The following supplement accompanies the article

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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Supplement 2

Table S1. Natural mortality (*M*) estimators used in the present study. A flow diagram showing the hierarchical selection of estimators depending on data available is shown in Fig. S4.

Estimator	Equation	Citation
$\text{Hoenig}_{\text{tmax}}$	$M = \frac{4.3}{t_{max}}$	Hoenig (1983)
$\text{Hoenig}_{\text{nls}}$	$M = 4.899 t_{max}^{-0.916}$	Then et al. (2015)
Jensen (*J*)	$M = 1.60\ K$	Jensen (1996)
$\text{Pauly}_{\text{nls}}$	$M = 4.118 K^{0.73} L_{\infty}^{-0.33}$	Then *et al.* (2015)
$\text{Pauly}_{\text{LKT}}$	$\log M = -0.0066 - 0.279 \ln L_{\infty} + 0.6543 \ln K + 0.4634 \ln T$	Pauly (1980)
Pauly_{KT}	$M = K e^{-0.22 + 0.3 \ln T}$	Froese and Pauly (2017)
Pauly_{LT}	$M = 10^{0.566 - 0.718 \ln L_{\infty}} + 0.02T$	Froese and Pauly (2017)

M = instantaneous natural mortality rate (yr^{-1})

$t_{\max}$ = maximum observed age of animals in the stock.

L_{∞} = the average length of an animal if it lived to an infinite age, and known as the asymptotic length of an animal in the von Bertalanffy growth function.

K= the curvature parameter of the von Bertalanffy growth function (yr^{-1}).

T= mean water temperature (°C) at the location and depth range inhabited by the species.

Table S2. Parameter values used for variables describing the susceptibility of capture for each species in the four fisheries defined for the eastern Pacific Ocean 'industrial' tuna fishery. DEL=dolphin sets, NOA=Unassociated tuna school sets, OBJ=floating-object sets. A description of susceptibility-at-length is given where parameter values differed by length for a particular variable.

Species	Fishery	Proportion of species-occupied grids (G_x) fished	Duration of fishing season (D_x)	Seasonal availability (A_{xj})	Encounterability (N_{xj})	Contact selectivity (C_{xj})	Post-release mortality (P_{xj})
Thunnus albacares	**Longline**	**0.74**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-250m (Schaefer et al. 2007).	**0.41** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Minte-Vera et al. 2017). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (DEL)	**0.05**	**0.83** 62-d closure	**1.0** Species available year-round	**0.80** DEL sets assumed to fish 0-200m. Species inhabits 0-250m (Schaefer et al. 2007).	**0.67** Used logistic-shaped selectivity ogive for dominant DEL fleet in EPO stock assessment (Minte-Vera et al. 2017). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (NOA)	**0.02**	**0.83** 62-d closure	**1.0** Species available year-round	**0.80** NOA sets assumed to fish 0-200m. Species inhabits 0-250m (Schaefer et al. 2007).	**0.66** Used dome-shaped selectivity ogive for dominant NOA fleet in EPO stock assessment (Minte-Vera et al. 2017). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (OBJ)	**0.17**	**0.83** 62-d closure	**1.0** Species available year-round	**0.80** OBJ sets assumed to fish 0-200m. Species inhabits 0-250m (Schaefer et al. 2007).	**0.61** Used dome-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Minte-Vera et al. 2017). See Fig. S5.	**1.0** Assumed no release of target species.
Thunnus obesus	**Longline**	**0.75**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.73** Deep sets assumed to fish 0-300m. Species inhabits 30-400m (Schaefer & Fuller 2010).	**0.56** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Aires-da-Silva et al. 2016). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (DEL)	**0.05**	**0.83** 62-d closure	**1.0** Species available year-round	**0.46** DEL sets assumed to fish 0-200m. Species inhabits 30-400m (Schaefer & Fuller 2010).	**0.65** Used logistic-shaped selectivity ogive for dominant DEL fleet in EPO stock assessment (Aires-da-Silva et al. 2016). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (NOA)	**0.02**	**0.83** 62-d closure	**1.0** Species available year-round	**0.46** NOA sets assumed to fish 0-200m. Species inhabits 30-400m (Schaefer & Fuller 2010).	**0.64** Used dome-shaped selectivity ogive for dominant NOA fleet in EPO stock assessment (Aires-da-Silva et al. 2016). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (OBJ)	**0.17**	**0.83** 62-d closure	**1.0** Species available year-round	**0.46** OBJ sets assumed to fish 0-200m. Species inhabits 30-400m (Schaefer & Fuller 2010).	**0.60** Used dome-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Aires-da-Silva et al. 2016). See Fig. S5.	**1.0** Assumed no release of target species.
Katsuwonus pelamis	**Longline**	**0.70**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-300m (Schaefer & Fuller 2007).	**0.48** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Maunder 2012). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (DEL)	**0.05**	**0.83** 62-d closure	**1.0** Species available year-round	**0.67** DEL sets assumed to fish 0-200m. Species inhabits 0-300m (Schaefer & Fuller 2007).	**0.31** Used logistic-shaped selectivity ogive for dominant DEL fleet in EPO stock assessment (Maunder 2012). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (NOA)	**0.02**	**0.83** 62-d closure	**1.0** Species available year-round	**0.67** NOA sets assumed to fish 0-200m. Species inhabits 0-300m (Schaefer & Fuller 2007).	**0.31** Used dome-shaped selectivity ogive for dominant NOA fleet in EPO stock assessment (Maunder 2012). See Fig. S5.	**1.0** Assumed no release of target species.
	Purse-seine (OBJ)	**0.18**	**0.83** 62-d closure	**1.0** Species available year-round	**0.67** OBJ sets assumed to fish 0-200m. Species inhabits 0-300m (Schaefer & Fuller 2007).	**0.31** Used dome-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Maunder 2012). See Fig. S5.	**1.0** Assumed no release of target species.
Thunnus alalunga	**Longline**	**0.70**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.94** Deep sets assumed to fish 0-300m. Species inhabits 20-320m (Williams et al. 2015).	**0.45** Used logistic-shaped selectivity ogive for dominant fleet in north Pacific stock assessment (International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) 2017b). See	**1.0** Assumed no release of target species.

						Fig. S5.	
Xiphias gladius	**Longline**	**0.68**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.75** Deep sets assumed to fish 0-300m. Species inhabits 0-400m (Abascal et al. 2010).	**0.35** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Hinton & Maunder 2011). See Fig. S5.	**1.0** Assumed no release of marketable species.
Kajikia audax	**Longline**	**0.74**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-100m (Brill et al. 1993).	**0.56** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Hinton 2009). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (NOA)	**0.02**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species inhabits 0-100m (Brill et al. 1993).	**0.56** Used logistic-shaped selectivity ogive for dominant NOA fleet in EPO stock assessment (Hinton 2009). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (OBJ)	**0.17**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-100m (Brill et al. 1993).	**0.56** Used logistic-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Hinton 2009). See Fig. S5.	**1.0** Assumed no release of marketable species.
Makaira nigricans	**Longline**	**0.77**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-150m (Goodyear et al. 2008).	**0.50** Used dome-shaped selectivity ogive for dominant fleet in north Pacific stock assessment (International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) 2016). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (OBJ)	**0.26**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-150m (Goodyear et al. 2008).	**0.32** Used dome-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) 2016). See Fig. S5.	**1.0** Assumed no release of marketable species.
Istiophorus platypterus	**Longline**	**0.76**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-100m (Hoolihan et al. 2011).	**0.51** No selectivity ogive in EPO stock assessment (Hinton 2009). IATTC EPO longline observer length-frequency data used to assume knife-edge selectivity from 100 cm OFL. See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (DEL)	**0.08**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species inhabits 0-100m (Hoolihan et al. 2011).	**0.68** No selectivity ogive for DEL sets in EPO stock assessment (Hinton 2009). IATTC DEL observer length-frequency data used to assume knife-edge selectivity from 71 cm OFL (Fitchett 2015). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (NOA)	**0.03**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species inhabits 0-100m (Hoolihan et al. 2011).	**0.68** No selectivity ogive for NOA sets in EPO stock assessment (Hinton 2009). IATTC NOA observer length-frequency data used to assume knife-edge selectivity from 71 cm OFL (Fitchett 2015). See Fig. S5.	**1.0** Assumed no release of marketable species.
Coryphaena hippurus	**Longline**	**0.76**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-60m (Furukawa et al. 2011).	**0.69** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Aires-da-Silva et al. 2017). See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (OBJ)	**0.06**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-60m (Furukawa et al. 2011).	**0.27** Used logistic-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Aires-da-Silva et al. 2017). See Fig. S5.	**1.0** Assumed no release of marketable species.
Acanthocybium solandri	**Longline**	**0.77**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-30m (Sepulveda et al. 2011).	**0.35** In absence of selectivity ogive for EPO longline fleet, mirrored logistic-shaped selectivity for yellowfin tuna for dominant fleet in EPO stock assessment.	**1.0** Assumed no release of marketable species.
	Purse-seine (NOA)	**0.03**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species inhabits 0-30m (Sepulveda et al. 2011).	**0.74** In absence of selectivity ogive, used IATTC observer length-frequency data to assume knife-edge selectivity from 50cm FL. See Fig. S5.	**1.0** Assumed no release of marketable species.
	Purse-seine (OBJ)	**0.07**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-30m (Sepulveda et al. 2011).	**0.80** In absence of selectivity ogive for EPO OBJ sets, mirrored logistic-shaped selectivity for yellowfin tuna for dominant OBJ fleet in EPO stock assessment. See Fig. S5.	**1.0** Assumed no release of marketable species.
Lepidocybium flavobrunneum	**Longline**	**0.36**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.22** Deep sets assumed to fish 0-300m. Species inhabits 100-1000m (Kerstetter et al. 2008).	**0.83** In absence of selectivity ogive for EPO longline fleet, used Hawaiian market landings observer length-frequency data to assume knife-edge selectivity from 40cm FL (Sundberg & Underkoffler 2011). See Fig. S5.	**1.0** Assumed no release of marketable species.
Lampris guttatus	**Longline**	**0.57**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.71** Deep sets assumed to fish 0-300m. Species primarily inhabits 50-400m (Polovina et al. 2008).	**0.58** In absence of selectivity ogive for EPO longline fleet, used Hawaiian market landings observer length-frequency data to assume knife-edge selectivity from 60cm FL (Sundberg & Underkoffler 2011). See Fig. S5.	**1.0** Assumed no release of marketable species.

Prionace glauca	**Longline**	**0.54**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-150m (Musyl et al. 2011).	**0.66** Used logistic-shaped selectivity ogive for dominant fleet in north Pacific stock assessment (International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) 2017a). See Fig. S5.	**1.0** Assumed no release of marketable species, despite potential for 33% post-release mortality of longline-caught blue sharks (Campana et al. 2015).
Isurus oxyrinchus	**Longline**	**0.59**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-150m (Musyl et al. 2011).	**0.79** In absence of selectivity ogive for EPO longline fleet, used observer length-frequency data from Taiwanese longline fleet (ISC) to assume knife-edge selectivity from the smallest size at birth (59.4 cm PCL) in the Pacific Ocean (Semba et al. 2011) and length at largest capture of 250 cm PCL. See Fig. S5.	**1.0** Assumed no release of marketable species, despite potential for 33% post-release mortality of longline-caught mako sharks (Campana et al. 2015).
Carcharhinus falciformis	**Longline**	**0.78**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-100m (Musyl et al. 2011).	**0.35** Used logistic-shaped selectivity ogive for dominant fleet in EPO stock assessment (Aires-da-Silva et al. 2014). See Fig. S5.	**1.0** Assumed no release of marketable species, despite potential for 100% post-release mortality of longline-caught silky sharks, but small sample sizes (Hutchinson 2016).
	Purse-seine (DEL)	**0.08**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species inhabits 0-100m (Musyl et al. 2011).	**0.37** Used logistic-shaped selectivity ogive for dominant DEL fleet in EPO stock assessment (Aires-da-Silva et al. 2014). See Fig. S5.	**0.95** IATTC Resolution C-16-06 prohibits retention. Tagging study of purse-seine-caught silky sharks indicated post-release mortality of 32-93% (Poisson et al. 2014, Hutchinson et al. 2015). Therefore, conservatively assumed 95% mortality.
	Purse-seine (NOA)	**0.02**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species inhabits 0-100m (Musyl et al. 2011).	**0.37** Used logistic-shaped selectivity ogive for dominant NOA fleet in EPO stock assessment (Aires-da-Silva et al. 2014).	**0.95** IATTC Resolution C-16-06 prohibits retention. Tagging study of purse-seine-caught silky sharks indicated post-release mortality of 32-93% (Poisson et al. 2014, Hutchinson et al. 2015). Therefore, conservatively assumed 95% mortality.
	Purse-seine (OBJ)	**0.27**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-100m (Musyl et al. 2011).	**0.48** Used logistic-shaped selectivity ogive for dominant OBJ fleet in EPO stock assessment (Aires-da-Silva et al. 2014).	**0.95** IATTC Resolution C-16-06 prohibits retention. Tagging study of purse-seine-caught silky sharks indicated post-release mortality of 32-93% (Poisson et al. 2014, Hutchinson et al. 2015). Therefore, conservatively assumed 95% mortality.
Alopias superciliosus	**Longline**	**0.71**	**1.0** Fishery open year-round	**1.0** Species available year-round	**0.62** Deep sets assumed to fish 0-300m. Species inhabits 20-450m (Musyl et al. 2011).	**0.64** In absence of selectivity ogive for EPO longline fleet, used observer length-frequency data to assume knife-edge selectivity from 100cm CFL. See Fig. S5.	**1.0** Assumed no release of marketable species, despite potential for >60% post-release mortality of longline-caught bigeye threshers (Hutchinson 2016).
	Purse-seine (DEL)	**0.28**	**0.83** 62-d closure	**1.0** Species available year-round	**0.40** DEL sets assumed to fish 0-200m. Species inhabits 20-450m (Musyl et al. 2011).	**1.0** In absence of selectivity ogive for EPO DEL sets, precautionary full selectivity of all length classes used. See Fig. S5.	**1.0** Assumed 100% mortality in absence of post-release mortality data for purse-seine-caught thresher sharks.
	Purse-seine (NOA)	**0.03**	**0.83** 62-d closure	**1.0** Species available year-round	**0.40** NOA sets assumed to fish 0-200m. Species inhabits 20-450m (Musyl et al. 2011).	**1.0** In absence of selectivity ogive for EPO NOA sets, precautionary full selectivity of all length classes used. See Fig. S5.	**1.0** Assumed 100% mortality in absence of post-release mortality data for purse-seine-caught thresher sharks.
	Purse-seine (OBJ)	**0.07**	**0.83** 62-d closure	**1.0** Species available year-round	**0.40** OBJ sets assumed to fish 0-200m. Species inhabits 20-450m (Musyl et al. 2011).	**1.0** In absence of selectivity ogive for EPO OBJ sets, precautionary full selectivity of all length classes used. See Fig. S5.	**1.0** Assumed 100% mortality in absence of post-release mortality data for purse-seine-caught thresher sharks.
Carcharhinus longimanus	**Longline**	**0.75**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-120m (Musyl et al. 2011).	**0.77** In absence of selectivity ogive for EPO longline fleet, used observer length-frequency data to assume knife-edge selectivity from 70cm FL. See Fig. S5.	**0.60** IATTC Resolution C-11-10 prohibits retention. Tagging studies of longline-caught oceanic whitetip sharks indicate post-release mortality of 5-30%, but small sample sizes (Hutchinson 2016). Therefore, conservatively assumed 60% mortality.
	Purse-seine (OBJ)	**0.24**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-120m (Musyl et al. 2011).	**0.77** In absence of selectivity ogive, used IATTC observer length-frequency data to assume knife-edge selectivity from 70cm FL.	**0.95** IATTC Resolution C-11-10 prohibits retention. Tagging study of purse-seine-caught silky sharks indicated post-release mortality of 32-93% (Poisson et al. 2014, Hutchinson et al. 2015). Given the silky shark is a closely related species, we conservatively assumed 95% mortality.
Sphyrna zygaena	**Longline**	**0.57**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species inhabits 0-60m (Francis 2016).	**0.69** In absence of selectivity ogive for EPO longline fleet, used observer length-frequency data to assume knife-edge selectivity from 80cm FL.	**1.0** Tagging study of longline-caught scalloped hammerheads indicate post-release mortality of 100%, but small sample sizes (Eddy et al. 2016). Therefore, conservatively assumed 100% mortality.

	Purse-seine (OBJ)	**0.16**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species inhabits 0-60m (Francis 2016).	**0.80** In absence of selectivity ogive, used IATTC observer length-frequency data to assume knife-edge selectivity from 55cm FL.	**1.0** Assumed 100% mortality in absence of post-release mortality data for purse-seine-caught hammerhead sharks.
Mobula mobular	**Purse-seine (DEL)**	**0.10**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species primarily inhabits 0-50m (Croll et al. 2012, Francis & Jones 2017).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed knife-edge selectivity from smallest size at birth (49.8cm DW) (White et al. 2006). Longline not included as catch is negligible (Croll et al. 2016).	**1.0** Tagging study indicated nearly 100% post-release mortality of purse-seine caught spinetail devil rays, but small sample sizes (Francis & Jones 2017). Therefore, conservatively assumed 100% mortality.
	Purse-seine (NOA)	**0.03**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species primarily inhabits 0-50m (Croll et al. 2012, Francis & Jones 2017).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed knife-edge selectivity from smallest size at birth (49.8cm DW) (White et al. 2006).	**1.0** Tagging study indicated nearly 100% post-release mortality of purse-seine caught spinetail devil rays, but small sample sizes (Francis & Jones 2017). Therefore, conservatively assumed 100% mortality.
	Purse-seine (OBJ)	**0.33**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species primarily inhabits 0-50m (Croll et al. 2012, Francis & Jones 2017).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed knife-edge selectivity from smallest size at birth (49.8cm DW) (White et al. 2006).	**1.0** Tagging study indicated nearly 100% post-release mortality of purse-seine caught spinetail devil rays, but small sample sizes (Francis & Jones 2017). Therefore, conservatively assumed 100% mortality.
Pteroplatytrygon violacea	**Longline**	**0.63**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species primarily inhabits 0-100m in Atlantic Ocean (Wilson & Beckett 1970)	**0.70** In absence of selectivity ogive for EPO longline fleet, assumed knife-edge selectivity from smallest fish (41cm DW) caught on longlines in a scientific survey off the US Pacific coast (Neer 2008).	**1.0** Assumed 100% mortality in absence of species-specific post-release mortality data for longline-caught stingrays.
Dermochelys coriacea	**Longline**	**0.50**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species primarily inhabits 0-58m (Shillinger et al. 2011)	**0.82** In absence of selectivity ogive for EPO longline fleet, used US observer length-frequency data from the Pacific Ocean to assume knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**1.0** Assumed 100% mortality in absence of species-specific post-release mortality data for longline-caught turtles.
	Purse-seine (DEL)	**0.08**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species primarily inhabits 0-58m (Shillinger et al. 2011).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**1.0** Assumed 100% mortality in absence of reliable species-specific post-release mortality data for purse-seine-caught turtles, but strong evidence for very high survival rate of purse seine-caught turtles due to conditions of IATTC Resolutions C-07-03 and C-04-07.
	Purse-seine (NOA)	**0.04**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species primarily inhabits 0-58m (Shillinger et al. 2011).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**1.0** Assumed 100% mortality in absence of reliable species-specific post-release mortality data for purse-seine-caught turtles, but strong evidence for very high survival rate of purse seine-caught turtles.
	Purse-seine (OBJ)	**0.26**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species primarily inhabits 0-58m (Shillinger et al. 2011).	**0.83** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**1.0** Assumed 100% mortality in absence of reliable species-specific post-release mortality data for purse-seine-caught turtles, but strong evidence for very high survival rate of purse seine-caught turtles.
Lepidochelys olivacea	**Longline**	**0.75**	**1.0** Fishery open year-round	**1.0** Species available year-round	**1.0** Deep sets assumed to fish 0-300m. Species primarily inhabits 0-60m (Swimmer et al. 2006)	**0.67** In absence of selectivity ogive for EPO longline fleet, used US observer length-frequency data from the Pacific Ocean to assume knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**1.0** Assumed 100% mortality in absence of species-specific post-release mortality data for longline-caught turtles and evidence of frequent deep hooking, that most likely results in mortality
	Purse-seine (DEL)	**0.07**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species primarily inhabits 0-60m (Swimmer et al. 2006)	**0.67** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**0.2** Conservatively assumed 20% post-release mortality in absence of reliable species-specific release data but strong evidence for very high survival rate of purse seine-caught turtles.
	Purse-seine (NOA)	**0.03**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** NOA sets assumed to fish 0-200m. Species primarily inhabits 0-60m (Swimmer et al. 2006)	**0.67** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**0.2** Conservatively assumed 20% post-release mortality in absence of reliable species-specific release data but strong evidence for very high survival rate of purse seine-caught turtles.
	Purse-seine (OBJ)	**0.26**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** OBJ sets assumed to fish 0-200m. Species primarily inhabits 0-60m (Swimmer et al. 2006)	**0.67** In absence of selectivity ogive for EPO purse seine fleet, assumed US observer length-frequency data from the Pacific Ocean represented minimum available size class in the EPO. Therefore, assumed knife-edge selectivity from 35cm SCL (=40 cm CCL) (Swimmer et al. 2017).	**0.2** Conservatively assumed 20% post-release mortality in absence of reliable species-specific release data but strong evidence for very high survival rate of purse seine-caught turtles.
Stenella attenuata	**Purse-seine (DEL)**	**0.18**	**0.83** 62-d closure	**1.0** Species available	**1.0** DEL sets assumed to fish 0-200m. Species assumed to inhabit 0-200m similar to the	**1.0** In absence of selectivity ogive for EPO purse seine fleet, it is plausible to assume knife-edge selectivity from smallest size at birth (82.5cm TL)	**1.0** Conservatively assumed 100% mortality in absence of reliable species-specific post-release mortality data, but

				year-round	closely related spotted dolphin (Scott & Chivers 2009).	in the EPO (Perrin et al. 1976). However, strong anecdotal evidence suggests mortality of sizes smaller than size at birth due to abortions and fetus injury when fully selected size classes are set on by purse seiners targeting yellowfin tuna (Hall 1998). Therefore, a precautionary approach taken by assuming full selectivity for all length classes.	strong evidence for very high survival rate of purse seine-caught dolphins (see https://www.iattc.org/AIDCPdocumentationENG.htm).
Delphinus delphis	**Purse-seine (DEL)**	**0.06**	**0.83** 62-d closure	**1.0** Species available year-round	**1.0** DEL sets assumed to fish 0-200m. Species assumed to inhabit 0-200m similar to the closely related spotted dolphin (Scott & Chivers 2009).	**1.0** In absence of selectivity ogive for EPO purse seine fleet, it is plausible to assume knife-edge selectivity from smallest size at birth (87cm TL) in the EPO (Danil & Chivers 2007). However, strong anecdotal evidence suggests mortality of sizes smaller than size at birth due to abortions and fetus injury when fully selected size classes are set on by purse seiners targeting yellowfin tuna (Hall 1998). Therefore, a precautionary approach taken by assuming full selectivity for all length classes.	**1.0** Conservatively assumed 100% mortality in absence of reliable species-specific post-release mortality data, but strong evidence for very high survival rate of purse seine-caught dolphins.

Table S3. Biological parameters for 24 species assessed using EASI-Fish including length type (fork length–FL, eye orbit fork length–OFL, precaudal length–PCL, disc width–DW, straight carapace length–SCL, total length–TL), maximum recorded age (t_{max}), the von Bertalanffy growth parameters (L_∞, K, t_0), length-weight relationship (L-W) parameters a and b, length-at-maturity (L_{MAT}), and natural mortality (M). L_{MAT} values reflect either the length at 50% maturity (L_{50}) or the length at first maturity (L_m). Values for M show the value used in stock assessment (source shown), or the mean value derived from various mortality estimators (see column "M method" for estimator(s) used), defined in Table S2. Values shown in parentheses are the minimum and maximum values for triangular (^{T}) and uniform (^{U}) distribution priors used in 10,000 iterations of Monte Carlo simulations. Sources of biological parameters are shown in Table S4.

Species	Length type	t_{max} (yrs)	L_∞ (yr^{-1})	K (yr^{-1})	t_0 (yr^{-1})	L-W a L-W b	L_{MAT} (cm)	M (yr^{-1})	M method
Thunnus albacares	FL	5	198.9	0.341	0.002	0.0139 3.086	91.8 $^{L}{}_{50}$	0.45 (0.32-0.51)^T	P_{nls}, P_{LKT}, J
Thunnus obesus	FL	16	200.8	0.330	-0.100	0.0366 2.902	138.2 $^{L}{}_{50}$	0.35 (0.25-0.45)^T	Aires-da-Silva et al. (2016)
Katsuwonus pelamis	FL	12	102.0	0.550	-0.020	0.0055 3.336	39.9 $^{L}{}_{50}$	1.50 (1.20-1.80)^T	Maunder (2012)
Thunnus alalunga	FL	15	112.9	0.253	-2.239	0.0390 2.840	85.0 $^{L}{}_{50}$	0.30 (0.28-0.34)^U	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Xiphias gladius	OFL	15	321.0	0.133	-2.460	0.0045 3.210	143.6 $^{L}{}_{50}$	0.25 (0.14-0.41)^T	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Kajikia audax	OFL	11	256.5	0.600	-0.700	0.0696 3.071	210.0 $^{L}{}_{50}$	0.52 (0.39-0.67)^T	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Makaira nigricans	OFL	20	316.1	0.110	-3.010	0.0184 2.956	179.8 $^{L}{}_{50}$	0.27 (0.22-0.32)^T	Lee and Chang (2013)
Istiophorus platypterus	OFL	11	207.5	0.370	-0.004	0.0399 3.930	175.0 $^{L}{}_{50}$	0.47 (0.39-0.55)^U	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Coryphaena hippurus	FL	4	140.5	0.670	-0.820	0.0006 3.440	77.0 $^{L}{}_{50}$	0.98 (0.60-1.38)^U	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Acanthocybium solandri	FL	7	149.9	1.580	-0.170	0.0009	104.6 $^{L}{}_{50}$	1.0	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}

Species	Length type	t_{max} (yrs)	L_∞ (yr^{-1})	K (yr^{-1})	t_0 (yr^{-1})	L-W a L-W b	L_{MAT} (cm)	M (yr^{-1})	M method
						3.280		$(0.61\text{-}1.47)^U$	
Lepidocybium flavobrunneum	FL	-	203.4	0.080	-1.290	0.0048 3.152	$104.4\ ^{L}_{m}$	0.15 $(0.11\text{-}0.19)^U$	P_{nls}, P_{LKT}, P_{KT}, P_{LT}, J
Lampris guttatus	FL	14	119.0	0.218	-0.780	0.0281 3.000	$80.0\ ^{L}_{m}$	0.23 $(0.20\text{-}0.25)^T$	Francis et al. (2005)
Prionace glauca	PCL	20	267.2	0.137	-1.130	0.0041 3.160	$156.6\ ^{L}_{50}$	0.23 $(0.15\text{-}0.32)^T$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Isurus oxyrinchus	PCL	29	269.5	0.115	-2.200	0.0167 2.847	$256.0\ ^{L}_{50}$	0.19 $(0.15\text{-}0.22)^T$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Carcharhinus falciformis	PCL	25	216.4	0.148	-1.760	0.0273 2.860	$147.5\ ^{L}_{50}$	0.22 $(0.17\text{-}0.28)^U$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Alopias superciliosus	PCL	20	224.6	0.092	-4.210	0.0091 3.080	$180.2\ ^{L}_{50}$	0.2 $(0.12\text{-}0.31)^U$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Carcharhinus longimanus	PCL	13	244.6	0.103	-2.698	0.0166 2.891	$140.5\ ^{L}_{50}$	0.18 $(0.08\text{-}0.28)^T$	Rice and Harley (2012)
Sphyrna zygaena	PCL	21	220.2	0.200	-0.710	0.0117 2.770	$114.9\ ^{L}_{m}$	0.27 $(0.20\text{-}0.34)^U$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Mobula mobular	DW	14	233.8	0.280	-1.680	0.00429 3.400	$201.6\ ^{L}_{50}$	0.37 $(0.27\text{-}0.44)^U$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Pteroplatytrygon violacea	DW	24	116.0	0.180	-0.780	0.0273 2.952	$46.0\ ^{L}_{m}$	0.29 $(0.17\text{-}0.38)^U$	H_{tmax}, H_{nls}, P_{nls}, P_{LKT}, J
Dermochelys coriacea	SCL	48	142.7	0.226	-0.170	0.0214	$139.3\ ^{L}_{50}$	0.12 $(0.09\text{-}0.14)^U$	H_{tmax}, H_{nls}
Lepidochelys olivacea	SCL	24	77.00	0.163	0.000	0.0005 2.673	$53.0\ ^{L}_{50}$	0.22 $(0.18\text{-}0.28)^U$	H_{tmax}, H_{nls}
Stenella attenuata	TL*	18	189.7	0.350	-1.650	0.0126 2.930	$181.0\ ^{L}_{50}$	0.29 $(0.24\text{-}0.35)^U$	H_{tmax}, H_{nls}
Delphinus delphis	TL*	25	197.2	0.530	-1.100	0.2754 2.360	$186.5\ ^{L}_{50}$	0.21 $(0.17\text{-}0.28)^U$	H_{tmax}, H_{nls}

* Total length (TL) measure used for dolphins follows (Norris 1961) from the “tip of upper jaw to deepest part of notch between flukes”.

Table S4. Sources of biological parameters used in EASI-Fish for assessing 24 species caught in the eastern Pacific Ocean tuna fishery, including maximum recorded length (L_{max}) and age (t_{max}), the von Bertalanffy growth parameters (L_∞, K, t_0), length-weight (L-W) relationship parameters a and b, and length-at-maturity (L_{MAT}).

Species	L_{max}	t_{max} (years)	L_∞, K, t_0	L-W a & b	L_{MAT} (cm)
Thunnus albacares	IATTC (2019)	Wild (1986)	Minte-Vera et al. (2015)	Wild (1986)	Schaefer (1998)
Thunnus obesus	IATTC (2019)	Farley et al. (2006)	Aires-da-Silva et al. (2015)	Nakamura and Uchiyama (1966)	Schaefer et al. (2005)
Katsuwonus pelamis	IATTC (2019)	Collette and Nauen (1983)	Uchiyama and Struhsaker (1981)	Maunder (2012)	Grande et al. (2014)
Thunnus alalunga	IATTC (2019)	Wells et al. (2013)	Wells et al. (2013)	Watanabe et al. (2006)	ISC (2017b)
Xiphias gladius	IATTC (2019)	Hinton and Maunder (2011)	Cerna (2009)	Hinton and Maunder (2011)	DeMartini et al. (2000)
Kajikia audax	IATTC (2019)	Kopf et al. (2005)	Kopf et al. (2011)	Wares and Sakagawa (1972)	Kopf et al. (2012)
Makaira nigricans	IATTC (2019)	Andrews et al. (2017)	Su et al. (2016)	ISC (2016)	Sun et al. (2009)
Istiophorus platypterus	IATTC (2019)	Cerdenares-Ladrón De Guevara et al. (2011)	Fitchett (2015)	Cerdenares-Ladrón De Guevara et al. (2011)	Hernandez and Ramirez (1998)
Coryphaena hippurus	Lasso and Zapata (1999)	Goicochea et al. (2012)	Aires-da-Silva et al. (2017)	Guzman et al. (2015)	Zúñiga-Flores et al. (2011)
Acanthocybium solandri	Collette and Nauen (1983)	Zischke et al. (2013b)	Zischke et al. (2013b)	Zischke et al. (2013b)	Zischke et al. (2013a)
Lepidocybium flavobrunneum	Nakamura and Parin (1993)	-	Froese and Binohlan (2000)	Keller and Kerstetter (2014)	Froese and Binohlan (2000)
Lampris guttatus	Hawn and Collette (2012)	Francis et al. (2004)	Francis et al. (2004)	Sundberg and Underkoffler (2011)	Francis et al. (2004)
Prionace glauca	Azevedo (2005)	Yokoi et al. (2017)	Yokoi et al. (2017)	Nakano (1994)	Fujinami et al. (2017)
Isurus oxyrinchus	Pratt and Casey (1983)	Bishop et al. (2006)	Semba et al. (2011)	Bishop et al. (2006)	Semba et al. (2011)
Carcharhinus falciformis	IATTC (2019)	Smith et al. (1998)	Oshitani et al. (2003)	Oshitani et al. (2003)	Oshitani et al. (2003)
Alopias superciliosus	Fernandez-Carvalho et al. (2011)	Liu et al. (1998)	Liu et al. (1998)	Froese and Pauly (2017)	Liu et al. (1998)
Carcharhinus longimanus	IATTC (2019)	Seki et al. (1998)	Seki et al. (1998)	Seki et al. (1998)	Seki et al. (1998)
Sphyrna zygaena	IATTC (2019)	Coelho et al. (2011)	Coelho et al. (2011)	Motta et al. (2014)	Froese and Binohlan (2000)
Mobula japanica	Notarbartolo-di-Sciara (1988)	Cuevas-Zimbrón et al. (2013)	Cuevas-Zimbrón et al. (2013)	Notarbartolo-di-Sciara (1988)	White et al. (2006)
Pteroplatytrygon violacea	Neer (2008)	Mollet et al. (2002)	Mollet et al. (2002)	Ribeiro-Prado and Amorim (2008)	Neer (2008)
Dermochelys coriacea	Márquez (1990)	Jones et al. (2011)	Jones et al. (2011)	Jones et al. (2011)	Reina et al. (2002)
Lepidochelys olivacea	Márquez (1990)	Whiting et al. (2007)	Whiting et al. (2007)	Whiting et al. (2007)	Zug et al. (2006)
Stenella attenuata	Perrin et al. (1976)	Perrin et al. (1976)	Perrin et al. (1976)	Perrin et al. (1976)	Perrin et al. (1976)
Delphinus delphis	Jefferson et al. (1993)	Danil and Chivers (2007)	Danil and Chivers (2007)	Gihr and Pilleri (1979)	Danil and Chivers (2007)

Table S5. Comparison of productivity attributes used by the Ecological Assessment of the Sustainable Impacts of Fisheries (EASI-Fish) model and a version of Productivity-Susceptibility Analysis (PSA) applied to six fisheries in the United States (Patrick et al. 2010).

Attributes	PSA	EASI-Fish
Productivity		
Intrinsic rate of population increase (r)	✓	
Maximum age (t_m)	✓	✓
Maximum size (L_{max})	✓	✓
Length-at-infinity (L_∞)		✓
von Bertalanffy growth rate coefficient (K)	✓	✓
Natural mortality (M)	✓	✓
Fecundity	✓	
Breeding strategy	✓	
Recruitment pattern	✓	
Age at maturity (t_m)	✓	
Length-at-maturity (L_m or L_{50})		✓
Mean trophic level	✓	
Susceptibility		
Areal overlap	✓	✓
Geographic concentration	✓	
Fishing season duration		✓
Vertical overlap (i.e. encounterability)	✓	✓
Seasonal availability	✓	✓
Schooling, aggregation, and behavioural responses	✓	
Morphological characteristics affecting capture	✓	
Gear selectivity		✓
Desirability or value of the fishery	✓	
Management strategy	✓	
Fishing rate relative to M (equivalent to F-based BRPs)	✓	✓
Biomass of spawners (SSB) or other proxies (equivalent to spawning biomass-based BRPs)	✓	✓
Survival after capture and release	✓	✓
Impact of fisheries on essential fish habitat	✓	

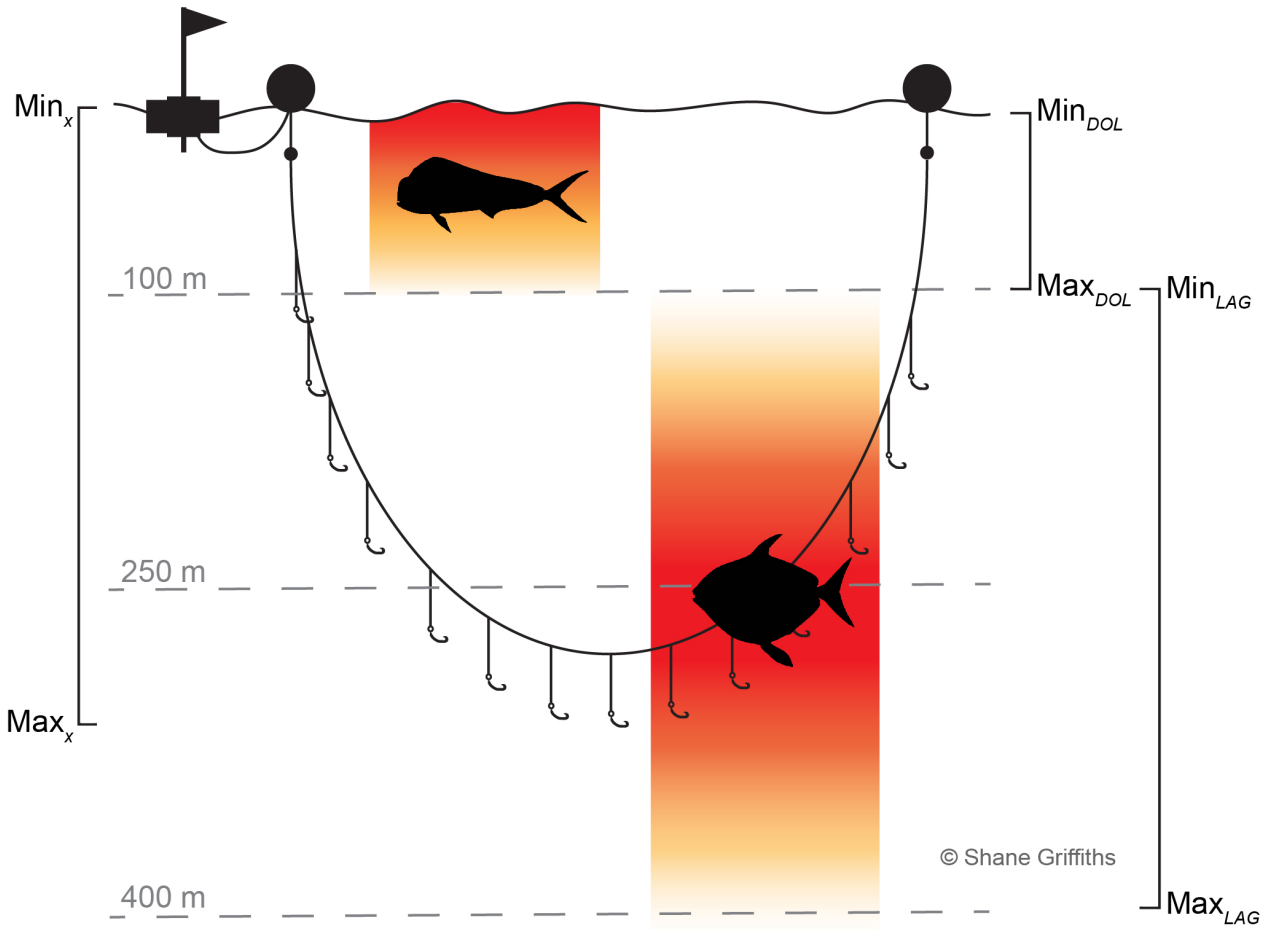


Figure S1. Schematic diagram illustrating the encounterability of two species *Coryphaena hippurus* (DOL) and *Lampris guttatus* (LAG) given their typical depth gradient (shown in red) relative to the maximum (Max) and minimum (Min) depth of gear used in fishery *x*—in this case longline—assumed to effectively fish depths of 0-300m during daytime "deep sets".

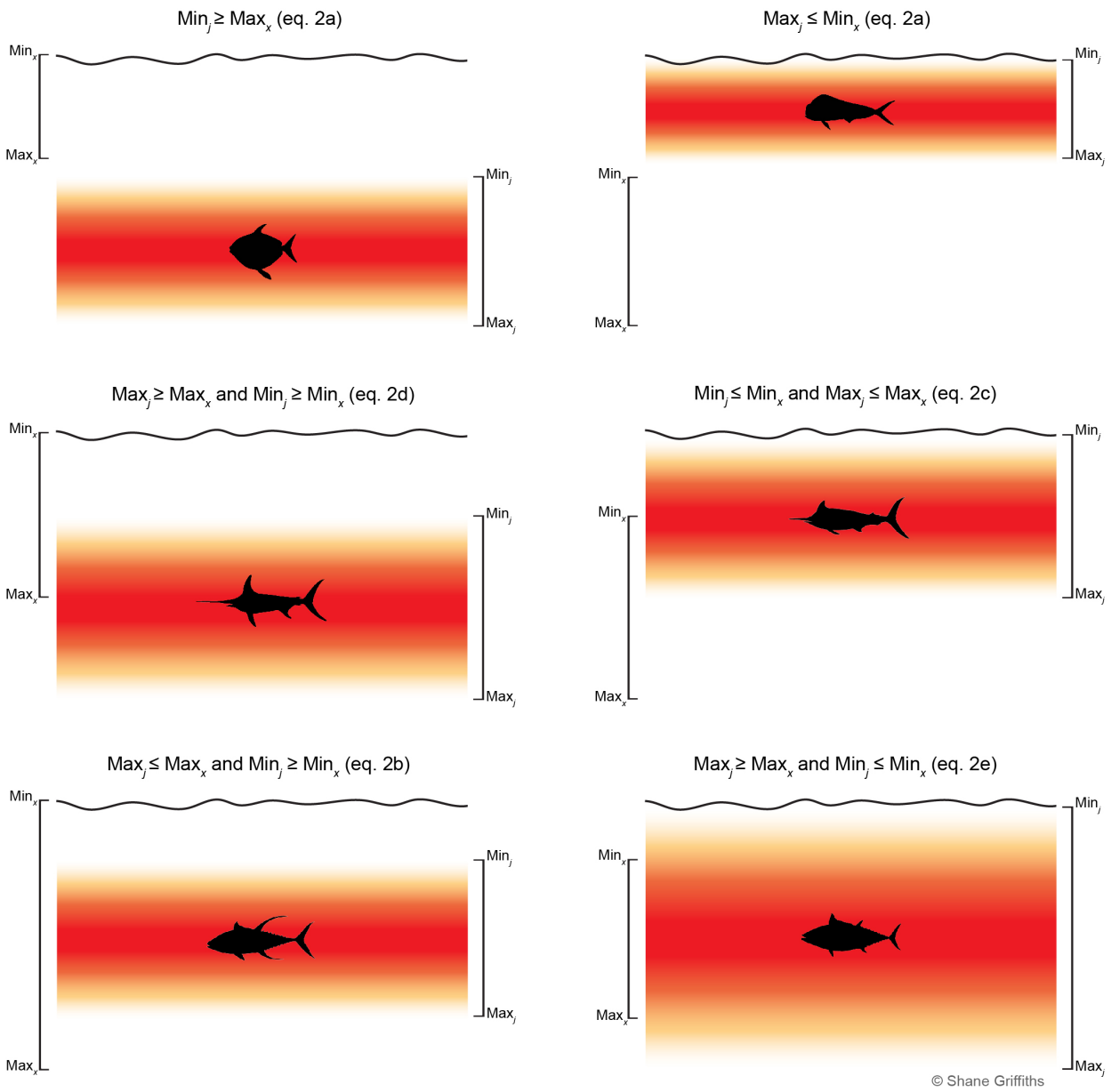
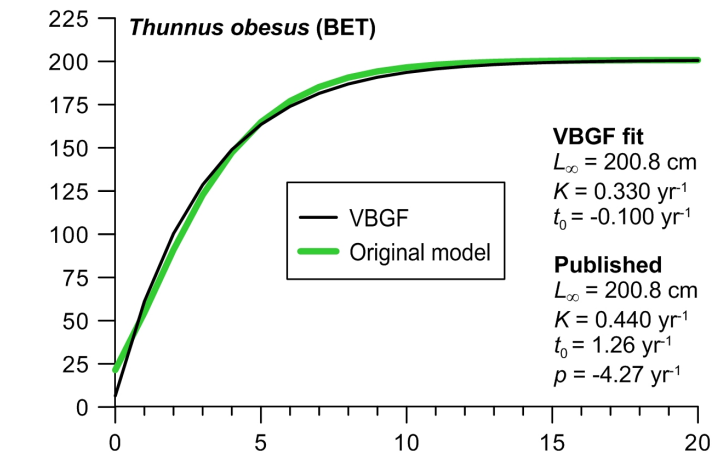
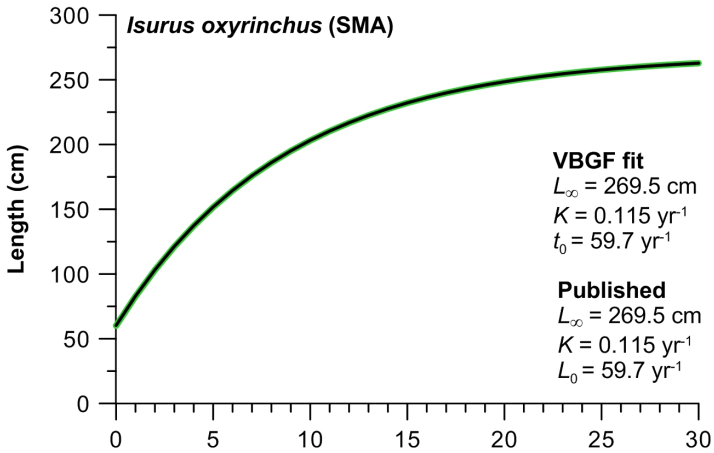


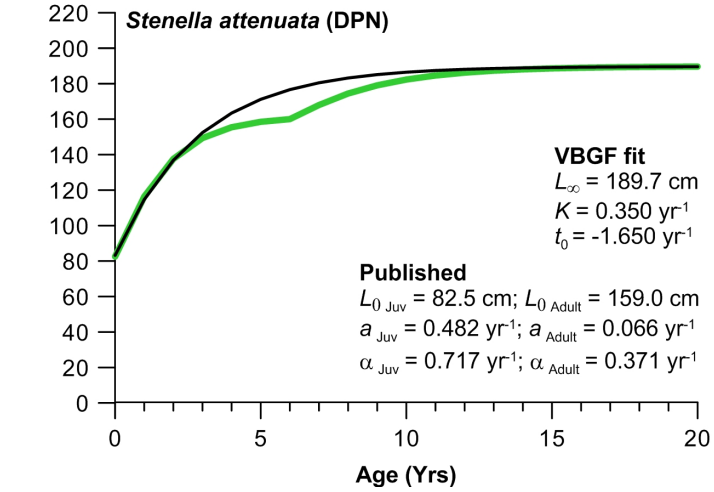
Figure S2. Schematic diagrams illustrating the six scenarios that represent the overlap of fishery *x*'s minimum (Min_x) and maximum (Max_x) depth with a species *j*'s minimum (Min_j) and maximum depth (Max_j).



Age (yrs)	Predicted length (Aires-da-Silva *et al.* 2015)	Predicted length (VBGF)
0	6.5	21.4
1	61.1	54.7
2	100.4	91.0
3	128.6	122.7
4	148.9	147.2
5	163.5	164.8
10	193.6	196.5
15	199.4	200.3
20	200.5	200.7



Age (yrs)	Predicted length (Semba *et al.* 2011)	Predicted length (VBGF)
0	60.2	60.0
1	82.9	82.8
2	103.2	103.0
3	121.3	121.1
4	137.4	137.3
5	151.7	151.6
10	203.2	203.2
15	232.2	232.2
20	248.5	248.5



Age (yrs)	Predicted length (Perrin *et al.* 1976)	Predicted length (VBGF)
0	83.2	82.5
1	114.7	116.3
2	136.8	137.6
3	152.4	149.4
4	163.4	155.5
5	171.2	158.5
10	186.5	182.3
15	189.1	188.6
20	189.6	189.6

Figure S3. Comparison of length-at-age for three of the 24 assessed species in the EPO predicted by published growth models (green lines) and reparametrized von Bertalanffy growth function (VBGF) (black lines). Parameter values for published and reparametrized models are shown.

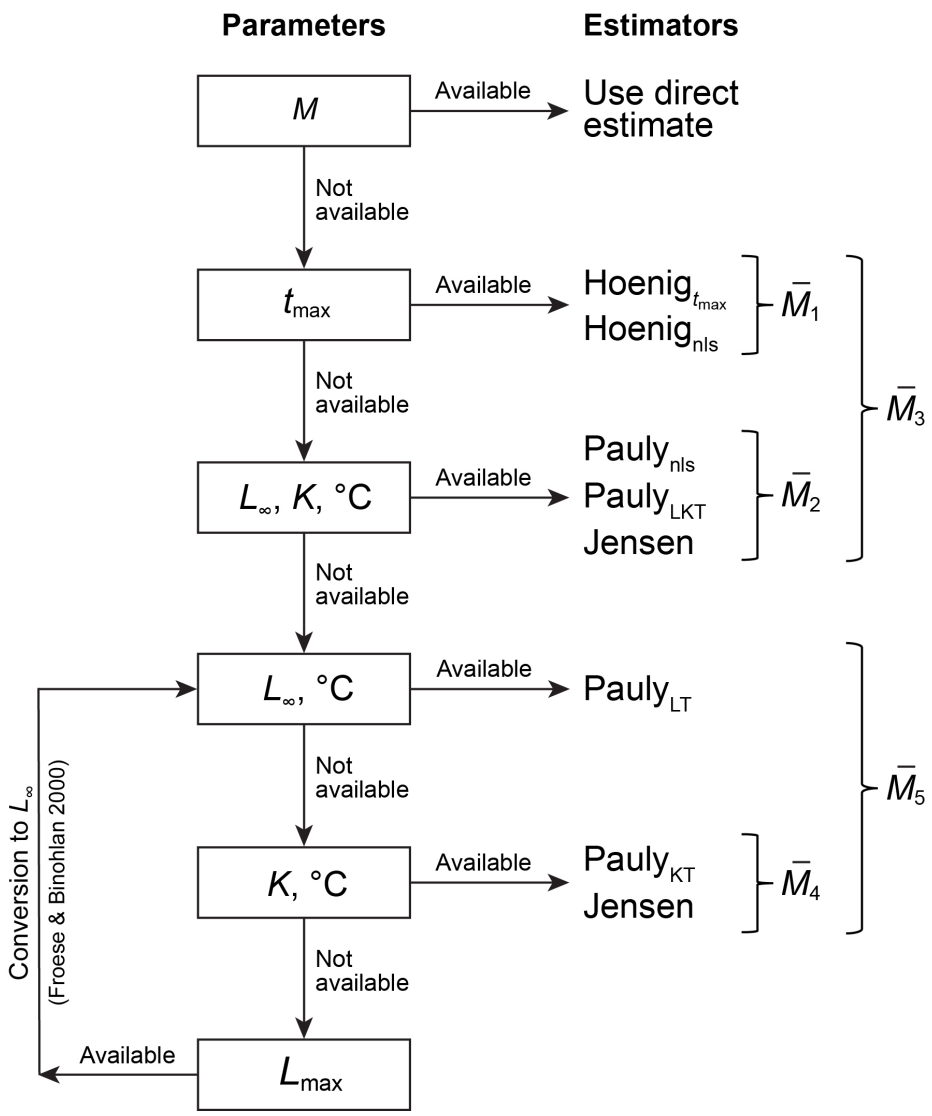


Figure S4. Flow diagram showing the hierarchical process in selecting appropriate natural mortality estimators depending on the life history parameter value(s) available for the 24 species caught in EPO tuna fisheries and assessed using EASI-Fish. Parameters are instantaneous natural mortality rate (M), maximum observed age of animals in the stock (t_{max}), the von Bertalanffy growth function parameters (L_∞ and K), the mean water temperature (°C) at the location and depth range inhabited by the species, and the maximum observed length of animals in the stock (L_{max}). Estimator values were averaged ($\bar{M}$) where sufficient data were available to derive estimates from multiple estimators.

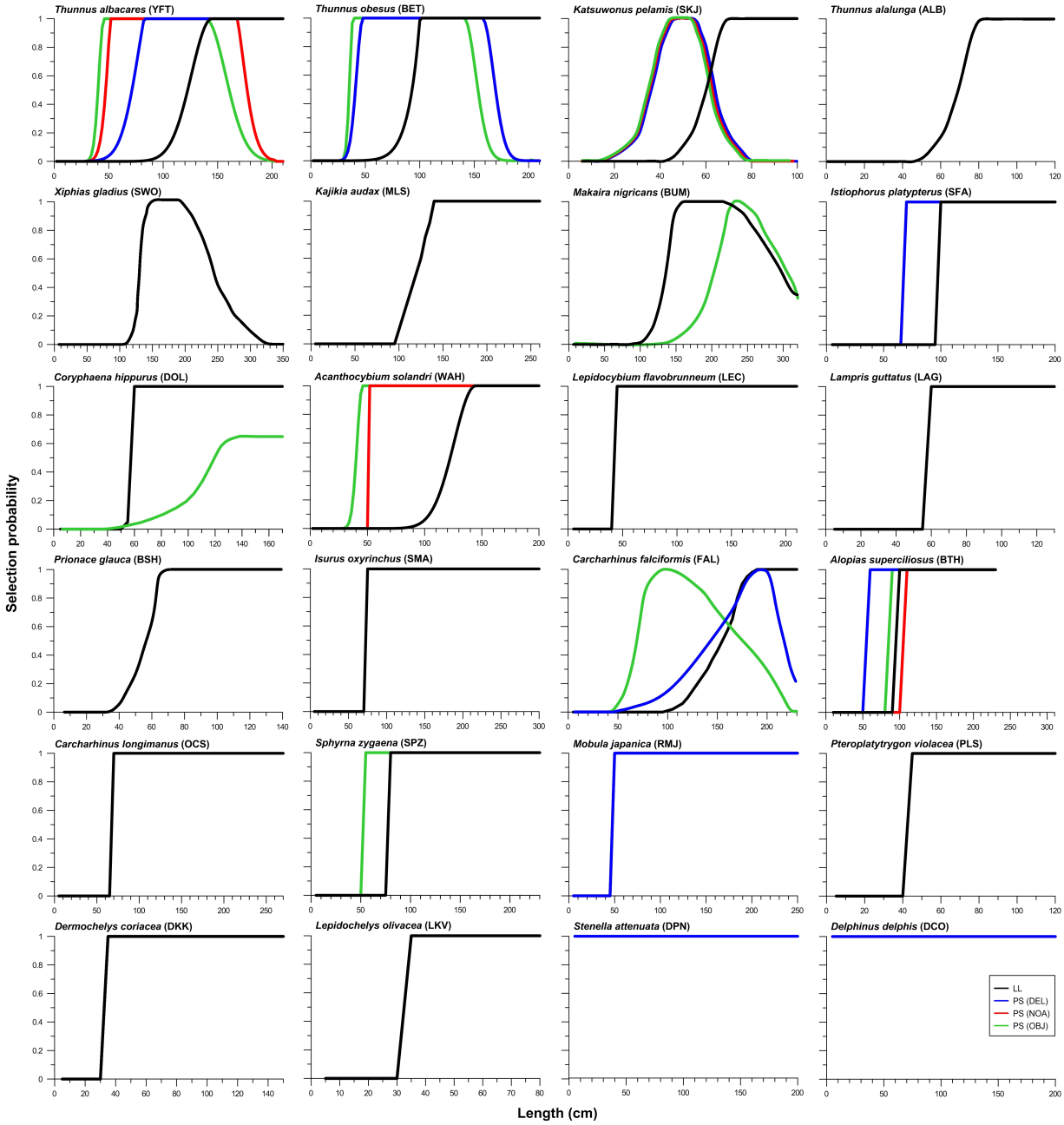


Figure S5. Selectivity-at-length models for the 24 species caught in the eastern Pacific Ocean tuna fisheries (longline–LL; purse-seine dolphin-associated sets–DEL; purse-seine unassociated sets–NOA; purse-seine sets on floating objects–OBJ) and their vulnerability assessed using EASI-Fish. Length is given as fork length (FL) for teleosts, eye orbit fork length (OFL) for billfishes, precaudal length (PCL) for sharks, disc width (DW) for rays, straight carapace length (SCL) for turtles, and total length (TL) for dolphins, which is measured from the "tip of upper jaw to deepest part of notch between flukes" (Norris 1961). Note that distributions for some fisheries are identical and may not be visible for some species.

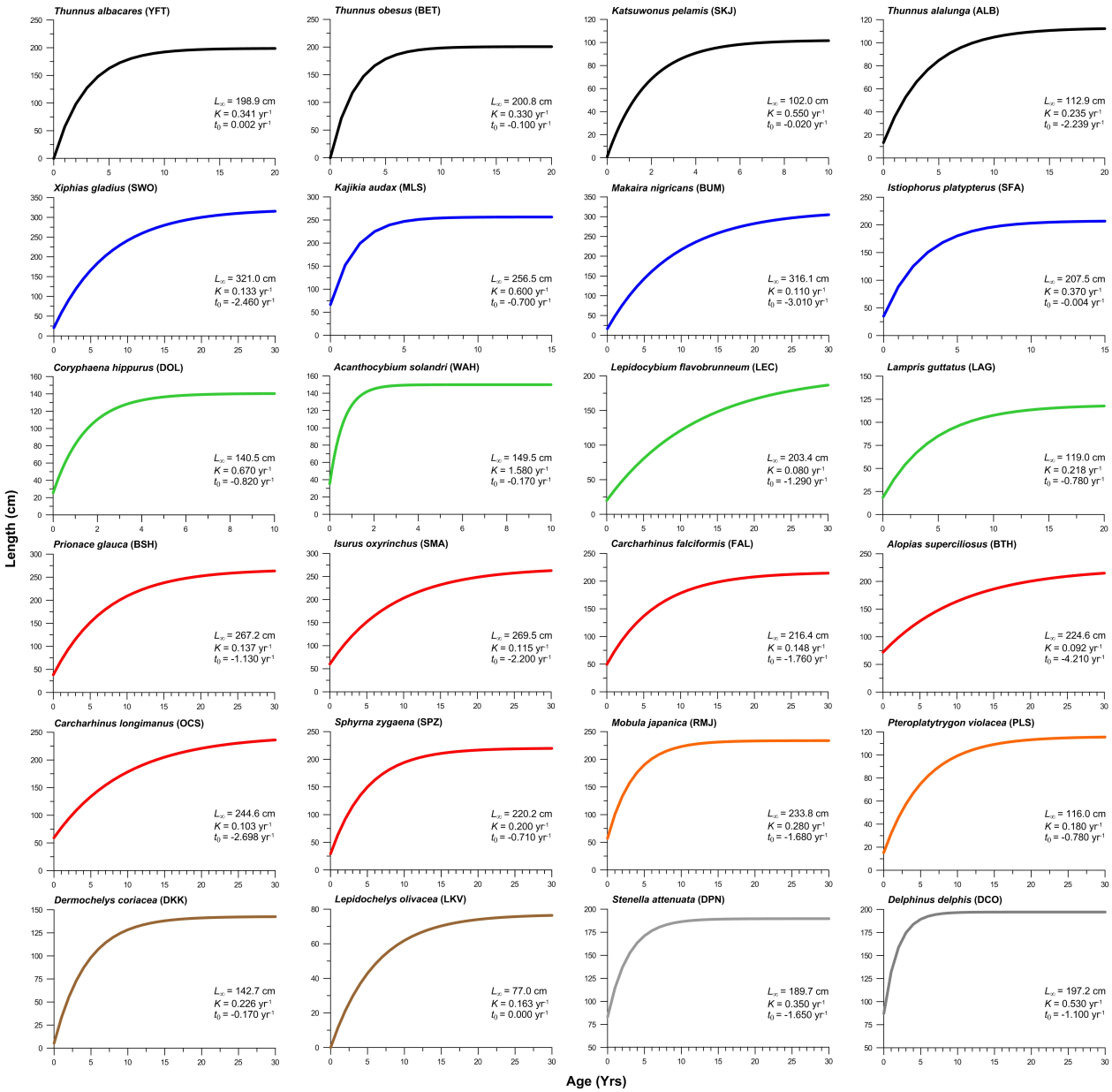


Figure S6. von Bertalanffy growth models used for each of the 24 species in EASI-Fish to assess the relative vulnerability of each species to tuna fishing in the eastern Pacific Ocean. Length is given as fork length (FL) for teleosts, eye orbit fork length (OFL) for billfishes, precaudal length (PCL) for sharks, disc width (DW) for rays, straight carapace length (SCL) for turtles, and total length (TL) for dolphins, which is measured from the "tip of upper jaw to deepest part of notch between flukes" (Norris 1961).

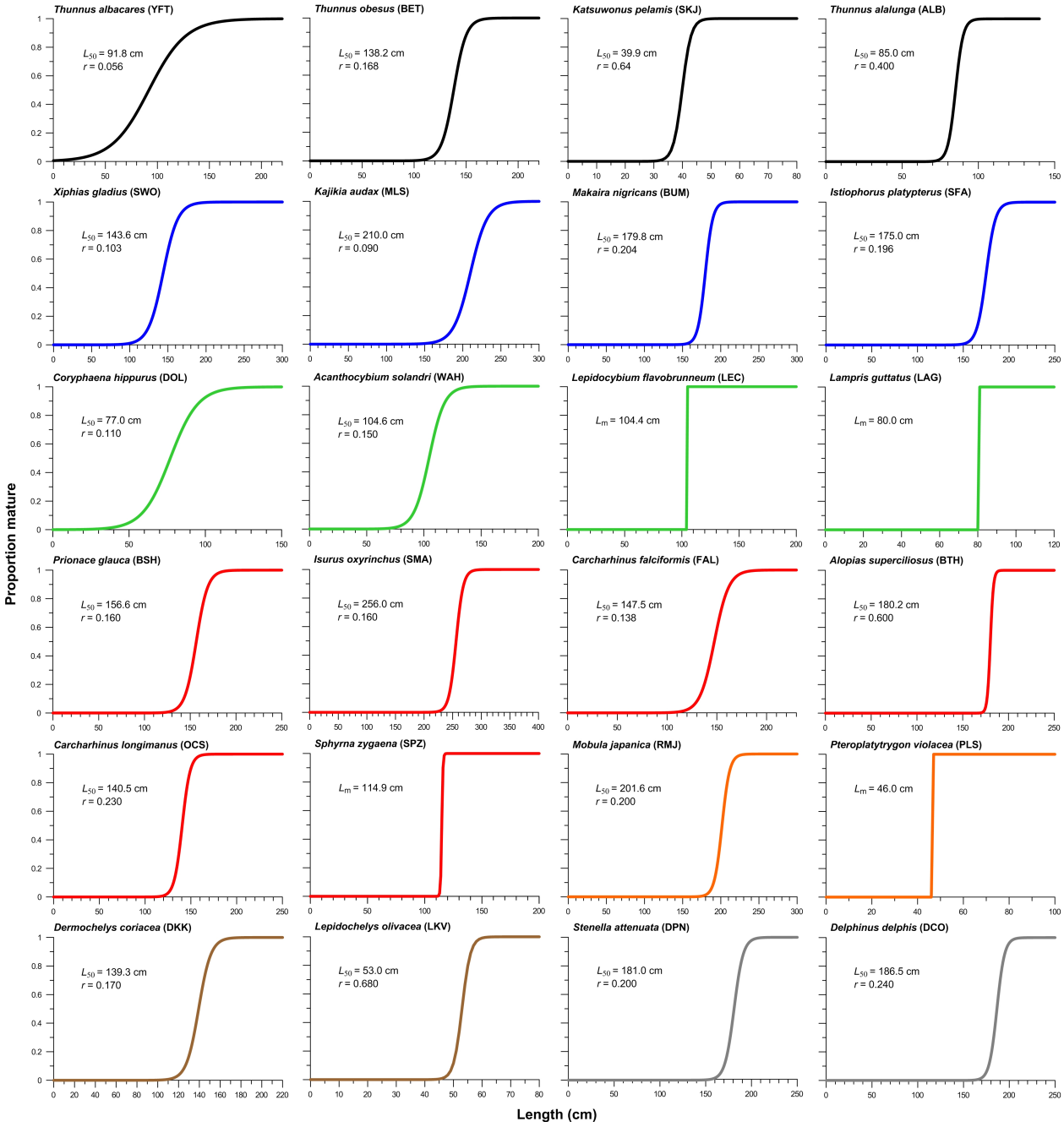


Figure S7. Maturity-at-length models used for each of the 24 species in EASI-Fish to assess the relative vulnerability of each species to tuna fishing in the eastern Pacific Ocean. Length is given as fork length (FL) for teleosts, eye orbit fork length (OFL) for billfishes, precaudal length (PCL) for sharks, disc width (DW) for rays, straight carapace length (SCL) for turtles, and total length (TL) for dolphins, which is measured from the "tip of upper jaw to deepest part of notch between flukes" (Norris 1961).

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