The Global Tuna Atlas: Services of interest to FAO, RFMOs, scientific Community and general public

E Chassot[1,2], P Taconet[1], E Blondel[3], J Barde[1]

[1]Institut de Recherche pour le Développement
[2]Seychelles Fishing Authority
[3]Food and Agriculture Organization

Table of Contents

Knowledge of data in the hands of the tRFMO Secretariats

Public domain tuna data sets

- Numerous: Nominal catch, spatial catch, spatial effort, raw size data, catch@size
- Rich: Long time series, basin-scale dimension, many species, etc.
- Complex: Specific terms, different coding systems between data sets, different units, redundancy, etc.
- Heterogenous: Data sources, processing and curation levels, species of interest, confidentiality rules, etc.
- Uncertain: Variablity and gaps in many artisanal fisheries, biases in longline size data, species composition in purse seine, etc.

Generate an operational global data set for science

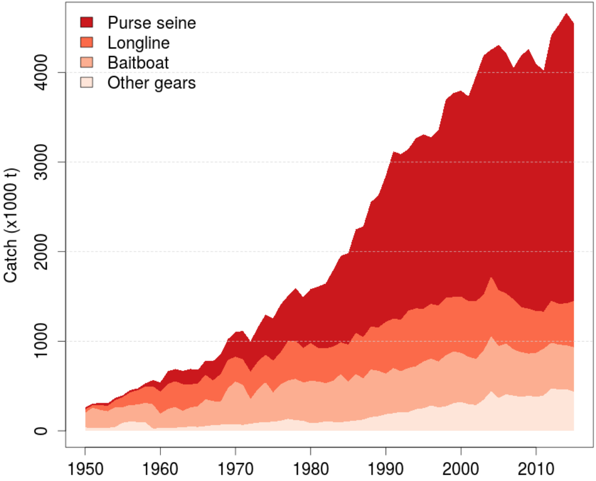
Reconciling tRFMO data sets

- Selection of data sets and reduction of redundancy for users
- Redistribution of catch/effort on land
- Conversions of catch into weight with description of factors/keys used
- Conversions of effort into a few units (hooks, days fished, sets)
- Addition of gear groups and species groups
- Standard code lists to facilitate understanding, merging and comparison across stocks/oceans/species/areas
- Standard metadata catalogue to help in both dissemination and interpretation (Emmanuel/Paul's presentations)

Direct interest of the Tuna Atlas to FAO

- Monitoring global fisheries production in the context of food security
- Assessing the relative importance of fisheries
- Linking with consumption of fish and fishery products
- Promoting exchanges of information and methods between tRFMOs
- Informing the general public on tuna fisheries
- Use case of spatial fisheries data portable to other case studies
- Facilitate comparison between data sources (Justel-Rubio et al., 2016)
- Provide data sets for management and science (see below)

Direct interest of the Tuna Atlas to FAO



Direct interest of the Tuna Atlas to FAO

- Monitoring global fisheries production in the context of food security
- Assessing the relative importance of fisheries
- Linking with consumption of fish and fishery products
- Promoting exchanges of information and methods between tRFMOs
- Informing the general public on tuna fisheries
- Use case of spatial fisheries data portable to other case studies
- Facilitate comparison between data sources (Justel-Rubio et al., 2016)
- Provide data sets for management and science (see below)

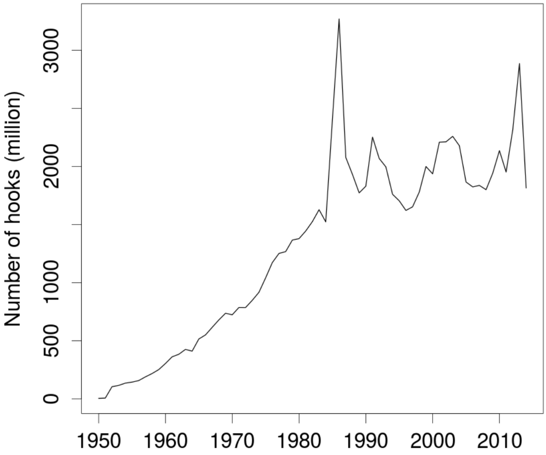
Direct interest to the tRFMOs Secretariats

Thinking global

- Contribute to the mapping and evolution of code lists and standards
- Provide feedbacks through identification of data inconsistencies
- Develop a generic approach for metadata production
- Increase the visibility of tRFMO data sets with metadata catalogue
- Provide (potential) complementary solutions of data access, extraction, and visualization

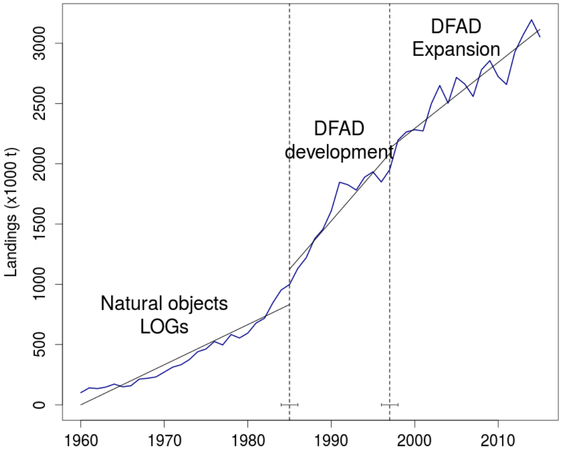
Table of Contents

Monitoring global fishing effort and capacity



Annual changes in global longline effort during 1950-2014

Monitoring global changes in fishing strategy



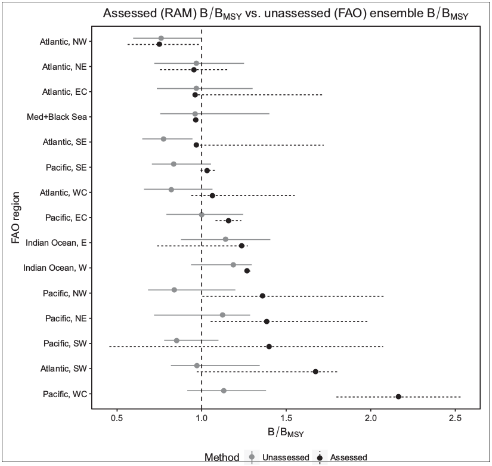
Annual changes in global catch on floating objects/FADs during 1950-2014

Assessments mainly based on catch data

Approaches

- Detection of patterns in time series of catch for defining fisheries status, e.g. collapse (Garcia and Grainger, 1997; Mullon et al., 2005)
- Data poor modelling approaches, including Management Strategy Evaluation (Carruthers et al., 2012; Rosenberg et al., 2017)
- Changes in mean trophic level of the catch at community scale (Pauly and Palomares, 2005)

Assessments based on catch data

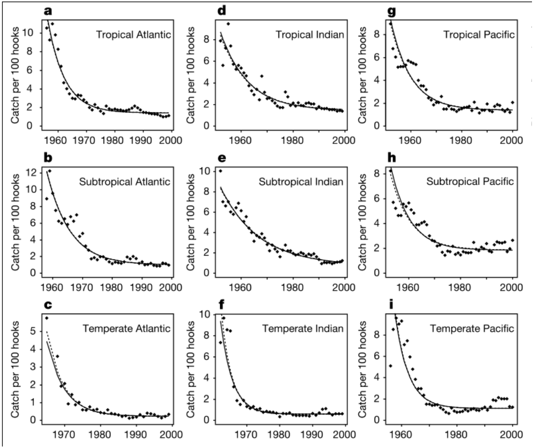


Comparison of stock status between assessed vs. unassessed stocks at basin scales (Anderson et al., 2017; Rosenberg et al., 2017)

Some patterns in CPUE time series observed across oceans

- Strong initial decline in longline CPUEs observed across oceans (Myers and Worm, 2003; Sibert et al., 2006; Polacheck, 2006)
- Major "jump" in longline CPUE in the mid-1970s due to development of deep-water longline
- Increasing CPUEs in purse seine linked to FAD fishery expansion
- Comparison of catch rates between oceans
- Local effects of seamounts on fisheries productivity

Some patterns in CPUE time series observed across oceans

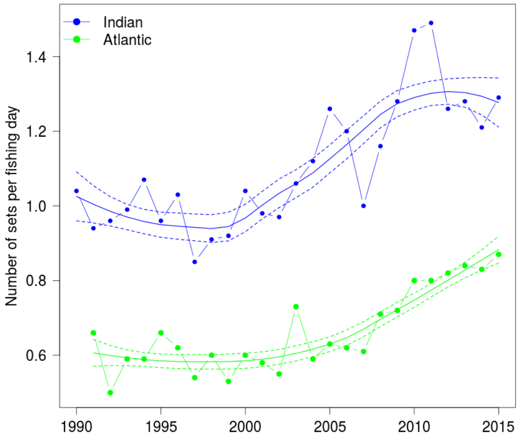


Changes in Japanese longline CPUEs – not abundance (Myers and Worm, 2003)

Some patterns in CPUE time series observed across oceans

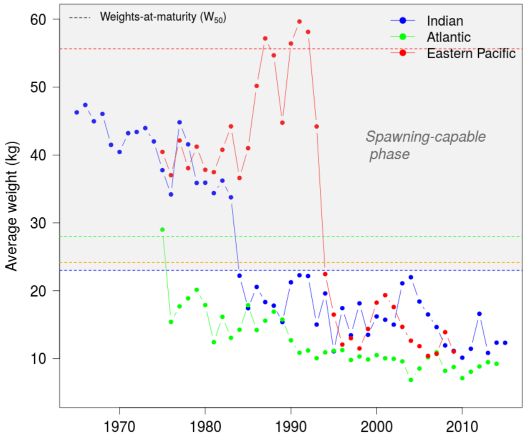
- Strong initial decline in longline CPUEs observed across oceans (Myers and Worm, 2003; Sibert et al., 2006; Polacheck, 2006)
- Major “jump“ in longline CPUE in the mid-1970s due to development of deep-water longline
- Increasing CPUEs in purse seine linked to FAD fishery expansion
- Comparison of catch rates between oceans
- Local effects of seamounts on fisheries productivity

Increasing fishing efficiency linked to purse seine strategy



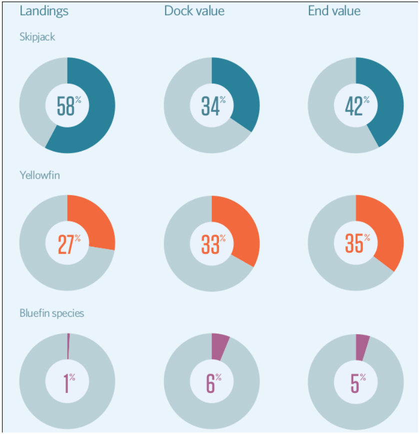
Annual changes in number of sets per fishing day during 1991-2015

Temporal changes in fishing pattern across oceans



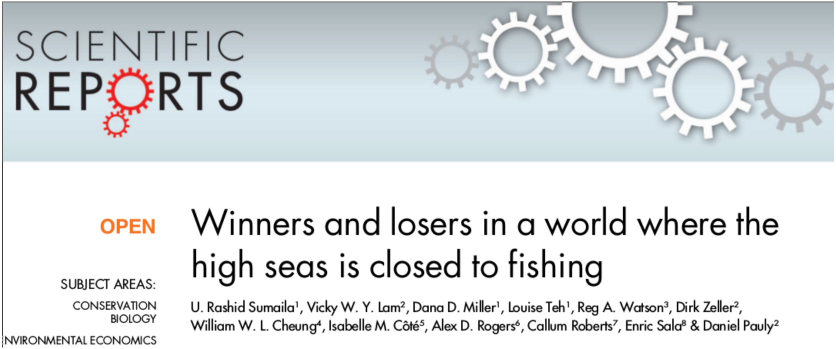
Annual mean weight in bigeye tuna during 1965-2014

Quantifying the economic value of tuna catches



Dock and end value for skipjack, yellowfin, and bluefins (Galland et al., 2016)

Addressing questions of spatial management for tunas


SCIENTIFIC REPORTS

OPEN

SUBJECT AREAS:
CONSERVATION BIOLOGY
NVIRONMENTAL ECONOMICS

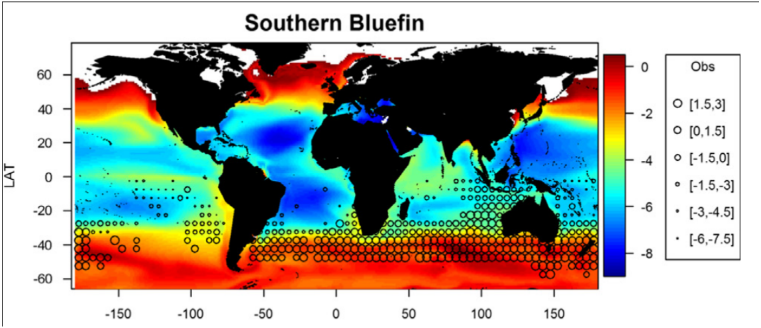
Winners and losers in a world where the high seas is closed to fishing

U. Rashid Sumaila[1], Vicky W. Y. Lam[2], Dana D. Miller[1], Louise Teh[1], Reg A. Watson[3], Dirk Zeller[2], William W. L. Cheung[4], Isabelle M. Côté[5], Alex D. Rogers[6], Callum Roberts[7], Enric Sala[8] & Daniel Pauly[2]

Estimation of catch within national jurisdictional waters and question of distribution of fisheries benefits (Sumaila et al., 2015; White and Costello, 2014)

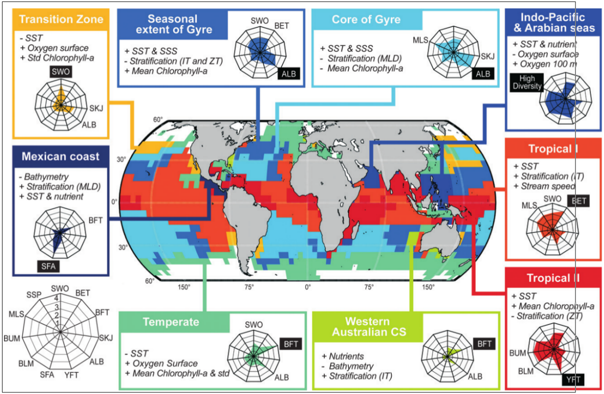
Table of Contents

Modelling habitat preferences of tuna populations



Observed CPUEs with predictions of habitat for southern bluefin (Arrizabalaga et al., 2015)

Understanding the biogeograpy of tuna communities



Classification of large ecological provinces described by similar tuna composition (Reygondeau et al., 2012)

Exploring the range-abundance relationship in tunas

PNAS

Range contraction in large pelagic predators

Boris Worm[a,1] and Derek P. Tittensor[a,b,c]

[a]Biology Department, Dalhousie University, Halifax, NS, Canada B3H 4R2; [b]United Nations Environment Programme World Conservation Monitoring Centre, Cambridge CB3 0DL, United Kingdom; and [c]Microsoft Research Computational Science Laboratory, Cambridge CB3 0FB, United Kingdom

Edited* by Robert T. Paine, University of Washington, Seattle, WA, and approved May 31, 2011 (received for review February 18, 2011)

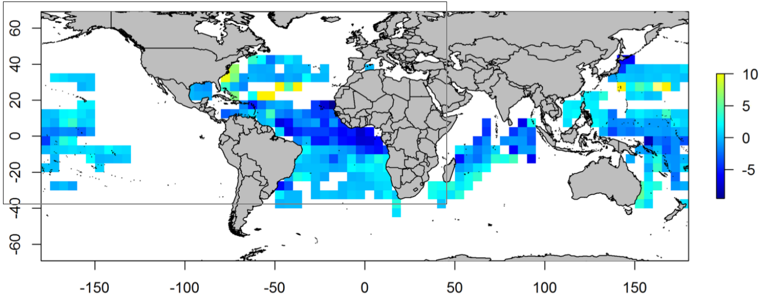
Large reductions in the abundance of exploited land predators have led to significant range contractions for those species. This pattern can be formalized as the range–abundance relationship, a general macroecological pattern that has important implications for the conservation of threatened species. Here we ask whether similar responses may have occurred in highly mobile pelagic predators, specifically 13 species of tuna and billfish. We analyzed two multi-

patterns in addition to the effects of reducing abundance via the hunting or culling of animals.

For marine fishes, particularly for pelagic and highly mobile species such as tuna and billfish, it is an open question whether similar patterns apply. Large reductions in abundance are a standard outcome of fisheries management for maximum yield (16–18), but how this may affect the range size of a species is

Use of FAO Tuna Atlas to relate spatial extent with abundance derived from assessment models (Worm and Tittensor, 2011)

Assessing the effects of ocean warming on tuna distribution



Change in the percentage of tropical tuna in longline catch between the 1960s and the 2000s (Monllor-Hurtado et al., 2017)

Large-scale analyses of bycatch on threatened species

Ecology Letters, (2004) **7**: 221–231 doi: 10.1111/j.1461-0248.2004.00573.x

REPORT

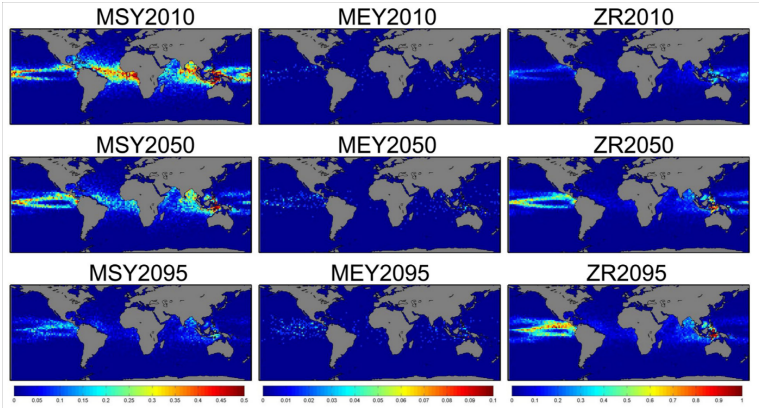
Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles

Rebecca L. Lewison*, Sloan A. Freeman and Larry B. Crowder
Duke University Marine Laboratory, Nicholas School of the Environment and Earth Sciences, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA
**Correspondence: E-mail: rebecca.lewison@duke.edu*

Abstract
The depletion of fish stocks from global fisheries has been a long-standing concern. More recently, incidental catch of non-target (termed bycatch) vertebrates also has been proposed as a serious conservation issue. Here we present a bycatch assessment for loggerhead and leatherback sea turtles that are incidentally caught by global pelagic longlines. We integrate catch data from over 40 nations and bycatch data from 13 international observer programmes. Despite infrequent rates of encounter, our analyses show that more than 200 000 loggerheads and 50 000 leatherbacks were likely taken as pelagic longline bycatch in 2000. Our analyses suggest that thousands of these turtles die each year from longline gear in the Pacific Ocean alone. Given 80–95%

Use of bycatch information available from tuna RFMOs for quantifying effects of longline on the conservation of sea turtles (Lewison et al., 2004)

Global ecosystem models and IPCC/IPBES scenarios



Spatial catch-effort data are inputs for ecosystem models such as APECOSM and SEAPODYM. Projections of skipjack abundance in 2050-2100 (Dueri et al., 2016)

Make the Tuna Atlas great again!

Key points

- Public-domain tuna data (catch, effort, size) are just one component of the data sets for management
- The spatial dimension of the data is however of much interest for many research questions
- The knowledge of the data sets comes from the tRFMOs and the data curation should be reflected in the metadata
- The standards adopted facilitate the connection between the tuna Atlas and other sources (environmental data, RAM Legacy database, FAD-tracking data, etc.)
- The Tuna Atlas is a link between the RFMO Secretariats and a wider audience of researchers

Make the Tuna Atlas great again!

Key points

- Public-domain tuna data (catch, effort, size) are just one component of the data sets for management
- The spatial dimension of the data is however of much interest for many research questions
- The knowledge of the data sets comes from the tRFMOs and the data curation should be reflected in the metadata
- The standards adopted facilitate the connection between the tuna Atlas and other sources (environmental data, RAM Legacy database, FAD-tracking data, etc.)
- The Tuna Atlas is a link between the RFMO Secretariats and a wider audience of researchers

Make the Tuna Atlas great again!

Key points

- Public-domain tuna data (catch, effort, size) are just one component of the data sets for management
- The spatial dimension of the data is however of much interest for many research questions
- The knowledge of the data sets comes from the tRFMOs and the data curation should be reflected in the metadata
- The standards adopted facilitate the connection between the tuna Atlas and other sources (environmental data, RAM Legacy database, FAD-tracking data, etc.)
- The Tuna Atlas is a link between the RFMO Secretariats and a wider audience of researchers

Make the Tuna Atlas great again!

Key points

- Public-domain tuna data (catch, effort, size) are just one component of the data sets for management
- The spatial dimension of the data is however of much interest for many research questions
- The knowledge of the data sets comes from the tRFMOs and the data curation should be reflected in the metadata
- The standards adopted facilitate the connection between the tuna Atlas and other sources (environmental data, RAM Legacy database, FAD-tracking data, etc.)
- The Tuna Atlas is a link between the RFMO Secretariats and a wider audience of researchers

Make the Tuna Atlas great again!

Key points

- Public-domain tuna data (catch, effort, size) are just one component of the data sets for management
- The spatial dimension of the data is however of much interest for many research questions
- The knowledge of the data sets comes from the tRFMOs and the data curation should be reflected in the metadata
- The standards adopted facilitate the connection between the tuna Atlas and other sources (environmental data, RAM Legacy database, FAD-tracking data, etc.)
- The Tuna Atlas is a link between the RFMO Secretariats and a wider audience of researchers

Anderson SC, Cooper B Andrew, Jensen OP, Minto C, Thorson JT, Walsh JC, Afflerbach J, Mark D, Kleisner KM, Longo C, Osio GC, Ovando D, Mosqueira I, Rosenberg AA, R SE (2017) Improving estimates of population status and trend with superensemble models. Fish and Fisheries 18(4):732–741. URL https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12200

Arrizabalaga H, Dufour F, Kell L, Merino G, Ibaibarriaga L, Chust G, Irigoien X, Santiago J, Murua H, Fraile I, Chifflet M, Goikoetxea N, Sagarminaga Y, Aumont O, Bopp L, Herrera M, Marc Fromentin J, Bonhomeau S (2015) Global habitat preferences of commercially valuable tuna. Deep Sea Research Part II: Topical Studies in Oceanography 113:102–112. URL http://www.sciencedirect.com/science/article/pii/S0967064514001738

Carruthers TR, Walters CJ, McAllister MK (2012) Evaluating methods that classify fisheries stock status using only fisheries catch data. Fisheries Research 119-120:66–79. URL http://www.sciencedirect.com/science/article/pii/S0165783611003894

Dueri S, Guillotreau P, Jiménez-Toribio R, Oliveros-Ramos R, Bopp L, Maury O (2016) Food security or economic profitability? Projecting the effects of climate and socioeconomic changes on global skipjack tuna fisheries under three management strategies. Global Environmental Change 41:1–12. URL http://www.sciencedirect.com/science/article/pii/S0959378016301352

Fonteneau A, Chassot E, Bodin N (2013) Global spatio-temporal patterns in tropical tuna purse seine fisheries on drifting fish aggregating devices (DFADs): Taking a historical perspective to inform current challenges. Aquatic Living Resources 26(1):37–48. URL http://www.alr-journal.org/10.1051/alr/2013046

Galland G, Rogers A, Nickson A (2016) Netting billions: A global valuation of tuna. Tech. rep., The PEW Charitable Trusts, Washington D.C., U.S.A.

Garcia S, Grainger R (1997) Chronicles of marine fishery landings (1950–1994). Trend analysis and fisheries potential. FAO Fisheries Technical Paper, FAO, Roma, Italy

Justel-Rubio A, Garibaldi L, Hampton J, Maunder M, Restrepo VR (2016) A comparative study of annual tuna catches from two different sources: FAO global capture database vs tuna RFMOs statistical databases (2000 -2014). ISSF Technical Report 2016-05, ISSF, Washington D.C., U.S.A. 10.13140/RG.2.2.32755.32801

Lewison RL, Freeman SA, Crowder LB (2004) Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7(3):221–231. URL http://dx.doi.org/10.1111/j.1461-0248.2004.00573.x

Monllor-Hurtado A, Pennino MG, Sanchez-Lizaso JL (2017) Shift in tuna catches due to ocean warming. PLOS ONE 12(6):e0178196. URL http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0178196

Mullon C, Fréon P, Cury P (2005) The dynamics of collapse in world fisheries. Fish and Fisheries 6:111–120

Myers RA, Worm B (2003) Rapid worldwide depletion of predatory fish communities. Nature 423(6937):280–283. URL http://www.nature.com/nature/journal/v423/n6937/abs/nature01610.html

Pauly D, Palomares ML (2005) Fishing down marine food web: It is far more pervasive than we thought. Bulletin of Marine Science 76(2):197–212

Polacheck T (2006) Tuna longline catch rates in the Indian Ocean: Did industrial fishing result in a 90% rapid decline in the absence of predatory species? Marine Policy 30:470–482

Reygondeau G, Maury O, Beaugrand G, Fromentin JM, Fonteneau A, Cury P (2012) Biogeography of tuna and billfish communities. Journal of Biogeography 39:114–129. URL http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2699.2011.02582.x/abstract. ACL

Rosenberg AA, Kleisner KM, Afflerbach Jamie, Anderson Sean C, DickeyCollas Mark, Cooper Andrew B, Fogarty Michael J, Fulton Elizabeth A, Gutiérrez Nicolás L, Hyde Kimberly JW, Jardim Ernesto, Jensen Olaf P, Kristiansen Trond, Longo Catherine, MinteVera Carolina V, Minto Cóilín, Mosqueira Iago, Osio Giacomo Chato, Ovando Daniel, Selig Elizabeth R, Thorson James T, Walsh Jessica C, Ye Yimin (2017) Applying a New Ensemble Approach to Estimating Stock Status of Marine Fisheries around the World. Conservation Letters 11(1):e12363. URL https://onlinelibrary.wiley.com/doi/full/10.1111/conl.12363

Sibert J, Hampton J, Kleiber P, Maunder M (2006) Biomass, size, and trophic status of top predators in the Pacific Ocean. Science 314(5806):1773–1776. URL http://dx.doi.org/10.1126/science.1135347

Sumaila UR, Lam VWY, Miller DD, Teh L, Watson RA, Zeller D, Cheung WWL, Côté IM, Rogers AD, Roberts C, Sala E, Pauly D (2015) Winners and losers in a world where the high seas is closed to fishing. Scientific Reports 5. URL http://www.nature.com/srep/2015/150212/srep08481/full/srep08481.html

White C, Costello C (2014) Close the High Seas to Fishing? PLoS Biol 12(3):e1001826. URL http://dx.doi.org/10.1371/journal.pbio.1001826

Worm B, Tittensor DP (2011) Range contraction in large pelagic predators. Proceedings of the National Academy of Sciences 108(29):11942–11947. URL http://www.pnas.org/content/108/29/11942