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Angling into the Future: Ten Commandments for Recreational Fisheries Science, Management, and Stewardship in a Good Anthropocene

Laura K. Elmer[1] · Lisa A. Kelly[1] · Stephanie Rivest[2] · S. Clay Steell[1] · William M. Twardek[1] · Andy J. Danylchuk[3] · Robert Arlinghaus[4] · Joseph R. Bennett[5] · Steven J. Cooke[1]

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Abstract A new geological epoch, the "Anthropocene", has been defined as the period in which humans have had substantial geological and ecological influence on the planet. A positive future for this epoch can be referred to as the "good Anthropocene" and would involve effective management strategies and changes in human behavior that promote the sustainability and restoration of ecosystems. Recreational fisheries hold significant social, cultural, and economic value and can generate many benefits when managed sustainably and thus be an integral part of a "good Anthropocene". Here, we list ten commandments to facilitate persistence and long-term sustainability of recreational fisheries in the "good Anthropocene". This list includes fostering aquatic stewardship, promoting education, using appropriate capture gear, adopting evidence-based management approaches, promoting the concept of resilience, obtaining and using effort data in management, embracing the ecosystem approach, engaging in multilevel collaboration, enhancing accessibility, and embracing optimism. When used singly, or simultaneously, these ten commandments will contribute to the harmonization of sustainable fish populations and angling practices, to create recreational fisheries' "bright spots".

Keywords Recreational fishing · Anthropocene · Sustainability · Management · Commandments

Introduction

The impact of humankind on the world's natural environment has become so extreme that some scholars have defined a new geological epoch for contemporary times: the Anthropocene (Crutzen 2006). While this epoch is defined by widespread anthropogenic ecological and environmental alteration with accelerating biodiversity loss (Jackson 2008), a growing body of work considers what a positive future for this epoch may look like—in other words, a "good Anthropocene" (Hamilton 2015; Salonen and Konkka 2015; Kareiva and Fuller 2016). This concept has been considered in the context of aquatic resources and ecosystems (Dudgeon 2011; Glaser and Glaeser 2014); yet, to our knowledge there has been little direct consideration of how recreational fisheries science, management, and stewardship can contribute to a "good Anthropocene".

Recreational fisheries are defined as the fishing of aquatic animals that do not constitute an individual's dietary or economic subsistence base, and are not sold or traded on any type of market (FAO 2012). Approximately 10.5% of the global population in industrialized countries has been

✉ Laura K. Elmer
lauraelmer193@gmail.com

[1] Fish Ecology and Conservation Physiology Laboratory, Department of Biology and Institute of Environmental Science, Carleton University, Ottawa, ON, Canada

[2] Department of Biology, University of Ottawa, 75 Laurier Ave E, Ottawa, ON, Canada

[3] Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, MA, USA

[4] Department of Biology and Ecology of Fishes, Leibniz-Institute of Freshwater Ecology and Inland Fisheries & Division of Integrative Fisheries Management, Faculty of Life Sciences & Integrative Research Institute on Transformation of Human-Environment Systems, Humboldt-Universität zu Berlin, Berlin, Germany

[5] Institute of Environmental Science and Department of Biology, Carleton University, Ottawa, ON, Canada

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estimated to practice recreational fishing (Arlinghaus et al. 2015), encompassing a spectrum of people in different demographics, classes, and circumstances, fishing in both freshwater and marine systems. No estimates for participation in recreational fishing have been proposed for the developing world due to a lack of available data (Arlinghaus and Cooke 2009). While recreational fishers use a variety of gear types, including spears, nets, and traps, we focus on recreational angling (using hook, line, and rod) for the purpose of this paper because this gear type is most prevalent. Although recreational fishing is somewhat diffuse of an activity compared to the commercial fishing sector, estimates of global annual catch by recreational fishers may be as high as 47 billion fish, with two-thirds of those fish estimated to be released (Cooke and Cowx 2006). When practiced and managed sustainably, recreational fishing can generate many positive socioeconomic benefits (Arlinghaus and Cooke 2009; Tufts et al. 2015). Given its scope and significance to global populations, recreational fishing is likely to continue in the Anthropocene. This continuation must be coupled with perspectives and strategies that would benefit both aquatic ecosystems and human populations if recreational fishing is to persist in a good Anthropocene scenario.

There have been numerous and diverse strategies (voluntary and formal; see Cooke et al. 2013b) implemented to manage recreational fisheries, such as stocking programs (Molony et al. 2003), harvest regulations (Johnson and Martinez 1995), promotion of catch-and-release fishing (Cooke and Schramm 2007), gear restrictions (Cerda et al. 2010), protected areas (Danylchuk and Cooke 2011), and many others (reviewed in Cowx 2002; EIFAC 2008; FAO 2012; Cooke et al. 2016a). At the international level, several codes of good practice and technical guidelines for responsible recreational fisheries have been developed (EIFAC 2008, FAO 2012). All of these guidelines propose ways to manage recreational fisheries more sustainably. With effective, evidence-informed management decisions and an engaged angling community, fish populations targeted and exploited by anglers are able to prosper, and thus recreational angling can continue in a manner that does not irreversibly harm fish populations while producing benefits to people. Systems in which anglers and fish both benefit can be defined as "bright spots" (Bennett et al. 2016), which offer lessons on management and stewardship approaches that sustain such systems. There are counterexamples, however, of recreational fisheries causing population declines with significant negative effects on fisheries (e.g., Post et al. 2002), which can be thought of as "dark spots" (Table 1). Ultimately, bright and dark spots highlight the substantial influence that poor management, or an absence of management, can have on fish populations and people, motivating the need to invest in suitable management strategies, as well as the opportunity to learn from past mistakes in envisioning recreational fishing in the future.

Recreational fisheries are presently understudied and undervalued by many governments and management agencies, yet are increasingly recognized as important elements of coastal (Cisneros-Montemayor and Sumaila 2010, Mora et al 2009) and inland cultures and economies (Arlinghaus et al. 2016a). Some countries are currently experiencing increases in participation in recreational angling, such as those with emerging economies (Freire et al. 2012; Gupta et al. 2015); creating opportunities for ensuring the development and growth of these fisheries is sustainable (FAO 2012; Bower et al. 2014; Barnett et al. 2016). Recreational fishery bright spots show that, with the presence of suitable management strategies, recreational angling can be a part of a "good Anthropocene" and an activity that can persist in the future. Visioning future scenarios and setting goals can facilitate sustainable development during this precarious new epoch (Bennett et al. 2016).

We propose ten commandments that would facilitate the sustainable management of recreational fishing as an activity in a good Anthropocene (Fig. 1). These commandments include strategies, actions, and collaborations that may be utilized singly or in concert to sustainably manage recreational fisheries. Stewardship, education, and appropriate gear use for minimal harm are proposed first, as they focus on individual people making informed decisions for sustainable management. Evidence-based approaches to management, the promotion of resilience, obtaining and using effort data, and ecosystem approaches to management are proposed next, as they call on managers and policy makers to promote the function of aquatic ecosystems which benefits both anglers and fish. Finally, we propose multilevel collaboration, accessibility, and optimism as means of engaging all parties involved in recreational fisheries and fostering constructive discussions for the Anthropocene. Some of these commandments were elements of previous treatises on sustainable and responsible recreational fisheries (EIFAC 2008; FAO 2012; Arlinghaus et al. 2016a). We consider the ten issues presented here as a condensed and accessible list of what we regard as the most important and effective commandments for all stakeholders to help sustainably manage recreational fisheries in the Anthropocene.

Ten Commandments of Recreational Fisheries in a Good Anthropocene: Principles for the Individual

Fostering Stewardship

Aquatic stewardship is a normative framework of sustainable aquatic resource use, encompassing the practices and

Table 1 Examples of "dark spots" in recreational fisheries

Species targeted	Location	Description	References
Striped bass (*Morone saxatilis*), blue crab (*Callinectes sapidus*), smooth dogfish (*Mustelus eanis*)	Northwestern Atlantic coast	In areas targeted by recreational angling an increase in the number of herbivorous crabs has been observed. This has been explained by selective removal of the top predators in that ecosystem by recreational angling. An increase in these herbivorous species is leading to depletion of the salt-marsh habitat due to overconsumption of plant species	Altieri et al. (2012); Coverdale et al. (2013)
Goliath grouper (*Epinephelus itajara*)	Northwestern Atlantic coast	An intense recreational fishery with no harvest limits led to serious declines in population numbers of the goliath grouper, and the species was listed as "critically endangered" on the IUCN Red List of Threatened Species. The species has yet to recover, despite stricter fishing regulations and even total fishing moratoriums in the USA	NMFS (2006); Porch et al. (2006); McClenachan (2009)
Rockfish (*Sebastidae*)	Northeastern Pacific	Severe declines in rockfish population numbers have led to three species now being listed under the Endangered Species Act (canary; *Sebastes pinniger*, yelloweye; *Sebastes ruberrimus*, and bocaccio; *Sebastes paucispinis*). Recreational angling that targets these fish at great depths leaves the fish vulnerable to barotrauma. Often unable to descend back to suitable depths following release leaves these fish in poor condition and susceptible to predation. As a result, mortality following catch-and-release of these fish is considered to be high, thus leaving this endangered species at risk	Hannah and Matteson (2007); Hochhalter and Reed (2011)
Red snapper (*Lutjanus campechanus*)	Gulf of Mexico	Red snapper is a popular target for both recreational and commercial fisheries, which, when combined, have high total catch rates and have resultantly caused significant declines in population numbers. Effective management of this species is resulting in conflict with anglers, however, due to the ever-increasing restrictions on fishing seasons, and conflict between federal and state management policies	Hood et al. (2007)
Barred sand bass (*Paralabrax nebulifer*), kelp bass (*Paralabrax clathratus*)	Southern California, USA	One study found that recreational anglers have been targeting barred sand bass and kelp bass in spawning areas where these fish tend to aggregate. This not only targets spawning individuals, which can have negative impacts on population numbers, but also gives an illusion of high, stable population numbers, when in fact populations of these species have been significantly declining, a phenomenon known as "hyperstability"	Erisman et al. (2011)
Guadalupe bass (*Micropterus treculii*)	Central Texas	Stocking of non-native smallmouth bass in streams of central Texas for recreational purposes has had dramatic impacts on population declines of the native Guadalupe bass. A high incidence of hybridization between the two species has been reported, and hybrids are able to outcompete native Guadalupe bass. Supplemental stocking of Guadalupe bass began 10 years ago, yet declines in population are still being reported	Littrell et al. (2007)
European catfish (*Silurus glanis)*	Europe	The European catfish is a freshwater fish species endemic to certain freshwater systems of eastern Europe and western Asia. However, due to its potential to reach large sizes the trophy species has been illegally introduced to non-native river systems in western European countries such as Spain, France, and the UK for recreational angling purposes. As a piscivorous species, its introduction is a potential predation threat for native fish species, as well as brings a threat of exotic disease transmission and hybridization	Copp et al. (2009)
European pike (*Esox lucius* L.)	Germany	Current harvest management strategies for pike in Germany follow minimum size limit strategies such that culling of larger fish is allowed. However, it is well known that larger fish in a population are often the most fecund and robust; thus, selectively removing the larger fish may be damaging to a population. Studies have shown that pike populations in Germany could benefit from harvestable-slot length limits; however, ethical opposition of agencies, angler	Arlinghaus et al. (2010)

Table 1 continued

Species targeted	Location	Description	References
		associations and some anglers to the then mandatory release of large, trophy fishes has prevented	
Largemouth bass (*Micropterus salmoides*) and bluegill sunfish (*Lepomis macrochirus*)	Japan	Largemouth bass and bluegill sunfish, both popular targets for North American fishers, have been introduced to Japan for recreational angling purposes. These invasive species have had negative impacts, decreasing the numbers of native species in Japan, and also have been reported to drive trophic cascades as a result of bass predation on other species	Yonekura et al. (2004); Maezono and Miyashita (2003)
Lake trout (*Salvelinus namycush*)	Eastern Canada	Declines in numbers of lake trout, a popular trophy fish across Canada, have been managed via stocking programs. However, stocking has led to further declines in wild populations of lake trout because not only does it give the illusion of high population numbers and thus maintain high exploitation rates, but juveniles from the hatchery programs will also predate on the smaller wild juveniles	Post et al. (2002); Evans and Willox (1991)

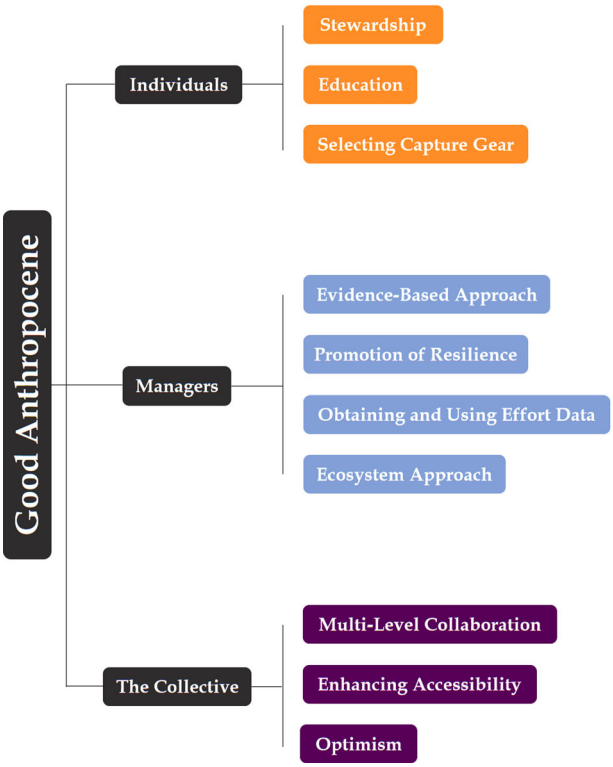

Fig. 1 Ten commandments that facilitate the sustainable management and use of recreational fisheries in the Anthropocene. These are grouped into three main categories: acting as a steward on an individual basis, promoting the continuation of aquatic ecosystem health, and, finally, facilitating the participation and cooperation of all interested parties to bring recreational fisheries into a new era of sustainability

ethical imperatives of both individual anglers and entire management regimes (FAO 2012). This framework is highly context-dependent and would look different from fishery to fishery in a good Anthropocene (e.g., varies with culture and local fishing right systems), but it would generally promote resilience, sustainability and equity through proactive and strongly adaptive policies, multiple objectives, and stakeholder involvement in management (Chapin et al. 2010; Arlinghaus et al. 2017). Diversity—whether at the biological, institutional, or stakeholder level—will be key to ensuring resilient and adaptable recreational fisheries in a future increasingly defined by irreducible uncertainties (FAO 2012; Schindler et al. 2015; Arlinghaus et al. 2016a, 2017). In terms of the behavior of each individual, aquatic stewardship proposes that individuals engaged in recreational fisheries can modulate their own mindset and behavior and become involved in active conservation efforts or work as "environmental actors", e.g., highlighting threats such as declining stocks and thus encouraging action and efforts to act against this (Granek et al. 2008; Tufts et al. 2015). As such, the angling community in a good Anthropocene volunteers to promote the sustainability of

recreational fish stocks, protect biodiversity, and champion social justice in the communities they affect, considering the complex political elements of recreational fisheries as social–ecological systems (Johnston et al. 2010; FAO 2012; Arlinghaus et al. 2016a).

Promoting Education and Social Learning

Education should be considered an integral part of bringing recreational fisheries into a good Anthropocene. Angler education and social learning within angler communities have been shown to improve compliance, reduce conflicts, and inspire stewardship by invoking voluntary changes in behavior (Cooke et al. 2013b). Mandatory training in best practices may be meritorious for first-time license holders, while more voluntary programs may be more suitable for experienced anglers by targeting their interests (Nguyen et al. 2013). A particularly effective way of learning is doing collaborative experiments with stakeholders and anglers, e.g., in the context of fish stocking to reduce ecological uncertainties through joint programs (Arlinghaus et al. 2016b, 2017; Fujitani et al. 2016). Education programs that target youth new to the fishing sector may be beneficial for forming good habits from the onset. Furthermore, programs that include actual fishing experiences and defined environmental education goals may be particularly useful for instilling a strong sense of stewardship towards fish and aquatic environments (Siemer and Knuth 2001; Danylchuk et al. 2011). Education and outreach programs in a good Anthropocene may be delivered in a variety of ways, including education materials found at local bait shops regarding aquatic invasive species from bait introductions (Nathan et al. 2014), outreach material from angling-based non-government organizations (Sims and Danylchuk 2017), and angling ecotourism, where guides provide education to anglers about local species, angling ethics, and conservation issues (Zwirn et al. 2005). Social media provides a cure and a problem; the cure is that communication about ecological sustainability can be exchanged in all social networks. The problem is that invalidated claims can similarly easily spread and affect well-intentioned education programs.

Selecting Appropriate Capture Gear

At the level of each participant, recreational fishing equipment can have an important role in determining the harm imposed on a fish, e.g., in the context of catch-and-release fishing (Cooke and Sneddon 2007). Here there is the greatest scope for simple changes in behavior having large impacts on fish well-being and fish stocks. Numerous studies have highlighted the importance of proper hook selection (Meka 2004; Rapp et al. 2008; French et al. 2015), gear strength (Cooke et al. 2016b), and landing method (Butcher et al. 2008; Colotelo and Cooke 2011) for reducing the impact on captured fish. In a good Anthropocene scenario, industry would focus on the development of innovative equipment and techniques that are "fish-and environment-friendly" and minimize the adverse effects on angled fish or the environment. The manufacturing sector would be held more accountable to conduct rigorous testing of fishing gear as part of the research and development process, rather than retroactively evaluating equipment following its widespread distribution and use by recreational anglers, as is currently done. Advancements in "fish-friendly" fishing gear exist, including the circle hook, knotless rubber nets, and dehooking devices (Colotelo and Cooke 2011; Serafy et al. 2012). As innovative "fish-friendly" gear is developed, it would become the joint role of the fishing trade and management agencies to promote its value and to implement its voluntary (and potentially mandatory) use in recreational fisheries (Danylchuk et al. 2017). The reef fish recreational fishery in the Gulf of Mexico is a bright spot example of these "fish-friendly" technologies being implemented in a regulatory context. Since 2008, dehooking devices and non-stainless-steel circle hooks when using natural bait are required when fishing for reef fish in federally managed waters of the Gulf of Mexico (NMFS 2008).

Principles for Managers

Adapting Evidence-Based Management Approaches

Evidence-based management practices offer numerous advantages over laissez-faire approaches, and should be widely applied in recreational fisheries in a good Anthropocene (Sutherland et al. 2004) through activities such as systematic reviews (see Cooke et al. 2017, for aquatic examples). Providing evidence that supports management decisions will help prevent ineffective strategies from being implemented or maintained (Pullin and Knight 2003) and can also help minimize conflicts among stakeholders. Underlying evidence-based approaches should be large-scale adaptive management experiments (Arlinghaus et al. 2017). Adaptive management approaches are beneficial to fisheries management, particularly in the face of climate change and ever-changing environmental conditions (Gardner 2013). Currently, adaptive management strategies are infrequently implemented by managers (Walters 2007; Allen and Gunderson 2011), despite the fact that their adoption could offer substantial long-term benefits and facilitate the development of more effective practices that benefit fisheries and aquatic ecosystems (King et al. 2010; FAO 2012; Hansen et al. 2015).

Promoting the Concept of Resilience

Resilience is defined as the amount of disturbance a system can absorb (while reorganizing) before moving into a functionally different state. In a good Anthropocene, recreational fisheries would be managed to promote resilience to unexpected environmental change (FAO 2012; Pope et al. 2014; Arlinghaus et al. 2017). Managing towards resilience includes accepting variability for the benefit of long-term persistence (Carpenter et al. 2015). Similarly, participatory management approaches and the conservation of biological and cultural diversity as well as accounting for connectivity among "environmental actors" and resource flows help achieve and manage resilience (Holling and Meffe 1996; Schindler et al. 2015). Other resilience principles, e.g., accounting for feedbacks and cross-scale interactions, have recently been defined for recreational fisheries (Biggs et al. 2012; Pope et al. 2014). The goliath grouper (*Epinephelus itajara*) fishery on the east coast of the United States is an example of a "dark spot", where management did not promote resilience (Table 1). Prior to 1985 there were no harvest regulations in place for the species, causing a rapid decline in population. A harvest moratorium in 1990 (NMFS 2006; Porch et al. 2006) has yet to fully recover the species (McClenachan 2009). Managing to promote resilience in recreational fisheries based on data-poor methods would also be valuable in countries with growing recreational fishing sectors that have yet to implement regional or species-specific angling regulations (Gupta et al. 2015).

Obtaining and Using Effort Data in Management

Although it is clear that resource limitations impact the ability to obtain complete monitoring information (Post et al. 2002), some basic information is necessary for sustainable management (Hansen et al. 2015). In particular, uncontrolled fishing effort is a threat to open-access recreational fisheries that is often underappreciated or ignored by managers (Walters and Cox 1999; Cox et al. 2002). Although recreational fishers are often regarded as less efficient than commercial fishers (Walters and Cox 1999), the amount of harvest from sport fisheries is not negligible. In this context, more resources should be devoted to assessing data on effort, rather than catch alone. Effort data serve three purposes—first, they allow the attraction of a given site to be revealed (the better the fishing, the higher the use). Moreover, one can understand the likely fishing mortality (the higher the effort, the higher the fishing mortality is bound to be). Finally, estimates of catch per unit effort data are trend indicators for abundance changes over time, assuming that one can control for effort sorting mechanisms (van Poorten et al. 2016). Effort data could be collected through mandatory reporting, or through voluntary means such as smartphone applications that allow anglers to record the details of their daily activities (Venturelli et al. 2016). Once data are collected, efficient controls could be put in place to avoid the overexploitation of recreational fisheries (Johnston et al. 2015).

Traditional management controls are often placed on the individual angler and might include season, size, and bag limits (Walters and Cox 1999). However, this may not be successful in restricting the overexploitation of recreational fisheries as it does not consider angler effort. An example of an effort control is a limited-entry program. Although rarely used, limited-entry programs could restrict the number of anglers allowed into a given system in a given season, effectively controlling angler effort (Cox et al. 2002).

Embracing the Ecosystem Approach

Managing recreational fisheries using a single-species approach may not be beneficial if stocks are impacted by external factors such as habitat degradation, nutrient loading, and water pollution (Cooke et al. 2013a). It will be necessary in a good Anthropocene to embrace an ecosystem approach when it comes to fisheries management, as healthy ecosystems may provide improved resilience to fish populations. One tool that is often advocated is protected areas, although there is ample debate about whether protected areas are needed for sustainable fisheries (Hilborn 2016). A risk with protected areas is that fishing effort may become concentrated elsewhere, with the potential to reduce fish populations more dramatically outside a protected area resulting in a poorer fishing experience for anglers (Danylchuk and Cooke 2011; McPhee 2011). Furthermore, recreational inland fisheries compete with many other sectors that utilize water resources, such as hydropower, agriculture, and industrial processes (Welcomme et al. 2010). Even if a protected area is established, if there is still external pollution occurring upstream, protected fish populations will continue to be exposed to threats. Embracing an ecosystem approach to fisheries management may include improving water quality from agricultural drainage basins or planting native vegetation along lake- and riverbanks for soil stabilization. It is important to understand the spectrum of ecosystem services that are available in a given region and understand how they contribute to local fisheries so that they may be managed appropriately (Beard et al. 2011).

Principles for the Collective

Engaging in Multilevel Collaboration

One of the key principles of resilience is poly-centric governance (Biggs et al. 2012). This principle states that issues have to be addressed at the appropriate scales, with local issues being solved locally and regional or national issues regionally or nationally. To put this principle into practice demands multilevel collaboration, wherein stewardship is occurring at all scales from local to global. Such collaboration actively engages all participants in cooperative communication. Important participants may include local community members and anglers (Arlinghaus 2006; Granek et al. 2008), non-governmental organizations, government managers, scientists (Cowx et al. 2010), and international organizations (FAO 2012). Effective management would therefore become "adaptive co-management" among all interested parties, rather than a single steward making individualistic choices. Given multiple stakeholders and multiple objectives, a balance must always be reached in terms of management actions and strategies, interfacing the recreational fisheries sectors and other sectors that affect aquatic ecosystems (Cowx et al. 2010; Danylchuk and Cooke 2011). Only when constructive, respectful, and positive communication between all stakeholders is widely practiced would such compromises occur.

Enhancing Accessibility

In most recreational fisheries today, a minority of anglers catch a majority of angled fish (Baccante 1995; Dorow et al. 2010). Moreover, the interests of vocal minorites (e.g., in public hearings) with their very particular preferences (Johnston et al. 2010; Beardmore et al. 2011) often bias management planning and implementation, disenfranchizing some anglers groups and creating equity issues. Recreational fishing can spur interest and engagement with nature that can lead to stewardship activity, and can confer other benefits such as improved food security or local economic growth (Granek et al. 2008; Cooke et al. 2014), and it is thus important that access remains for all and that the preferences of all are considered in decision-making. Management frameworks in a good Anthropocene would aim for inclusivity, using objectives like optimum social yield to determine the most sustainable fishing regulations that benefit the most people (Johnston et al. 2010). Equitizing access to recreational fisheries in developing countries may also facilitate their sustainable development and popularize aquatic stewardship, as the ability to angle tends to fall on the lines of economic inequality that exclude large populations (Bower et al. 2014). Aligning such socially equitable access with ecologically defined limits would be necessary to ensure fisheries sustainability. This could require controlling effort or limiting access to some areas (Cox et al. 2002; Danylchuk and Cooke 2011).

Embracing Optimism

The future of recreational fisheries would be viewed with optimism in a good Anthropocene. Conservationists face substantial hurdles such as climate change, habitat destruction, and an ever-increasing human population putting excessive pressure on fish stocks, and are often portrayed dramatically and negatively in the popular media (Beever 2000). Recreational fisheries bright spots (e.g., Case Studies 1 and 2) demonstrate that effective management techniques can successfully sustain recreational fisheries, and that fisheries are not necessarily doomed. A positive world view and an emphasis on success is more likely to inspire the public to become involved in conservation, so optimistic education and outreach programs would be particularly important. Promoting conservation success stories in the media or through focused conference sessions would also help to engage more people in caring for sustainable recreational fisheries. This optimism would be tempered with a sense of urgency that reflects the ecological losses at stake so that a false sense of unconcern is not conveyed (Noss 1995). Conservationists and managers would strive for objectives that are achievable, and focus on projects with a greater likelihood of success when funding or resources are limited. In this context, nature conservation must not marginalize and actively resent the interests of the recreational fisheries, as is common in the management of nature conservation areas in some countries (e.g., Germany) where access to angling is often prohibited or constrained without objective justification (Arlinghaus 2006). This creates a defensive attitude among recreational fisheries managers and anglers, which is counterproductive for successful cooperation.

Bright Spot Case Study 1: Muskellunge in Midwestern North America

The muskellunge fishing industry was once dominated by commercial and catch-and-kill fisheries. Overexploitation and habitat destruction contributed to historic declines in muskellunge abundance (Kerr 2011). This encouraged the development of management practices to restore muskellunge populations and establish a sustainable fishery. Several factors have enabled this fishery to successfully manage a sustainable recreational fishery: collaboration with stakeholders and fostering stewardship, promoting education, evidence-based management strategies and engaging in multi-level collaboration (Midwood et al.

2015). Of particular note is that muskellunge fisheries are primarily targeted by highly specialized anglers often associated with clubs (e.g., Muskies Inc, Muskies Canada) and muskellunge release rates approach 99% in most regions. A hallmark of successes in muskellunge management has been fora (e.g., International Musky Research Symposium) where researchers, managers, and stakeholders work collaboratively for common goals (e.g., Diana and Margenau 2007; Midwood et al. 2015). Anglers have participated in data collection, including angler diary programs (Kerr 2007) and providing aging structures such as cleithera when dead fish are encountered (Casselman and Crossman 1986). Anglers also volunteer in habitat and stock restoration efforts, and provide valuable funding support through donations, e.g., the "Adopt a Muskie" program of Muskies Canada for the Lake Simcoe Muskie Restoration Project. New regulations, including modifications to angling seasons, fishing quotas, and experimentally determined minimum size limits, have been used along with educational programs informing inexperienced anglers on best handling practices for muskellunge (Midwood et al. 2015).

Bright Spot Case Study 2: Australian Marine Protected Areas and Recreational Fishing

The Great Barrier Reef Marine Park (GBRMP) in Australia is an excellent example of a large-scale marine park that promotes both the conservation of important habitats and species, as well as allowing for human activities through the use of a multiple-use spatial zoning approach (Day 2002). Specific no-take or Green zones protect sensitive areas and prohibit the use of fishing gear (recreational and commercial). Human activities are still permitted in other regions of the GBRMP; for example, Blue zones have been designated for recreational fishing and certain other extractive activities (Day 2002). The rezoning of the GBRMP in 2004 resulted in an increase in the percentage of no-take areas from 4.5 to 33% (Fernandes et al. 2005) and involved extensive stakeholder consultation and participation in the planning process through public meetings and written submissions provided by Great Barrier Reef Marine Park (GBRMP) Authority (Sutton and Tobin 2009). A study completed 3 years post implementation of the revised zoning plan revealed that the majority of surveyed recreational fishers supported the rezoning of the GBRMP for increased protection, and believed this would increase fisheries through a more sustainably managed park (Sutton and Tobin 2009). It was also found that recreational fishers were more likely to support the rezoning plan if it aligned with their own perceptions about the need and value of increased protection, a strong indicator of the value of education and engagement of recreational fisheries stakeholders in the decision-making process (Sutton and Tobin 2009). However, this was still a contentious issue and negative opinions from dissatisfied fishers garnered attention with the media from the onset (Sutton and Tobin 2009), highlighting the fact that while marine reserves are beneficial to protecting diversity and habitats, there are still trade-offs that occur (Danylchuk and Cooke 2011). The most obvious of these is a substantial loss of fishing access to recreational fishers and, consequently, concentrated effort in the surrounding fished areas (McPhee 2011). However, marine reserves can provide refuge to targeted fish species and result in a spillover effect of adults and juveniles into adjacent fished areas, as well as protect important nursery grounds that aid in re-stocking fishing grounds (McPhee 2011). Studies on the spillover effect of adults and larvae have provided somewhat mixed results. However, a study on inshore reefs of two species of reef fish (*Plectropomus* spp. and *Lutjanus carponotatus*) targeted by hook-and-line fishing in the Great Barrier Reef demonstrated that increased stock biomass of both species occurred in no-take marine reserves compared with surrounding fished areas (Evans and Russ 2004). The long-term benefits that marine reserves could have on the surrounding fished areas may provide an enhanced experience for recreational fishers, and may be a positive trade-off with the initial loss of fishing access (McPhee 2011).

Conclusion

Existing frameworks of management for recreational fisheries already recognize many of the ideals represented above (e.g., FAO 2012), yet most recreational fisheries governance systems have not implemented these management measures. Governments have undervalued the significance of recreational fisheries, a trend that must be reversed to prevent recreational fishery degradation and to ensure fisheries develop sustainably (Arlinghaus et al. 2016a; Barnett et al. 2016). Angler demographics, ecosystem threats, and fishery types all stand to change in the Anthropocene, and the maintenance of recreational fisheries will depend on their ability to adapt to these changes. The dark spots we identified (Table 1) tend to focus on issues that are rather singular but are presumably symptomatic of broader problems. Conversely, the bright spots (Case Studies 1 and 2) seem to be uniformly positive, with evidence of "success" related to most if not all of the commandments presented here. To achieve a good Anthropocene, anglers and managers alike must recognize aspects of the status quo that are failing today and boldly envision pragmatic steps to a brighter future (Bennett et al. 2016). By doing so quickly, recreational fisheries may be maintained and strengthened in an era otherwise defined by alteration or loss of natural systems.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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