Marine Policy 50 (2014) 318–322

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Short Communication

Trophy fishing for species threatened with extinction: A way forward building on a history of conservation

D.S. Shiffman [a,b,*], A.J. Gallagher [a,b], J. Wester [a,b], C.C. Macdonald [a,b], A.D. Thaler [c], S.J. Cooke [d], N. Hammerschlag [a,b]

[a] Abess Center for Ecosystem Science and Policy, University of Miami 1365 Memorial Drive, Miami, FL 33146, USA
[b] RJ Dunlap Marine Conservation Program, University of Miami 4600 Rickenbacker Causeway, Miami, FL 33149, USA
[c] Upwell, 110 Capp St. Suite 300, San Francisco, CA 94110, USA
[d] Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, ON, Canada K4P045

ARTICLE INFO

Article history:
Received 9 May 2014
Received in revised form
1 July 2014
Accepted 1 July 2014

Keywords:
Fish conservation
Fisheries policy
International game fishing association
IUCN Red List
Recreational fishing
Threatened fish species

ABSTRACT

Trophy fishing occurs when anglers target the largest members of a species with the goal of obtaining an award with perceived prestige. The largest members of many species are also the most fecund, raising alarms about the disproportionate impact of removing the largest individuals of species of conservation concern. Presented here is the first systematic analysis of the conservation status of fishes targeted for world records by the International Game Fishing Association. Eighty-five species for which IGFA records have been issued are listed as Threatened by the International Union for the Conservation of Nature (IUCN) Red List. If the IGFA stopped issuing records that implicitly require killing the fish for IUCN Red List Threatened species, it would immediately reduce fishing pressure on the largest individuals of species of conservation concern while still allowing anglers to target more than 93% of species that records have been issued for.

1. Introduction

1.1. Ecological impacts of recreational fishing

Overfishing is recognized as one of the greatest threats to marine biodiversity, resulting in declines in both population size [1] and average body size [2] of many fish species. While the negative consequences of both target and non-target commercial exploitation on the populations of some fish species are well documented, there is growing recognition that in some instances, recreational fishing has the potential to have negative consequences for fish populations and ecosystems (rockfishes in California, [3]; U.S. managed marine fishes with a focus on red drum *Sciaenops occelatus*, bocaccio *Sebastes paucispinis*, and red snapper *Lutjanus campechanus*, [4]; general overviews in [5] and [6]).

The impact of recreational fisheries is driven by the volume of participants. In the United States alone there are more than ten million saltwater recreational fishers [7], and the global average rate of participation in recreational fishing is approximately 10% [8]. Estimates of global capture by recreational fisheries (using extrapolations for areas in which data exist) exceed 47 billion fish, of which approximately two thirds are released [5]. Of these released fish, a variable proportion (depending on gear, angler behavior, environmental conditions, and intrinsic biotic factors, [8]) will suffer post-release mortality which is often cryptic and difficult to quantify or estimate [9].

The primary motivation for recreational angler participation differs from commercial fishers (i.e. leisure vs. employment/profit, [10,11]), which in turn influences the distribution of fishing effort. Whereas commercial fishers need to fish in areas with higher biomass to make a profit, recreational fishers may choose to target more isolated areas and rarer species [8]. Moreover, recreational anglers are often permitted to fish for threatened species prohibited from commercial harvest and subject to recovery plans [12]. Trophy fishing is a form of recreational fishing in which the largest individuals of a species are targeted, with the goal of catching record-sized specimens certified by a central authority [10]. The capture of a trophy sized fish is the driving factor in some angler's satisfaction [10], and for those anglers this is a very strong motivator [13].

Fecundity, larval quality, and offspring survival are also positively correlated with size in fishes [14], and it has been widely

* Correspondence to: 4600 Rickenbacker Causeway, Miami FL 33149, USA. Tel.: +1 305 284 8259; fax: +1 305 284 3370.
E-mail addresses: David.Shiffman@gmail.com (D.S. Shiffman), Gallagher.Austin@gmail.com (A.J. Gallagher), Julia.Wester@gmail.com (J. Wester), CMacdonald@inbox.com (C.C. Macdonald), Andrew.David.Thaler@gmail.com (A.D. Thaler), Steven.Cooke@Carleton.ca (S.J. Cooke), NHammerschlag@rsmas.miami.edu (N. Hammerschlag).

http://dx.doi.org/10.1016/j.marpol.2014.07.001
0308-597X/

demonstrated that the number of eggs a female can produce is, to a large extent, dependent on the volume of that individual [15]. For example, older and larger red snapper *Lutjanus campechanus* spawn 50% more often than younger, smaller red snapper [16]; the removal of a single 61 cm individual has an impact on the population equivalent to removing 212 individuals of 41 cm (Palumbi [15]). Larger mothers also have higher energy reserves, and are able to invest more resources into each individual larvae. For example, black rockfish *Sebastes melanops* larvae from larger mothers have larger globules of oil than those from smaller mothers, a feature associated with growth rates three times as high and survival twice as high as larvae from smaller mothers [17]. Since fish exhibit infinite growth, larger fish are also older and more experienced. Many species of fish also exhibit sexual dimporphism, where females are larger than males (Parker 1992), meaning that gravid females are often the largest individuals within a population. Taken together, larger fish tend to have a disproportionately large positive impact on population dynamics as well as the potential of a population to sustain or recover from human-induced negative impacts, such as fishing pressure or climate change.

Trophy fishing selectively targets and removes the largest individuals in a population, and as a consequence can have a disproportionately large negative impact on the population dynamics of that species even when relatively few individuals are removed from the population [18]. These issues are of particular concern among species which exhibit low rates of biological productivity or those which already have experienced population declines [19]. That people earn prestigious awards for this behavior presents a unique social and biological challenge that warrants further investigation.

1.2. Trophy fishing and the international game fishing association

The largest recreational trophy fishing organization is the International Game Fishing Association (IGFA), with more than 15,000 members in over 100 countries [20]. One of the IGFA's primary functions is certifying the official world record sizes of fish caught by trophy anglers. The most common record certification is based on mass, and thus necessitates transporting the fish to an official land-based weigh station. Consequently, this requirement effectively precludes catch and release for trophy fishing, particularly for larger pelagic fish species which are caught farther from shore (and that are difficult to retain and transport while meeting key physiological requirements for survival- e.g., ram ventilation for some species).

The perceived prestige associated with obtaining an IGFA world record is a major motivator for trophy fishers, resulting in global fishing pressure for the largest individuals of over 1200 species of fish (IGFA 2011 world record book), including many gravid or disproportionately fecund individuals. Despite a low probability of catching a record-sized fish, anglers frequently land near-record sized fish for evaluation [21]. As such, the largest individuals within a population continue to be caught without making it into the record books. While some species of fish have relatively healthy populations that are resilient to some level of sustained recreational fishing pressure associated with anglers focusing on the largest individuals, variable life history characteristics and population statuses mean that this is not the case for all species.

The IUCN Red List of Threatened Species, produced by a worldwide network of scientists and environmental managers, is a thorough, respected, and widely utilized assessment of the conservation status of many species [22]. The species of fish listed as Threatened (Vulnerable, Endangered, and Critically Endangered) by the IUCN Red List often have relatively low populations that are susceptible to overfishing, particularly when fishing effort is directed at more fecund females. As a listing is a scientific assessment without the force of law, many species listed as Threatened on the IUCN Red List are not legally protected from exploitation.

While anglers attempting to obtain an IGFA certified record are required to follow all local laws and regulations, the IGFA currently has no policies prohibiting anglers from catching unprotected species identified as Threatened by the IUCN Red List. Donaldson et al. [20] reviewed the IUCN Red List status of selected IGFA targeted fishes; however, a complete analysis of all IGFA record species has never been performed. Presented here is an analysis of the IUCN Red List status and selected biological characteristics of fish species targeted for IGFA world records by recreational trophy fishers around the world for the purpose of evaluating the conservation concern of targeted species.

2. Methods

A copy of the IGFA 2011 world record guide was obtained. For each of the 1222 fish species in the 2011 world record guide for which all-tackle records existed, the IUCN Red List status was determined using the online database found at IUCNredlist.org. The record-setting weight was also recorded for statistical analysis within R using 2-tailed z tests.

3. Results and discussion

3.1. Threatened fish species with IGFA world records

Of the 1222 species for which all-tackle records were issued by the IGFA (IGFA 2011), 687 were Not Evaluated by the IUCN Red List (56%), and 241 species (19.7%) were evaluated as Least Concern. Eighty-five species (6.95%) are listed as Threatened with extinction (Vulnerable, Endangered, or Critically Endangered, Table 1). Of the 52 species highlighted on the cover of the 2011 IGFA World Record book, 5 are Threatened with extinction (Fig. 1).

In general, Threatened species of fish exhibit biological characteristics that differ from species evaluated as Least Concern (Fig. 2). Threatened species make up a significantly higher proportion of the largest size class, (Fig. 2a,b) Least concern species make up a significantly higher proportion of the smallest size class. Least concern species average record weight of 17.21 kg and Threatened species have an average record weight of 108 kg. The largest IGFA-certified record (1208 kg) for any trophy fish is from the Threatened great white shark *Carcharodon carcharias*.

3.2. A way forward

The IGFA's mission statement asserts that they are “committed to the conservation of game fish and the promotion of responsible, ethical angling practices” (www.IGFA.org, (accessed 30.06.14). However, recreational trophy fishing occurring with the goal of earning an IGFA world record may have a disproportionate negative impact on the population dynamics of Threatened fish species by removing larger, more fecund individuals.

The IGFA has a long history of partnering with scientists and managers to support responsible fishing practices in the commercial sector, including voicing public support for new regulations to reduce commercial bycatch, stronger regulations to prevent shark finning, and protections for certain Threatened species via listing on the Convention on the International Trade in Endangered Species (CITES), and therefore a policy to reduce the consequences of IGFA trophy fishing on Threatened species of fish would be consistent with the values and history of this conservation-minded organization. Therefore, it is recommended that the IGFA

Table 1
IUCN Red List Threatened species of IGFA all-tackle world record fish. Common names are those used by the IGFA record book. In column "commercial fishing pressure", I=current or historical commercial fishing pressure indicated in the IUCN Red List database entry, F=current or historical commercial fishing pressure indicated in the FishBase database entry, B=current or historical fishing pressure indicate in both the IUCN Red List and FishBase database entries, and N=current or historical fishing pressure not indicated in either database entry. Threats from commercial fishing pressure include bycatch.

Scientific Name	Common Name	Commercial fishing pressure?
Critically Endangered (Freshwater)		
Anguilla Anguilla	European eel	B
Catlocarpio siamensis	Giant barb	B
Chasmistes cujus	Cui-ui	F
Oncorhynchus apache	Apache trout	N
Pangasianodon gigas	Giant catfish	B
Pangasius sanitwongsei	Giant pangasius	B
Critically Endangered (Marine)		
Epinephelus drummondhayi	Speckled hind	B
Epinephelus itajara	Goliath grouper	B
Hucho perryi	Japanese huchen	B
Hyporthodus nigritus	Warsaw grouper	B
Pristis perotteti	Large-tooth sawfish	B
Squatina squatina	European monkfish	B
Thunnus maccoyii	Southern Bluefin tuna	B
Stereolepis gigas	Giant sea bass	B
Huso huso	Beluga sturgeon	B
Endangered (freshwater)		
Balantiocheilos melanopterus	Tricolor sharkminnow	N
Hucho hucho	Huchen	B
Lates microlepis	Forktail lates	B
Pangasianodon hypophthalmus	Swai catfish	B
Tor putitora	Golden mahseer	B
Endangered (marine)		
Aetobatus flagellum	Longheaded eagle ray	B
Argyrosomus hololepidotus	Kob	B
Cheilinus undulatus	Humphead wrasse	B
Dasyatis margarita	Daisy stingray	B
Epinephelus akaara	Hong Kong grouper	B
Epinephelus marginatus	Dusky grouper	B
Epinephelus striatus	Nassau grouper	B
Hippoglossus hippoglossus	Atlantic halibut	F
Mycteroperca fusca	Island grouper	B
Mycteroperca jordani	Gulf grouper	B
Pagrus pagrus	Red porgy	F
Raja undulata	Undulate ray	B
Rhinobatos cemiculus	Blackchin guitarfish	B
Rhynchobatus luebberti	African wedgefish	B
Sebastolobus alascanus	Shortspine thornyhead	F
Sphyrna lewini	Scalloped hammerhead shark	B
Sphyrna mokarran	Great hammerhead shark	B
Thunnus thynnus	Bluefin tuna	B
Vulnerable (freshwater)		
Acipenser brevirostrum	Shortnose sturgeon	B
Cirrhinus cirrhosus	Mrigal	B
Cyprinus carpio	Common carp	F
Hucho taimen	Taimen	F
Hypsibarbus lagleri	Lagleri barb	B
Oreochromis andersonii	Threespot tilapia	B
Salvelinus confluentus	Bull trout	N
Scaphirhynchus platorynchus	Shovelnose sturgeon	I
Ambloplites cavifrons	Roanoke bass	N
Coregonus lavaretus	Powan	F
Vulnerable (marine)		
Alopias superciliosus	Bigeye thresher shark	B
Alopias vulpinus	Thresher shark	B
Balistes vetula	Queen triggerfish	F
Carcharhinus longimanus	Oceanic whitetip shark	B
Carcharhinus obscurus	Dusky shark	B
Carcharhinus plumbeus	Sandbar shark	B
Carcharhinus signatus	Night shark	B
Carcharodon carcharias	White shark	B
Cynoscion othonopterum	Gulf weakfish	B
Epinephelus bruneus	Longtooth grouper	B
Epinephelus lanceolatus	Giant grouper	I
Gadus morhua	Atlantic cod	F
Galeorhinus galeus	Tope shark	B
Gymnura altavela	Spiny butterfly ray	B
Hyporthodus flavolimbatus	Yellowedge grouper	B
Hyporthodus niveatus	Snowy grouper	B
Isurus oxyrinchus	Mako shark	B
Kajikia albida	White marlin	B
Lachnolaimus maximus	Hogfish	B
Lamna nasus	Porbeagle shark	B
Lutjanus analis	Mutton snapper	B
Lutjanus cyanopterus	Cubera snapper	F
Makaira nigricans	Blue marlin	B
Megalops atlanticus	Tarpon	B
Melanogrammus aeglefinus	Haddock	F
Mycteroperca interstitialis	Yellowmouth grouper	B
Mycteroperca rosacea	Leopard grouper	F
Negaprion acutidens	Sicklefin lemon shark	B
Carcharias taurus	Sand tiger shark	B
Platyrhina sinensis	Fanray	I
Plectropomus laevis	Blacksaddled coralgrouper	F
Raja radiata	Thorny skate	B
Rhynchobatus djiddensis	Giant guitarfish	B
Semicossyphus pulcher	California sheepehead	B
Sphyrna zygaena	Smooth hammerhead shark	B
Squalus acanthias	Spiny dogfish	B
Tautoga onitis	Tautog	B
Thunnus obesus	Bigeye tuna	B
Nemipterus virgatus	Itoyoridai	B

issue a declaration that all-tackle weight-based world record certifications will no longer be offered for species identified by the IUCN Red List as Threatened.

This policy decision would presumably result in an instantaneous reduction in fishing pressure on the most fecund members of these at-risk species, and would promote the recovery of their populations. In addition to adding to the IGFA's history of supporting marine conservation measures, this would only affect a small number of species targeted by trophy fishers: out of the 1222 species that the IGFA has issued an all-tackle world record for, only 6.95% are listed as Threatened by the IUCN Red List. However, certain exceptions to this policy could provide further nuance and lead to better environmental outcomes. For example, there are species which have a local population that is more or less threatened than the global population assessment would suggest. Common carp *Cyprinus carpio* are considered Vulnerable globally by the IUCN Red List, yet trophy fishing for this species in regions where they are highly invasive and abundant could be desirable. Indeed, in some regions there are derbies held to encourage harvest of carp. Revisiting the IGFA regulations to include a regional component would be a possible approach to identifying species or populations in the most need of additional local or regional scale protections, but a global IUCN Red List assessment would be a good starting point.

Minimizing trophy fishing pressure on Threatened species can be accomplished through an expansion of the role of the IGFA's

newly introduced length-based catch-and-release world records, or by the cessation of new IGFA records for Threatened species entirely. New technology including digital cameras and smartphones can provide opportunities for validating records without the need to retain or harvest Threatened species of fish. Similar approaches have yielded positive economic benefits for recreational fishing stakeholders. For example, bonefish *Albula vulpes* represent an economically thriving catch-and-release sport fishery in Florida and the Bahamas, and many economically successful shark fishing tournaments are moving to a catch-and-release only model. Few policy changes can accomplish so much for so many species of Threatened animals with so little cost. Though some recreational anglers have obstructed marine conservation policy-making [23], others are conservation-minded [5,24] and would likely be supportive of catch limits if framed in terms of Threatened species conservation.

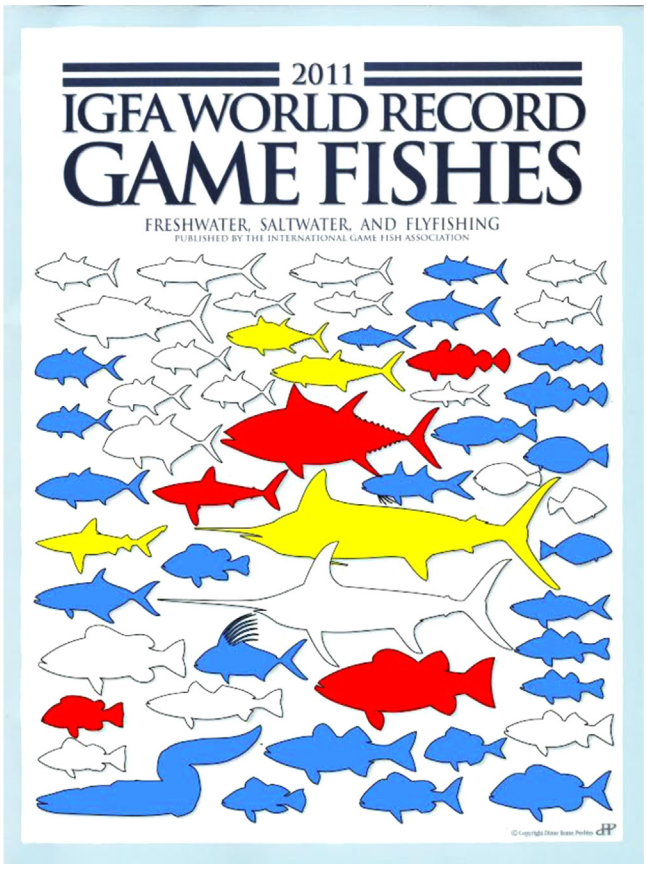

Fig. 1. The cover of the 2011 IGFA world record book with new coloration showing the IUCN Red List status of each species. Red=Threatened, Yellow=Near Threatened, Blue=Least Concern, and White=Not Evaluated. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

The population declines in many of these species can be largely attributed to commercial fishing rather than trophy fishing. 81 of 85 species identified by this study listed current or historical commercial fisheries in their IUCN Red List or FishBase database entry (Table 1). Threatened fishes such as elasmobranchs [25], tunas and billfishes [26] and groupers [27], for example, are all targeted by recreational trophy fishers but are also known to be commercially overfished. Additionally, Donaldson et al. [24] found that 92.1% of game fish are also targeted by commercial fisheries. However, the already-reduced populations may be further negatively affected by trophy fishing.

3.3. Conclusions

So long as there are incentives to catch the largest, oldest, most fecund and fittest individuals within a population, recreational fishing pressure will continue to target these fish and likely exacerbate population declines. However, as long as release mortality and sublethal effects are negligible, recreational fishing can generate numerous benefits for many species, as recreational anglers are a highly engaged group of stakeholders [24,12]. It is also possible to conduct formal assessments of the vulnerability of species to recreational trophy fisheries to determine which are sustainable and which are not (Cooke et al. 2014). In other words, science could guide the determination of which threatened species' recovery plans could accommodate recreational fisheries. Until this occurs, the risk-averse strategy would be to restrict recreational fishing for Threatened species where such studies have not yet been conducted. It is time for the IGFA to consider revising their policies with respect to Threatened species to be consistent with their mission of fish conservation and ethical angling.

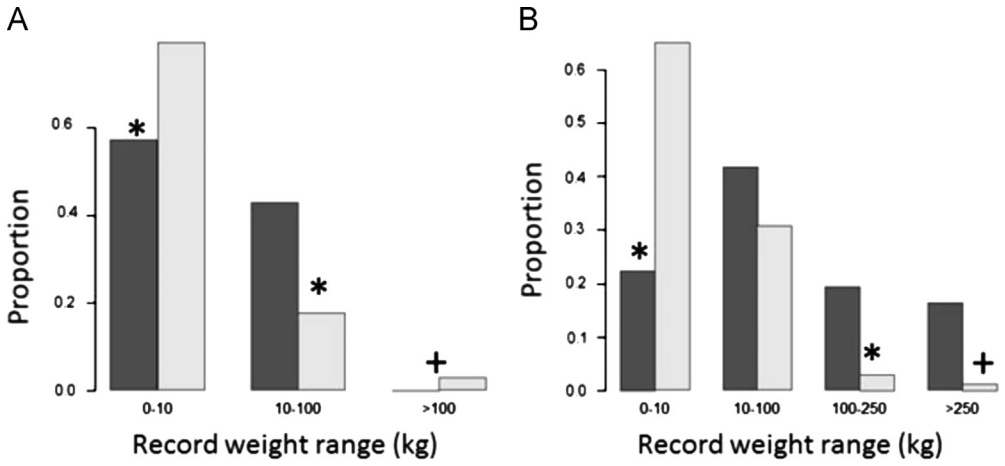

Fig. 2. (a): The proportion of record-setting weights with bins set as small (0–10 kg), medium (10–100 kg), large (> 100 kg), and very large (< 250 kg, marine fishes only) size classes in both freshwater and marine (b) fishes. Dark bars indicate Threatened species, while gray bars indicate Least Concern species. Size classes do not represent an official IGFA designation, but a convention developed in this analysis. *=significance at $P < 0.05$ level with a 2-tailed Z test of proportions. For both marine and freshwater fishes, Least Concern species make up a significantly higher percentage of the smallest size class, and Threatened species make up a significantly higher percentage of the largest size class.+ =insufficient sample size ($n > 5$) to run a test.

References

[1] Jackson JB, Kirby MX, Berger WH, Bjorndal KA, Botsford LW, Bourque BJ, et al. Historical overfishing and the recent collapse of coastal ecosystems. Science 2001;293(5530):629–37.

[2] McClenachan L. Documenting loss of large trophy fish from the Florida Keys with historical photographs. Conserv Biol 2009;23(3):636–43. http://dx.doi.org/10.1111/j.1523-1739.2008.01152.x.

[3] Schroeder DM, Love MS. Recreational fishing and marine fish populations in California. California Cooperative Oceanic Fisheries Investigations Report. 2002; 182–90.

[4] Coleman FC, Figueira WF, Ueland JS, Crowder LB. The impact of United States recreational fisheries on marine fish populations. Science 2004;305(5692): 1958–60. http://dx.doi.org/10.1126/science.1100397.

[5] Cooke S, Cowx IG. The role of recreational fishing in global fish crises. BioScience 2004;54(9):857–9.

[6] Lewin WC, Arlinghaus R, Mehner T. Documented and potential biological impacts of recreational fishing: Insights for management and conservation. Rev Fish Sci 2006;14(4):305–67. http://dx.doi.org/10.1080/10641260600886455.

[7] Service NMF.. Fisheries Economics of the United States 2009; 2010.

[8] Arlinghaus R, Cooke S, Lyman J, Policansky D, Schwab A, Suski C, et al. Understanding the complexity of catch-and-release in recreational fishing: an integrative synthesis of global knowledge from historical, ethical, social, and biological. Rev Fish Sci 2007;15(1–2):75–167.

[9] Coggins LG, Catalano MJ, Allen MS, Pine WE, Walters CJ. Effects of cryptic mortality and the hidden costs of using length limits in fishery management. Fish Fish 2007;8(3):196–210.

[10] Holland SM, Ditton RB. Fishing trip satisfaction: A typology of anglers. N Am J Fish Manage 1992;12(1):37–41.

[11] Fedler AJ, Ditton RB. Understanding angler motivations in fisheries management. Fish 1994;19(4):6–13.

[12] Cooke SJ, Hogan ZS, Butcher PA, Stokesbury MJW, Raghavan R, Gallagher AJ, Hammerschlag N, Danylchuk AJ. Angling for endangered fish: conservation problem or conservation action? Fish Fish 2014. http://dx.doi.org/10.1111/faf.12076.

[13] Arlinghaus R. Overcoming human obstacles to conservation of recreational fishery resources, with emphasis on central Europe. Environ Conserv 2006; 33(1):46–59.

[14] Birkeland C, Dayton PK. The importance in fishery management of leaving the big ones. Trends Ecol Evol 2005;20(7):356–8. http://dx.doi.org/10.1016/j.tree.2005.03.015.

[15] Palumbi SR. Fisheries science: why mothers matter. Nature 2004;430(7000): 621–2.

[16] Collins L A, Fitzhugh GR, Mourand L, Lombardi LA, Walling WT, Fable WA, et al. Preliminary results from a continuing study of spawning and fecundity in the red snapper (Lutjanidae: *Lutjanus campechanus*) from the Gulf of Mexico, 1998–1999. Proc Gulf Car Fish Inst 2001;52:34–47.

[17] Berkeley S, Chapman C, Sogard S. Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. Ecology 2004;85(5): 1258–64.

[18] Sutter DAH, Suski CD, Philipp DP, Klefoth T, Wahl DH, Kersten P, et al. Recreational fishing selectively captures individuals with the highest fitness potential. P Natl Acad Sci 2012;109(51):20960–5. http://dx.doi.org/10.1073/pnas.1212536109.

[19] Le Quesne WJF, Jennings S. Predicting species vulnerability with minimal data to support rapid risk assessment of fishing impacts on biodiversity. J Anim Ecol 2012;49(1):20–8. http://dx.doi.org/10.1111/j.1365-2664.2011.02087.x.

[20] Donaldson MR, Connor CMO, Thompson LA, Gingerich AJ, Danylchuk SE, Duplain RR, et al. Feature: contrasting global game fish and non-game fish species. Fisheries 2011;36(8):37–41.

[21] Wilde GR, Pope KL. Anglers' probabilities of catching record-size fish. N Am J Fish Manage 2004;24(3):1046–9. http://dx.doi.org/10.1577/M03-100.1.

[22] Baillie J, Hilton-Taylor C, Stuart SN. IUCN red list of threatened species: a global species assessment. Int Union Conserv Nat Oxf 2004.

[23] McClenachan L. Recreation and the 'right to fish' movement: anglers and ecological degradation in the Florida Keys. Environ Hist 2013;18(1):76–87.

[24] Granek EF, Madin EMP, Brown MA, Figueira W, Cameron DS, Hogan Z, et al. Engaging recreational fishers in management and conservation: global case studies. Conserv Biol 2008;22(5):1125–34.

[25] Dulvy NK, Fowler SL, Musick JA, Cavanaugh RD, Kyne PM, Harrison LR, et al. Extinction risk and conservation of the world's sharks and rays. eLife 2014;3: ee590.

[26] Collette BB, Carpenter KE, Polidoro BA, Juan-Jorda MJ, Boustany A, Die DJ, et al. High value and long life: double jeapordy for tunas and billfishes. Science 2011;333(6040):291–2.

[27] Sadovy de Mitcheson Y, Craig MT, Bertoncini AA, Carpenter KE, Cheung WWL, Choat JH, et al. Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. Fish Fish 2013;14(2):119–36.