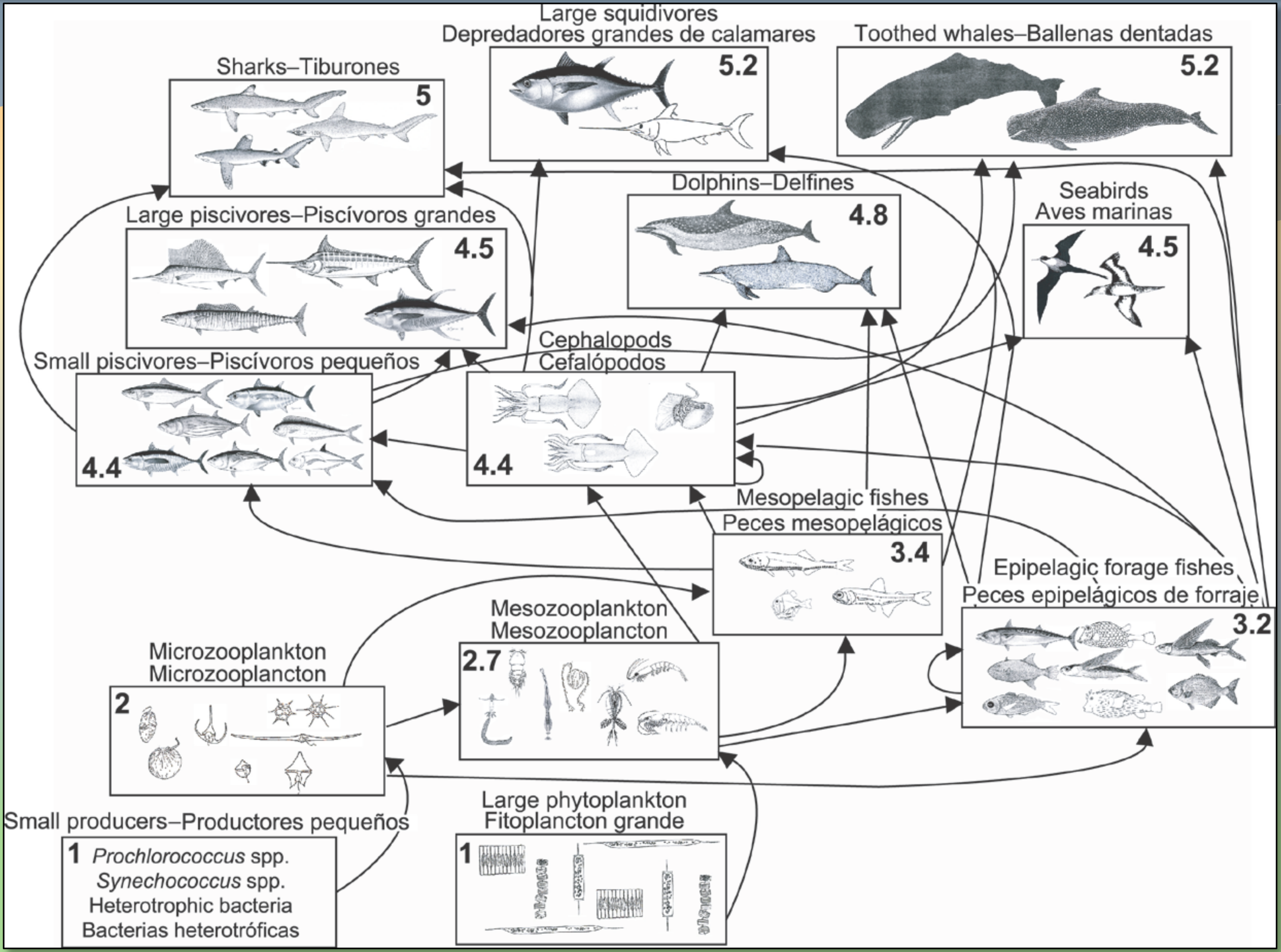
ALB best fitting model	*p* value	DE%
s(Fork length)+	< 2e-16 ***	
te(Longitude, Latitude)+	< 2e-16 ***	
s(SST) +	2.07e-05 ***	
s(chla)+	0.01573 *	91
s(MLD)+	< 2e-16 ***	
s(oxygen)+	< 2e-16 ***	
s(EKE)	0.00349 **	



Conclusions: classification tree analysis (global tuna-diet study)

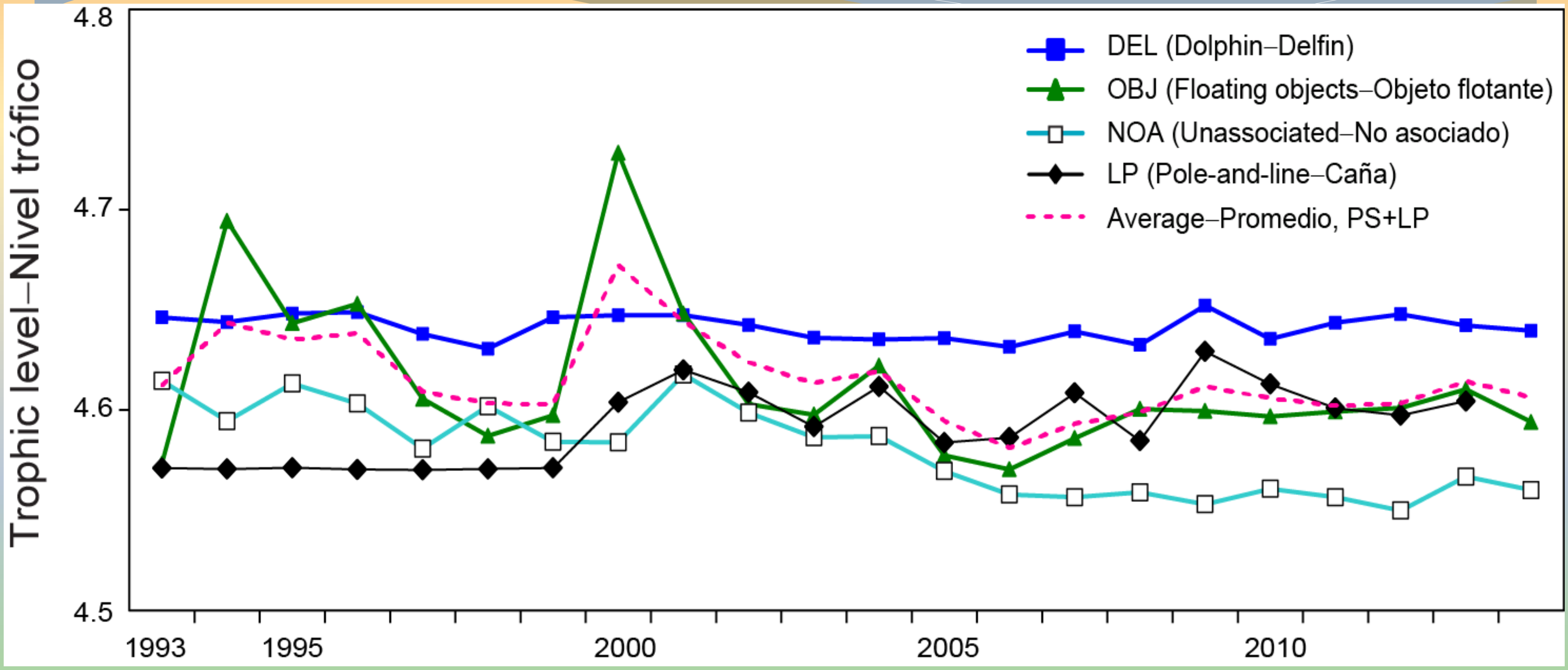
- Global and ocean basin differences were detected
- Spatial variables were more important than biological and environmental variables in explaining diet composition and diet diversity
- Spatial patterns in diversity of YFT were consistent with theories that predict an inverse relationship between primary productivity and species richness
- Results suggest current expansion of warmer, less productive waters may alter foraging opportunities of YFT
- Due to the larger depth range across which BET and ALB forage, these species are less likely to be affected by changes in environmental processes within the surface and mixed layer
- Results support maintenance and development of long-term tuna feeding studies as an approach to monitor effects of climate variability on micronekton communities

Aggregate indicators:
trophic levels and a simplified food-web diagram in the EPO



Aggregate indicators: yearly mean trophic level of the catches

Mean trophic level – useful metric of ecosystem change and sustainability



Ecological Risk Assessment (ERA)

- Dr. Shane Griffiths to join IATTC staff as an Ecosystem Specialist in August 2016

- Dr. Griffiths is an expert in ERA and has worked on several approaches:

  - Qualitative – Likelihood-Consequence Analysis, Scale Intensity Consequence Analysis (SICA)

  - Semi-quantitative attribute-based methods (e.g. PSA)

  - Quantitative models – Sustainability Assessment for Fishing Effects (SAFE), and stock assessment models (not often used)

Ecological Risk Assessment (review): vulnerability of non-target species

Goal – Develop a tool for determining vulnerability of a species/stock to a fishery

- **Vulnerability**: potential for the productivity of a stock to be diminished by direct and indirect fishing pressure. PSA: vulnerability is 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)

- **Susceptibility** – degree to which a fishery can negatively impact a stock (propensity of species to be captured by and incur mortality from a fishery). Can differ by fishery.

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. U.S. 108: 305-322.

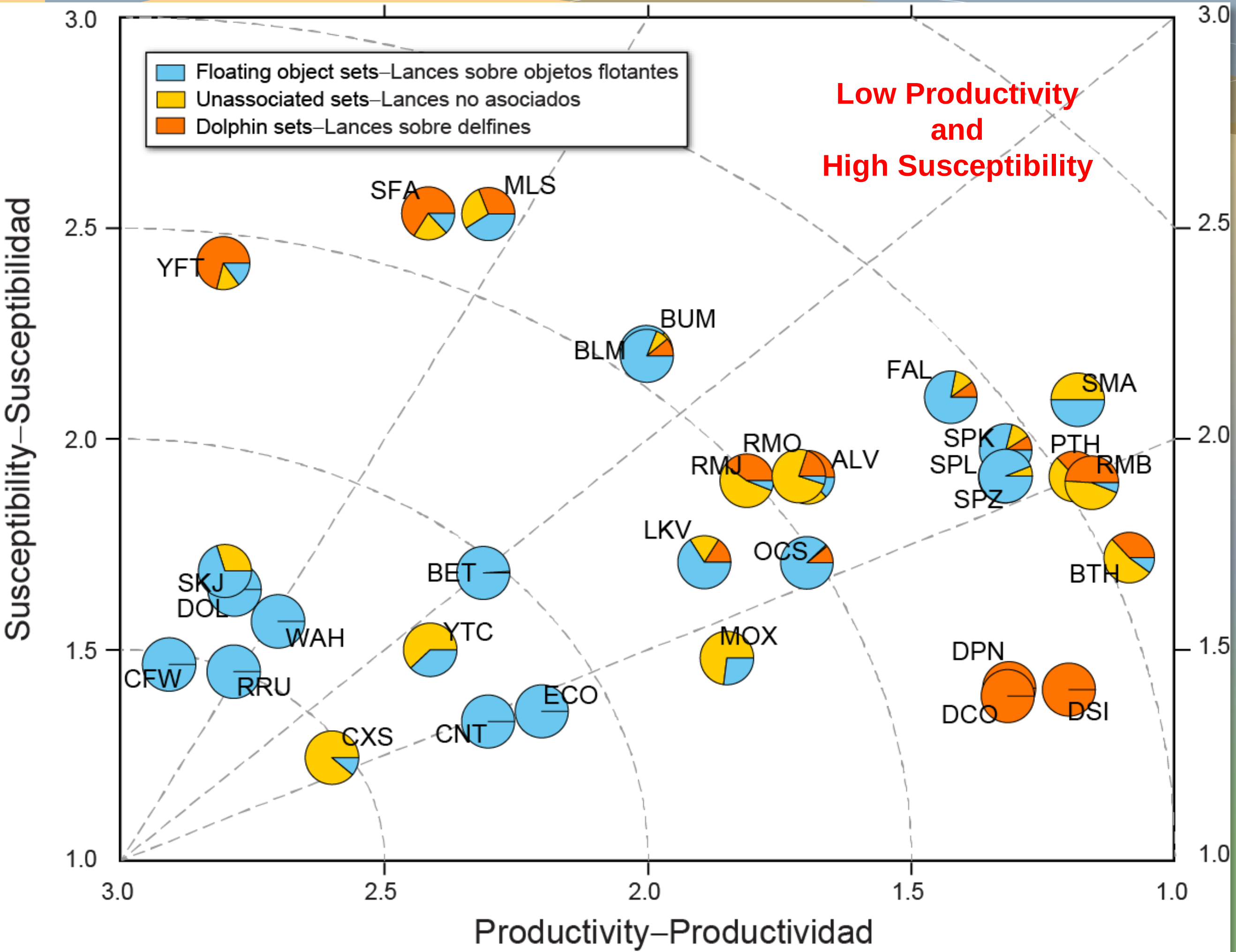
Ecological Risk Assessment: Proof of concept review of modifications to the EPO PSA for the purse-seine fishery

- Created alternate concepts for computing susceptibility tailored to EPO purse-seine fishery
- The susceptibility values for each fishery (set type) were combined to produce one overall susceptibility value for each species
- The use of bycatch and catch information in the formulation of susceptibility was modified (created 2 alternate susceptibilities)

1. Current catch information used in the formulation of susceptibility
2. Long-term catch trend information used in the formulation of susceptibility

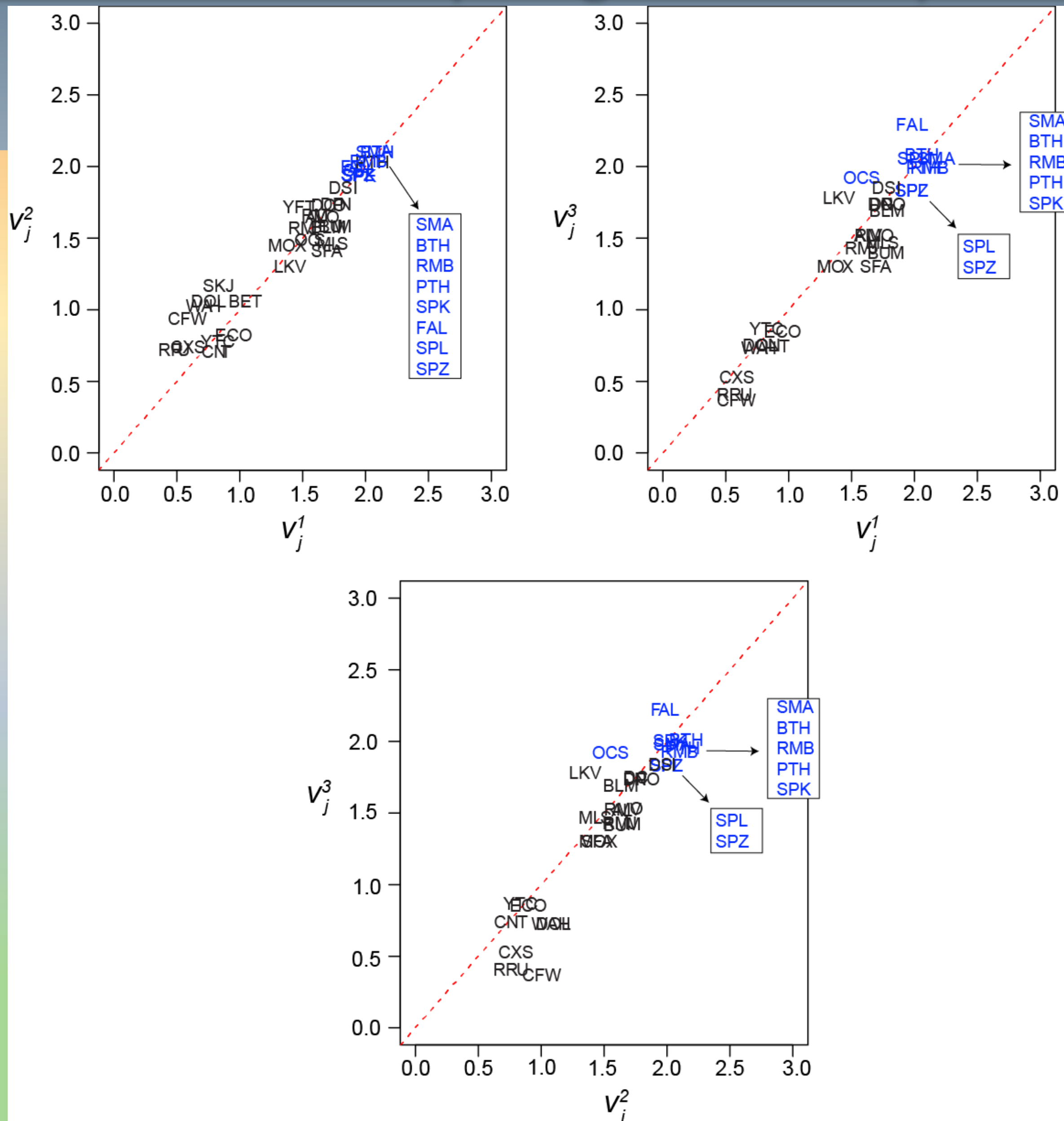
Ecological Risk Assessment: EPO PSA, review of proof of concept Approach 1

Approach 1 combined susceptibility: $s_j^1 = \sum_k s_{jk} p_k$



Group	Species code	Common name
Tunas	YFT	Yellowfin tuna
	BET	Bigeye tuna
	SKJ	Skipjack tuna
Billfishes	BUM	Blue marlin
	BLM	Black marlin
	MLS	Striped marlin
	SFA	Indo-Pacific sailfish
Dolphins	DSI	Spinner dolphin
	DPN	Spotted dolphin
	DCO	Common dolphin
Large fishes	DOL	Common dophinfish
	CFW	Pompano dolphinfish
	WAH	Wahoo
	RRU	Rainbow runner
	MOX	Ocean sunfish
	CXS	Bigeye Trevally
	YTC	Yellowtail amberjack
Rays	RMB	Giant manta ray
	RMJ	Spinetail manta
	RMO	Smoothtail manta
Sharks	FAL	Silky shark
	OCS	Ocean whitetip shark
	SPL	Scalloped hammerhead
	SPZ	Smooth hammerhead
	SPK	Great hammerhead
	BTH	Bigeye thresher shark
	PTH	Pelagic thresher shark
	ALV	Common thresher shark
	SMA	Shortfin mako shark
Small fishes	CNT	Ocean triggerfish
	ECO	Bluestriped chub
Turtles	LKV	Olive Ridley turtle

Ecological Risk Assessment: review of comparing vulnerability



Ecological Risk Assessment:
Data summaries compiled in 2015

DOCUMENT SAC-07-INF C(d)

DESCRIPTION OF REPORTED CATCH DATA FOR NON-TARGET SPECIES: DOES SUFFICIENT DATA EXIST TO PRODUCE A COMPREHENSIVE ECOLOGICAL RISK ASSESSMENT?

Leanne Duffy, Cleridy Lennert-Cody, Nickolas Vogel, Joanne Boster, Joydelee Marrow

Ecological Risk Assessment: Data summaries compiled in 2015: SAC-07-INF C(d)

Two main shortcomings in the reported catch data were identified

(1) Information on retained and discarded catches of non-target species for fisheries other than large purse seiners is incomplete and/or is of limited use for an ERA

- It is not clear if catch of non-target species is fully reported
- Problematic for ERA (outcomes will be compromised because excluded species will erroneously appear unaffected by a particular fishery)

(2) The fundamental basis for ERA is a comprehensive list of all species that are impacted by the activities of individual fisheries

- Catch data is sometimes provided by pooled groups (e.g., “sharks”)
- Problematic for ERA (species within an aggregate group can have very different life history characteristics and/or susceptibility traits to a particular gear)

Lack of fundamental information on species composition and total catches severely compromises our ability to produce a comprehensive EPO ERA

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Questions

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