Reviews in Fisheries Science & Aquaculture
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/brfs21

Status of Recreational Fisheries in India: Development, Issues, and Opportunities

Nishikant Gupta[a], Shannon D. Bower[b], Rajeev Raghavan[cde], Andy J. Danylchuk[f] & Steven J. Cooke[b]

[a] Department of Geography, King's College London, Strand, London, UK

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

[c] Conservation Research Group, Department of Fisheries and Aquaculture, St. Albert's College, Kochi, Kerala, India

[d] Laboratory of Systematics, Ecology and Conservation, Zoo Outreach Organization, Coimbatore, India

[e] Mahseer Trust, The Freshwater Biological Association, East Stoke River Laboratory, Wareham, Dorset, UK

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

Published online: 14 Jul 2015.

To cite this article: Nishikant Gupta, Shannon D. Bower, Rajeev Raghavan, Andy J. Danylchuk & Steven J. Cooke (2015) Status of Recreational Fisheries in India: Development, Issues, and Opportunities, Reviews in Fisheries Science & Aquaculture, 23:3, 291-301, DOI: 10.1080/23308249.2015.1052366

To link to this article: http://dx.doi.org/10.1080/23308249.2015.1052366

Reviews in Fisheries Science & Aquaculture, 23:291–301, 2015

ISSN: 2330-8249 print / 2330-8257 online
DOI: 10.1080/23308249.2015.1052366

Status of Recreational Fisheries in India: Development, Issues, and Opportunities

NISHIKANT GUPTA,[1] SHANNON D. BOWER,[2] RAJEEV RAGHAVAN,[3,4,5] ANDY J. DANYLCHUK,[6] and STEVEN J. COOKE[2]

[1]Department of Geography, King's College London, Strand, London, UK
[2]Fish Ecology and Conservation Physiology Laboratory, Department of Biology and Institute of Environmental Science, Carleton University, Ottawa, Canada
[3]Conservation Research Group, Department of Fisheries and Aquaculture, St. Albert's College, Kochi, Kerala, India
[4]Laboratory of Systematics, Ecology and Conservation, Zoo Outreach Organization, Coimbatore, India
[5]Mahseer Trust, The Freshwater Biological Association, East Stoke River Laboratory, Wareham, Dorset, UK
[6]Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, MA, USA

Recreational fishing is an established activity in developed countries across the world. Many emerging economies have well-established recreational fisheries; however, in countries such as India there has been little discourse on what is needed to support this activity's sustainable development. Here, we review the history of recreational fishing and the current status of recreational fisheries in India. The lack of scientific knowledge on the basic biology of sport fish species, targeting of threatened species, and the absence of region- or species-specific angling regulations for recreational fisheries are identified as some of the challenges associated with this sector in India. Moreover, governance structures are disorganized, with multiple agencies assuming some responsibility for recreational fishing but none tasked explicitly with its sustainable development and management. With improved legislative support and a clear policy framework, developing a responsible and sustainable recreational fisheries industry in India is possible.

KEYWORDS angling, conservation, catch-and-release, stakeholders, freshwater

INTRODUCTION

Recreational fishing can be defined as fishing of aquatic animals (mainly fish) that do not constitute the individual's primary resource to meet basic nutritional needs and are not generally sold or otherwise traded on export, domestic, or black markets (Food and Agriculture Organization [FAO], 2012). Although this activity has a high participation rate in developed countries (average of ~10%; Arlinghaus and Cooke, 2009; Arlinghaus et al., 2014), the status of recreational fisheries in developing countries are poorly understood (Bower et al., 2014). There are both social and economic benefits associated with recreational angling worldwide (Arlinghaus and Cooke, 2009), and these benefits may be substantial in developing countries (Everard and Kataria, 2011; Pinder and Raghavan, 2013). However, one of the emerging issues for recreational fishing in developing economies is that despite the presence of multiple grass-roots angling organizations and participants, very little is known regarding the issues and opportunities associated with this activity (Bower et al., 2014). Furthermore, national surveys focusing on recreational anglers as important stakeholder groups are unavailable in most developing countries unlike other jurisdictions like Canada (Brownscombe et al., 2014) and Australia (Henry and Lyle, 2003), where such surveys are common and have been conducted across several decades. In the last few years there has been some interest in implementing such surveys in emerging economies such as Brazil (Freire et al., 2012), yet such data sources are still relatively rare (but see Gupta et al., 2015).

India represents one of the most prominent emerging economies with a population of over 1.2 billion and an annual

Address correspondence to Nishikant Gupta, Department of Geography, King's College London, Strand, London WC2R 2LS, United Kingdom. E-mail: nishikantgupta@live.in

GDP growth of 5% (2009–2013). India has many large watersheds as well as >7,000 km of coastline. Recreational angling in India dates back to the British Empire when many opportunities were present for anglers worldwide to travel to rivers in pursuit of fish species renowned for their fighting skills (Everard and Kataria, 2011). Over the last decade, the recreational angling industry has expanded (as measured by the increasing number of rods per season), and attracted large numbers of international anglers to the region. Yet, most of what is known about recreational fishing in India is anecdotal, and has never been synthesized in a single document.

Globally, recreational fishing has generated substantial income for regional and national economies (Cooke and Cowx, 2004; Cowx et al., 2010; Danylchuk and Cooke, 2011; Everard and Kataria, 2011), but has also been implicated in negative effects on biodiversity and ecosystems (Cooke and Cowx, 2006; Lewin et al., 2006). Further, while collaboration between recreational fishers and local stakeholders has led to a number of conservation successes, including for initiatives targeting threatened and endangered species (Arlinghaus et al., 2002; Fernandes et al., 2005; Arlinghaus, 2006; Granek et al., 2008; Pereira et al., 2008; Cowx et al., 2010), impacts resulting from recreational fisheries are species-specific and successful outcomes require research and management investments. Unfortunately, a divide between policy makers and anglers in countries such as India has hindered such investments (Pinder and Raghavan, 2013) and underscores the importance of better understanding the sector to inform its responsible development.

By combining a review of the literature, with informal stakeholder interactions (local and international anglers, tour operators, angling guides, local communities, Forest Department staff), we aim to review the history of recreational fishing and the current status of catch-and-release (C&R) recreational fisheries in India, and identify issues and opportunities necessary for its sustainable development. We expect this synthesis to be useful for other emerging economies and developing countries where recreational fisheries development is expected or underway. Although we attempt to provide equal coverage to freshwater and marine fisheries, most recreational fisheries effort in India appears to be focused on inland waters, with accessibility to suitable angling sites being a possible contributing factor.

Development of Recreational Fisheries in India

Safeguarding freshwater bodies has been a priority in India since ancient times. During the reign of King Asoka (269–232 BC), fishing was prevented during July and November because fish breeding occurred during these months. King Sōmēśvara's (1127 AD) chapter on angling (Matsyavinōda) in his treatise Mānasōllosā is probably the earliest known writing from India on recreational fisheries (Hora, 1951). The Indian Fisheries Act was enacted in 1897, primarily to regulate destructive fishing methods.

Mahseer (*Tor* spp) were first described in the Ganges in the early 19th century (Hamilton, 1822) and attained popularity as an angling species through the efforts of the Oriental Sporting Magazine (see Nautiyal, 2014). The earliest publications related to angling in British India were written by H. S. Thomas and came out in 1873 (*Tank Angling in India*), and 1897 (*The Rod in India*). The legendary British hunter and tracker-turned-conservationist Edward James "Jim" Corbett (1875–1955) often spoke of the mahseer in many of his works dealing with tigers and leopards of India. Commercial tackle advertisements from 1897 and 1903 also mentioned mahseer (Figure 1). The introduction of brown trout (*Salmo trutta*) in the 1860s and rainbow trout (*Oncorhynchus mykiss*) in 1909 by British anglers in streams and rivers of the Himalayas and Western Ghats served to further the popularity of this leisure activity (Sehgal, 1999a,b).

Although recreational angling struggled to maintain its popularity after India's independence, interests of both foreign and Indian anglers began to focus on Indian freshwater systems and its fish species in the 1970s. Established and emerging angling organizations across the country invested both time and money to build on the earlier foundations of sport fishing.

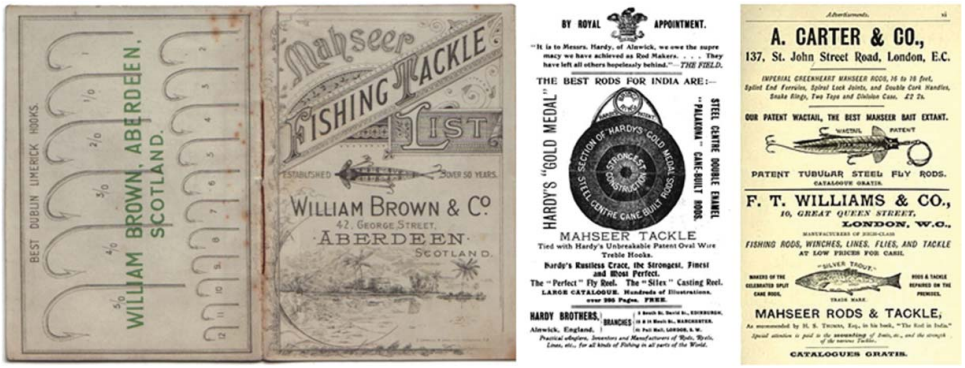

Figure 1. Commercial tackle advertisements from 1897 and 1903 mentioning mahseer.

In 1976, a 22 km stretch of the Cauvery River in Karnataka was leased by the Wildlife Association of South India (WASI) to protect the mahseer (*Tor* sp.) from anthropogenic threats. Along with the stocking of mahseer fingerlings, C&R angling using rod and line was permitted for both domestic and international anglers. Fishing records were maintained, and management ensured that anglers adhered to local guidelines (Sehgal, 1999b). In 1978, the Indian Tourism Development Corporation (ITDC) in collaboration with Air India and WASI, organized an event with the Trans World Fishing Expedition (TWFE) and Boote Mission to obtain vital information regarding the mahseer (Sehgal, 1999b). Further, the National Commission on Agriculture recommended a comprehensive survey of mahseers in the Indian water bodies.

Influenced by the successful activities of WASI, the Karnataka state government-owned Jungle Lodges and Resorts (JLR) set up three angling camps in the 1980s and 1990s on the Cauvery (at Doddamakali, Galibore, and Bheemeshwari), followed by a private fishing camp at Bush-Betta along the same river. Similar to WASI, these efforts ensured both protection for the mahseer species and livelihood benefits for local communities (see Jung, 2012; Pinder and Raghavan, 2013). Further, a UK-based angling organization, Angling Direct Holidays (ADH), collaborated with JLR to bring in clients between January and March each year (Pinder and Raghavan, 2013). In 1993, the Coorg Wildlife Society (CWS) began protecting mahseer on a 28 km stretch of the Cauvery River following the same approach as WASI (Sehgal, 1999b), and increased to 92 km in 2006 (Dinesh et al., 2010).

In addition to local-scale fisheries management efforts, stocking was also employed as a conservation measure for mahseer. The Tata Electric Companies (TEC) fish seed farm in Lonavala in Maharashtra supplied more than a million mahseer fingerlings to several state fisheries departments and angling associations during the 1980s and 1990s (Ogale, 2002). The Fish Farmers Development Agency (FFDA) in Mysore was involved in releasing some of these fingerlings into the Cauvery (Sehgal, 1999b). In 1987, the Department of Fisheries, Karnataka, set up a mahseer hatchery to produce fingerlings for stocking rivers and reservoirs in the Western Ghats, and a similar hatchery was started by the Karnataka Power Corporation Limited (Sehgal, 1999b).

Fisheries management efforts were not limited to the state of Karnataka or to mahseer. In 2004, a group of local stakeholders from the Mahseer Conservancy secured a lease from the Forest Department for a 24 km stretch of the Ramganga River encompassed within the boundaries of Corbett National Park in the State of Uttarakhand (Mahseer Conservancy, 2014). The objectives of the Conservancy were to promote the conservation of the golden mahseer, *Tor putitora*; attract recreational anglers to the region; utilize the revenue generated from recreational angling to fund conservation projects; and provide social and economic benefits to local communities (Gupta et al., in press). Further, Jeremy Wade, a world renowned recreational angler, helped promote the mahseer and the goonch catfish (*Bagarius bagarius*) as important angling species through his television series "Jungle Hooks India" and "River Monsters." In northern India, special bylaws of the Indian Fisheries Act permitted the brown and the rainbow trout to be caught in the Himalayan region on rod and line using artificial and live baits, with the fishing season, bag limit, and prescribed baits regulated (Sehgal, 1999a).

Recent Developments in Indian Recreational Fisheries

In April 2009, a legal notice was issued under Section 55 of the Indian Wildlife Protection Act (WPA) to the Karnataka Forest Department questioning the temporary construction of the privately owned Bush Betta fishing camp within the Cauvery Wildlife Sanctuary (see Pinder and Raghavan, 2013). This resulted in the issue of a legal notice to the Central Empowerment Committee (CEC) of the Supreme Court, drawing attention to the potential violation of the WPA by permitting angling within the boundaries of the Cauvery Wildlife Sanctuary. Subsequently, the Union Ministry of Environment and Forest (MoEF) intervened, and angling was banned within the Cauvery Wildlife Sanctuary. In July 2012, recreational angling was halted in all protected areas (PAs) of the country by the direction of the Supreme Court of India (Ajay Dubey vs. National Tiger Conservation Authority (NTCA): special leave petition no(s).21339/2011). Today, recreational angling in India is permitted only on river reaches outside PAs, and this is where the majority of foreign and Indian recreational anglers now concentrate their efforts. Dominant species targeted by recreational anglers in India include *Tor* sp (previously known as Tor mussullah or the hump-backed mahseer; see Pinder et al., 2015), *T. putitora* (golden mahseer), *T. khudree* (Deccan mahseer), *Neolissochilus hexagonolepis* (copper or chocolate mahseer), and *Gibelion catla* (Indian major carp/catla; also see Table 2). Occasionally caught other Indian native fish species include *Channa diplogramma* (giant snakehead), *C. marulius* (bullseye snakehead), *C. punctata* (spotted snakehead), *C. striata* (snakehead murrel), *Wallago attu* (wallago), *Hemibagrus maydelli* (Krishna red tail Catfish), *Bagarius bagarius* (goonch), *Labeo rohita* (rohu), *Cirrhinus cirrhosus* (mrigal), *Hypophthalmichthys molitrix* (silver carp), *Cyprinus carpio* (common carp), *Ctenopharyngodon idella* (grass carp), and *Hypophthalmichthys nobilis* (big head carp).

Although the number of international anglers visiting the Indian freshwater systems greatly decreased since the angling ban, the number of Indian anglers is reportedly on the rise (N. Gupta, personal communication with angling guides on the Ramganga River) and may be contributing to increases in angling-related expenditures. For example, Indian tackle companies report significant growth in sales and international companies have shown a keen interest in venturing into the Indian tackle market (N. Gupta, personal communication with tackle companies).

In northern India, angling is regulated mainly by the state forest departments who give out rod licenses on a daily basis, while those in the north eastern states are regulated by state fisheries departments (Derek D'Souza, All India Game Fishing Association/AIGFA personal communication; also see Everard and Kataria, 2011 for a detailed description). However, in the north-eastern states, no regulations are in place including controls on the number of rods. In marine waters, vessels obtain licenses from the respective State Fisheries Department (Derek D'Souza, AIGFA personal communication).

Over the past few years, recreational fisheries in marine waters has also emerged as a highly popular leisure activity and many angling associations (see Table 1) have helped attract domestic anglers to the Indian ocean and the Bay of Bengal, especially in the seas around the Andaman Islands. Approximately 90–120 boats (carrying capacity of five to six persons) operate per month in the marine waters during an angling season, which typically extends from October to April depending upon the arrival of monsoon (N. Gupta, S. Panwar, personal communication). Marine species targeted by Indian anglers include *Caranx ignobilis* (giant trevally), *Cynoglossus macrostomus* (tounge sole), *Gymnosarda unicolor* (dogtooth tuna), *Lates calcarifer* (Asian seabass), *Sphyraena* sp. (barracuda), *Rachycentron canadum* (cobia), and *Thunnus obesus* (bigeye tuna; see Table 2).

ISSUES FACING THE PRESENT RECREATIONAL ANGLING SECTOR IN INDIA

Despite the potential benefits that can be harnessed from recreational fisheries in India, there are various issues that need urgent attention as they could be constraining the sustainable development of this sector here. We present a list of the key issues identified from informal interactions with fisheries managers and anglers is India and our broader understanding of issues that have been experienced in other jurisdictions.

Lack of Information on Basic Biology and Taxonomy of Game Fish

In India, freshwater fish are poorly studied, with little or no information available on the biology, ecology, and population status of the vast majority of species (Dahanukar et al., 2011), including those targeted in recreational fisheries. There are significant knowledge gaps in our understanding of taxonomy and natural history for even charismatic and popular species, such as the mahseer, which have been documented since the 12th century. Uncertainties also exist surrounding the actual number of mahseer species found in India and their exact distribution (Pinder and Raghavan, 2013). The most popular mahseer

Table 1. Angling-based organizations in India

Organization	Approximate membership size	Target fish	Region
All India Game Fishing Association/AIGFA	2200	All	India
Wildlife Association of South India/WASI	350	Mahseer	Karnataka
Coorg Wildlife Society/CWS	1000	Mahseer	Kodagu, Karnataka
Maharashtra State Angling Association/MSSA	600	Carp[a]	Maharashtra
Anglers Association, Futala Lake	5000	Carp[a]	Nagpur, Maharashtra
Chennai Anglers Association	1200	Marine fish	Tamil Nadu
Cochin Anglers	200	Marine fish	Kerala
Jamshedpur Anglers	400	Carp[a]	Jharkhand
Kolkata Anglers[b]	8000	Carp[a]	West Bengal
Sikkim Anglers Association	500	Mahseer, trout	Sikkim
Naushad Ali Sarovar Samvardhani/NASS	>100	Mahseer, trout	Maharashtra
Anamalai Anglers Association	*	*	Anamalai Hills, Tamil Nadu
Assam (Bhoreli) Angling & Conservation Association/A(B)ACA	>500	Mahseer	Assam
Game Fishing India	*	All	Andaman Islands
International Game Fish Association/IGFA	*	All	India
Indian Angler	*	All	India
West Bengal Anglers Association	*	*	West Bengal
Kalimpong Fishing Association	*	*	Kalimpong, West Bengal
Nagaland Anglers Association	*	Mahseer, trout	Nagaland
The Himalayan Outback	*	Mahseer, trout	Uttarakhand
Tripura Angling Association	*	Mahseer, trout	Tripura
Trout Conservation and Angling Association	*	Trout	Kullu, Himachal Pradesh
Kemang Angling Association	*	Mahseer, trout	Arunachal Pradesh
Pasighat Angling Club	*	Mahseer, trout	Arunachal Pradesh
High Range Angling Association	*	Trout	Munnar, Kerala

[a]Common Carp and Indian Major Carps (Catla, Rohu, and Mrigal)
[b]Comprised of several individual lake-based associations
*Not known
Note: The International Game Fish Association has two representatives from India on their International Advisory Committee.

Table 2. Dominant freshwater and marine fish species targeted during recreational angling

Fish species	Common name	Conservation status[a]	Ecosystem
Anguilla bengalensis	Indian mottled eel	Near Threatened	Freshwater
Bagarius bagarius	Goonch	Near Threatened	Freshwater
Caranx ignobilis	Giant trevally	Not Evaluated	Marine
Channa striata	Striped or Cheveron snakehead	Least Concern	Freshwater
Cirrhinus cirrhosus	Mrigal	Vulnerable	Freshwater
Clarias gariepinus	African sharp tooth catfish	Least Concern[b]	Freshwater
Cynoglossus macrostomus	Tounge sole	Not Evaluated	Marine
Gibelion catla	Catla	Least Concern	Freshwater
Gymnosarda unicolor	Dogtooth tuna	Least Concern	Marine
Hypophthalmichthys molitrix	Silver carp	Near Threatened[c]	Freshwater
Labeo calbasu	Orangefin labeo	Least Concern	Freshwater
Labeo rohita	Rohu	Least Concern	Freshwater
Lates calcarifer	Asian sea bass	Not Evaluated	Marine
Neolissochilus hexagonolepis	Copper/Chocolate mahseer	Near Threatened	Freshwater
Oncorhynchus mykiss	Rainbow trout[d]	Not Evaluated	Freshwater
Salmo trutta	Brown trout[e]	Least Concern[e]	Freshwater
Schizothorax progastus	Dinnawah snow trout	Least Concern	Freshwater
Sphyraena sp.	Barracuda	Not Evaluated	Marine
Thunnus obesus	Big eye tuna	Vulnerable	Marine
Tor khudree	Deccan mahseer	Endangered	Freshwater
Tor putitora	Golden mahseer	Endangered	Freshwater
Wallago attu	Mully catfish/Freshwater shark	Near Threatened	Freshwater

[a]IUCN Red List of Threatened Species™.
[b]IUCN assessment based on status in the native range of the species; is an alien invasive species in India.
[c]IUCN assessment based on status in the native range of the species; is an exotic species introduced for aquaculture in India.
[d]Exotic species introduced into India during the colonial period.
[e]IUCN assessment based on status in the native range of the species; is an exotic species introduced into India during the colonial period.

species targeted by anglers in India, the "Cauvery hump-backed mahseer," awaits the recognition of a scientific name (see Pinder et al., 2015), and other species such as *T. putitora, T. tor*, and *T. khudree*, currently known to have a wide range of distribution, could in fact be "species complexes" comprised of several range-restricted species, many of which would need formal taxonomic recognition (see Table 2).

Although numerous studies are available on the natural history of some mahseers (for a review see Nautiyal, 2014), the ambiguities surrounding species taxonomy and distribution make these of little value for practical conservation planning and action. But for others (e.g., chocolate mahseer, *N. hexagonolepis*; see Table 2), there have been very few biological studies conducted. The situation is similar for the goonch, *Bagarius bagarius*, one of the largest freshwater catfish occurring in the Indian subcontinent, which has very complex taxonomy and genuine knowledge of distribution is therefore limited (see Ng, 2010).

Undertaking scientific research for many of the species discussed above is a challenge given that habitats are often located in remote areas that are not easily accessible, not accessible year-round (Pinder et al., in press), and/or are located inside PAs where research permits are difficult to obtain (Madhusudan et al., 2006).

Recreational fisheries, therefore, could play an important role in supporting research on many such freshwater species that are otherwise difficult to sample, as demonstrated through a recent study using angler catch data to generate biological information for conservation and management of mahseers in the Cauvery (Pinder et al., in press).

Lack of Understanding of Biotic Responses to Capture and Release

There are no studies to date that have examined post-capture mortalities in mahseer or other species targeted by anglers in India, but studies have assumed (with no scientific backing) that many of them may die owing to the exhaustion, injuries, and associated infections (see Dinesh et al., 2010). The type of fishing gear used can have an effect on the mortality rate of fish caught by C&R angling (Cooke and Schramm, 2007; Danylchuk et al., 2014; Rocklin et al., 2014). In comparison to artificial lures and flies, natural, worm-baited, and live baits have been shown to increase the mortality rates among fish species due to deeper hooking (Clapp, 1989; Payer, 1989; Siewert, 1990; Wilde et al., 2000). Also, circle hooks have been found to decrease angling mortality in C&R among fish species in that they promote shallow hooking (Cooke and Suski, 2004). Barbless hooks tend to reduce the handling time required to remove the hook (Cooke et al., 2001; Schaeffer, 2002) and lessen the tissue damage to fish species (Casselman, 2005).

The lack of information on the effects of C&R practices on common sports fish of India makes it difficult to determine the extent to which the activity is sustainable. Moreover, given that many recreational fisheries management strategies (e.g., minimum size limits, closed seasons for some species) require release of some fish, it is difficult for fisheries managers to know which regulator approaches may be appropriate. There is a clear need for research on the post-release mortality rates of key recreationally targeted species (especially those that are imperiled) in India. Additional studies focused on understanding the factors that mediate mortality or sub-lethal (physiological, behavioral) impacts will be useful in the development of best practices that can be shared with the angling community to ensure that C&R practices are responsible and sustainable (Cooke and Suski, 2005; see below).

Figure 2. Current recreational angling practices in India, as depicted by photographs on angling association websites.

Need for Development and Dissemination of Best Practices for Sustainable Angling Promotion

Presently, there are no official guidelines relevant to recreational fisheries that exist in India, and there is no monitoring of these fisheries. The onus therefore is solely on the angling associations, and many of them advocate best management practices. For example, in June 2014 an "All India Fresh Water Angling Competition" organized by AIGFA in partnership with Maharashtra State Angling Association and WASI in River Cauvery was attended by over 30 recreational anglers (Derek D'Souza, AIGFA personal communication). A set of nine recreational angling guidelines was provided to each participant (including mandatory C&R), and anglers had to abide by these rules to stay in the competition.

However, such practices are neither advocated nor used by many angling associations. For example, a quick survey of the photographs on closed group pages of angling associations in India by one of the authors (NG) revealed that wall nails were being used as fish hooks by some members; the air exposure to fish was often unacceptable (e.g., fish photographed >20 m away from the water body); and visible wounds were present on captured fishes, which were going to be released back into the water. Reducing the prevalence of such practices will require increasing awareness through angler education and encouraging compliance through enforcement by a statutory recreational angling body (see Figure 2).

Unregulated Stocking and Introductions

To some extent, the development of recreational fisheries in India has been aided by stocking and introduction of both exotic species and captive bred populations of native species. During the British Raj, many upland lakes and upper reaches of rivers were regularly stocked with exotic salmonids to develop recreational fishing opportunities. It has been documented that five species of salmonids—brown trout (*S. trutta*), rainbow trout (*O. mykiss*), eastern brook trout (*Salvelinus fontinalis*), splake (brook trout × lake trout; *Salvelinus namaycush* × *S. fontinalis*), and a land-locked variety of Atlantic salmon (*Salmo salar*)—were introduced in the Himalayan waters between 1905 and 1969, of which only the brown trout established self-sustaining populations, subsequently impacting endemic snow trout (Sehgal, 1999a).

Similar stocking programs have been carried out in the Nilgiri, Anamalai, and Cardamom hills of the Western Ghats (Sehgal, 1999b), with trout hatcheries set up in Avalanche (Nilgiris) and Eravikulam-Rajamalai (Munnar, Kerala). That recreational fishing for trout continues to take place in these regions to this day, actively encouraged by the local angling associations (see Table 1), is indicative of the presence of either self-sustaining populations of these exotic species, or continuous stocking from the local hatcheries.

The biological and socio-economic impacts of the angling for exotic fish species (*S. trutta* and *O. mykiss* in the Himalayas; *Cyprinus carpio* and *O. mykiss* in the Western Ghats) is poorly understood, especially with regard to large-scale stocking of such species in areas of high biodiversity and endemism. In this context, there is also a specific need to assess in detail the preferences and awareness among C&R anglers regarding the targeting of native and non-native fishes, to understand the extent to which anglers target non-native fish species (see Hickley and Chare, 2004; Nguyen et al., 2013), and to gauge support for stocking to enhance recreational fishing experience (see Granek et al., 2008). Given the relationship between stakeholder support and the success of management and conservation initiatives (e.g., see Jensen et al., 2009; Jentoft et al., 2012; Song and Chuenpagdee, 2014), evaluating the attitudes of anglers and other stakeholders on issues related to stocking would help to inform management decisions.

Large-scale stock replenishment of various "species" of mahseer has been carried out in the Western Ghats region, particularly in the Cauvery River (see Ogale, 2002), which has resulted in the reported proliferation of hybrids and the

suspected decline of native lineages (Dinesh et al., 2010; Pinder and Raghavan, 2013; Pinder et al., 2015). It is known that the Tata Electric Company in Lonavala, the source of most stocked fingerlings in the Cauvery, experimentally hybridized mahseer species (Ogale and Kulkarni, 1987) and have provided fingerlings of various mahseer species including T. mussullah (now understood to represent a distinct genus; see Knight et al., 2014) to different angling associations in India (Ogale, 2002). In the case of the Cauvery, no historical information is available to describe the original mahseer community prior to this stocking program, and its implications for the genetic integrity of populations are unknown (Pinder and Raghavan, 2013). The current diversity of mahseer in the Cauvery is a "taxonomist's nightmare" with several phenotypes being recorded, and none of them matching historic species descriptions.

Fisheries Focused on Biodiversity Hotspots

The most popular fishing locations are currently situated in the Himalayas and Western Ghats, two of the important biodiversity hotspots known for their exceptional freshwater fish diversity and endemism, which are also currently threatened by numerous anthropogenic pressures (Vishwanath et al., 2010; Dahanukar et al., 2011). Although some species targeted by anglers in India have shown a declining population trend and are listed as threatened in the IUCN Red List (e.g., *T. khudree* and *T. putitora*, assessed as "Endangered;" the goonch catfish, *B. bagarius* assessed as "Near Threatened;" and *Cirrhinus cirrhosus* assessed as "Vulnerable"), none of these assessments list recreational angling as a threat to the species (see species specific accounts in the IUCN Red List of Threatened Species), possibly because no studies have been carried out to assess the impacts of recreational fisheries (Cooke et al., in press).

Poorly Defined Governance Structures

Both within and among the Indian states and union territories, the multi-jurisdictional nature of fisheries governance (see Raghavan et al., 2012) has played a substantial role in slowing the development of recreational fisheries sector. For example, absence of a centralized governing body has constrained decision-making capabilities at both the national and state levels. A centralized governing body with legislative support and funding will be crucial to oversight, management, and regulation of sustainable recreational fisheries in India. Although a large majority of angling associations in India are registered and catalogue the practice of recreational angling through paid permits, a number of unlicensed angling associations continue to operate in major angling locations of India.

The ever-dynamic disconnect between recreational fisheries management associations and government agencies (e.g., forest and fisheries departments) is an additional obstacle to the sustainable development of recreational fisheries sector in India. In the Himalayan region for example, the Forest Department is currently responsible for issuing recreational fishing permits (at a set price) to anglers fishing in the Ramganga River, but there is limited capacity within the department for patrolling freshwater reaches including angling spots (Gupta et al., 2014). In addition, an ongoing concern regarding the distribution of revenue, generated through the fishing permits, between the Forest Department, angling associations, and village communities has led to the suggestion that the Uttarakhand Fisheries Department should manage recreational angling in the region (Gupta et al., 2014).

Although recreational angling tourism in India provides social and economic benefits to some local communities (Everard and Kataria, 2011; Pinder and Raghavan, 2013), concerns have been raised by local stakeholders regarding transparency during profit-sharing stages (Gupta et al., in press). A recent suggestion by an angling association operating on the Ramganga River in Uttarakhand to introduce a conservation tax (US$ 8) on visiting recreational anglers to further support local communities was widely appreciated by village members (N. Gupta, personal communication with Misty Dhillon, the Himalayan Outback). However, preventing village members from catching food fish from pools protected by angling associations resulted in village members expressing anxiety about additional recreation angling areas being developed near their freshwater reach without prior consultation (N. Gupta, personal communication with village members in Uttarakhand).

Need for Science-Based Adaptive Management

There has been a general lack of assessment of the status of recreational fisheries in India. For example, not all registered angling associations have maintained a record of effort, catch, harvest, and release rates of fish species. No records are maintained on fishing behaviors (e.g., target species and bait preference) and information available from record books is often scant, with significant gaps between angling seasons (but see Gupta et al., in press; Pinder et al., in press). Additionally, no scientific studies have been conducted to understand the impacts of recreational fisheries on fish population structure or evaluate impacts of recreational fishing activity in PAs. Finally, surveys have yet to be conducted to document the potential response from the angling community regarding fixing catch size limits, or closed seasons. Although frequently implemented in North America and Europe (Granek et al., 2008; Hasler et al., 2011), it is important to understand the applicability and potential compliance for such management strategies in India. There is also an urgent need for an adaptive management approach where data gathered and lessons learned from experiences of important stakeholders are shared among management agencies in a systematic way so as to build on management successes (FAO, 2012).

Poor Stakeholder Engagement

Personal interactions with a majority of anglers highlighted the lack of government support for recreational fisheries in India, and the need to set up angling conservation units within village communities to ensure that local stakeholders benefit from the industry. Anglers also described concerns about law enforcement, such that persons indulging in illegal fishing practices were seldom arrested and punished by the authorities, as no formal protection strategies for critical fish habitats from anthropogenic stressors occur anywhere in India. Finally, it was mentioned that more scientific studies were urgently needed to understand the impacts of recreational angling on freshwater biodiversity in India to raise public awareness regarding freshwater ecosystems.

The ongoing general access conflict between stakeholders (i.e., angling managements and village members) requires a common platform to bring opposing sides together. The suggestion to set up freshwater fish safe zones on river reaches monitored by local communities could be an ideal solution (Gupta et al., 2014). The spill-over effect of fish species from such "protected" sites could provide both recreational and sustenance opportunities for local stakeholders. Legislative support (central or state level) for recreational angling could provide an overall structure to this leisure activity and highlight its associated benefits (FAO, 2012). However, this has to be linked with ongoing/additional freshwater conservation approaches to control the use of illegal fishing techniques, and introduction of exotic fish species.

Conflict Between Recreational Fisheries and Other Activities

A majority of the anglers informally interacted with mentioned that they had witnessed destructive fishing techniques at/near their angling locations, e.g., the use of explosives such as dynamite, illegal fishing nets, poisons, and electricity. They identified factors such as overfishing, the use of illegal fishing techniques to catch fishes, water pollution, the lack of administrative support from authorities and poor availability of freshwater management strategies, the clearing of riparian habitats, existing and proposed hydro-electric projects, and the introduction of exotic fish species as threats to freshwater ecosystems—most of which have also been recorded in the scientific literature (Dahanukar et al., 2011; Raghavan et al., 2012).

Lack of Representative Data from the Recreational Fishery Sector

One of the issues facing the recreational fisheries in India is the lack of representative data for the recreational fishery from which to inform management. This is a challenging issue because of the enormous difficulties in sampling people in a developing country where contact by phone, physical address, or online is highly variable by region and state. The widely adopted standard of a telephone-diary survey may be difficult to implement under these conditions; therefore, alternative sampling methods such as face-to-face interviews or angler diaries may need to be explored. Strategies currently being tested in Australia (i.e., social network sampling without the use of online methods) may be relevant in India, if successful. There are many other potential methods used in health sciences (e.g., simple random sampling, systematic sampling, stratified sampling, or snowball sampling) that could be applied to difficult-to-sample populations. There is also a crucial need to involve agencies (i.e., government, fishing organizations, and communities) responsible for funding such surveys. Such an approach has the potential to assist in obtaining representative sample of Indian recreational fishers.

REALIZING OPPORTUNITIES FOR THE FUTURE

This study revealed that recreational angling is a male-dominated leisure activity in India, mostly attributable to the social structure of Indian society, where sporting activities are mainly indulged in by male members of the family. However, angling associations could invest in providing opportunities for female associates of visiting anglers and promoting angling locally as a female-friendly activity. This will not only help in promoting the sport among the female population, but could also provide additional benefits to local communities, e.g., cottage industries could benefit from the revenue brought in through "angling families."

In October 2012, a day-long angler's camp was co-organized by AIGFA for children between the age group of seven and nine years at the WASI lakes in Karnataka. Information relating to different species of fish in the lake, importance of C&R angling for the environment, and an introduction to angling equipment and its assembly was provided to each participant (Derek D'Souza, AIGFA personal communication).

There is an urgent need to resolve the debate regarding the governance structure and mechanisms for freshwater fisheries management in India, including those related to angling locations. It is often the case that some reaches of a water body are located inside the legislatively defined boundaries of PAs, and therefore automatically under the jurisdiction of state forest departments. However, forest managers often claim the right to the entire water body, a simmering debate among local stakeholders and forest managers across India. From the forest managers' point of view, protecting the entire stretch of the water body in question safeguards the reaches within the PA. This is crucial for the survival of the terrestrial and aquatic species within the PA, as anthropogenic stressors originating outside PA boundaries can have devastating consequences for organisms within PA boundaries (Gupta et al., 2014, 2015).

Such divisive actions often give rise to demands for the involvement of the state fisheries departments by local stakeholders. There is a need for both the departments and local

Table 3. Recreational fisheries management approaches currently practiced in India (Source: FAO, 2012)

Criteria	Explanation	Current status	Target ecosystem
Licensing and fees	Regulates recreational fisheries	Common	Freshwater and marine
Gear restrictions	Prevents damage to target fish species	Common	Freshwater
Method restrictions	Reduces damage to species and habitats	Uncommon	Freshwater and marine
Closed times, seasons	Less stressful environment conditions during spawning and migration	Common	Freshwater
Closed areas	Protects spawning areas, migration routes	Uncommon	Freshwater
Fishing contests	Overharvests undesirable species	Uncommon	Freshwater and marine
User conveniences	Provides suitable angling locations to attract recreational fishers	Common	Freshwater and marine
Effort restrictions	Limits number of rods per angling site	Common	Freshwater
Length limits	Limits size of fish retained	Uncommon	Freshwater and marine
Bag limits	Limits number of fish retained	Uncommon	Freshwater and marine
Sale of fish	Prohibits commercialization of recreational fish species	Uncommon	Freshwater and marine
Harvest restrictions	Restricts targeting threatened species	Uncommon	Freshwater and marine
Fish holding	Prohibits translocation and stress to species	Uncommon	Freshwater and marine
Harvest mandates	Encourages harvest of undesirable species	Uncommon	Freshwater and marine

stakeholders to reach a consensus, and work in tandem to manage freshwater ecosystems and species. A potential way to achieve this would be to acknowledge village communities as important stakeholders within conservation management plans. The recreational fisheries sector in India is also dependent on the assistance and support from local communities living near the angling locations, thus recreational fisheries associations would do well to incorporate village communities in their planning for the long-term success of their organizations (Gupta et al., 2014).

It is vital for stakeholders to understand that stocking/ranching is suitable under a particular suite of conditions and may cause a decline in the genetic diversity and reduction in the gene pool if implemented otherwise (Hickley and Chare, 2004; Everard and Kataria, 2011; Pinder and Raghavan, 2013). The IUCN Guidelines for Reintroductions and other Conservation Translocations (IUCN, 2012) explicitly suggest that reintroduction should be beneficial to the species in question and the ecosystem it occupies, and should only be carried out after scientific research. Therefore, the need to stock fish species merely to increase the catch size or increase the number of catches for recreational anglers should be avoided, particularly as the genetic structure of many target fish populations (including mahseer) are still unknown.

Recreational fisheries management approaches currently applied in India need to be developed to provide long-term ecological, social, and economic benefits (Table 3), and channeled to assist with additional freshwater conservation projects (see Gozlan et al., 2013; Rogers, 2013).

CONCLUSION

Here we provided the first overview of the status of recreational fisheries in India by combining a traditional literature review with informal interactions with the angling community in India. The recreational fisheries sector is in an expansion phase in the country, and as an important stakeholder anglers have the potential to facilitate the conservation of native fish species and their habitats and help facilitate improved livelihoods in rural areas. Monetary incentives have a great potential to motivate local communities to participate voluntarily in angling-based tourism, and further assist in the protection of target fish species. However, care needs to be taken to ensure that long-term, satisfactory socio-economic benefits are being provided to all participating stakeholders, especially at the local level.

With many freshwater and coastal ecosystems in India threatened by a multitude of anthropogenic stressors, there is a never-ending search for novel and effective management strategies. If provided an appropriate opportunity, recreational fishers as a group could potentially play a key role to realize freshwater fish conservation objectives. To do so will require coordination and cooperation from both grass-roots angling organizations and "top-down" government regulatory agencies. Improving governance and management of recreational fisheries should be a priority, but doing so will require formal commitments and collective willingness to embrace recreational fishing as a legitimate activity. The science needs are immense (e.g., basic natural history, stock assessment, consequences of C&R) but such information is needed to support adaptive management approaches that could lead to a vibrant and sustainable recreational fisheries sector in India.

ACKNOWLEDGMENTS

We thank the Fisheries Society of the British Isles for providing travel support, which led to the development of the ideas presented herein.

FUNDING

Rajeev Raghavan is supported by the Mohammed Bin Zayed Species Conservation Fund, and the Mahseer Trust. Cooke is supported by the Canada Research Chairs Program and

NSERC. Cooke and Bower are further supported by the Too Big to Ignore Network organized by Memorial University and funded through SSHRC.

REFERENCES

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

Arlinghaus, R., and S. J. Cooke. Recreational fisheries: Socioeconomic importance, conservation issues and management challenges, pp. 39–58. **In**: *Recreational Hunting, Conservation and Rural Livelihoods: Science and Practice* (Dickson, B., J. Hutt, and W. M. Adams, Eds.). Oxford, UK: Blackwell (2009).

Arlinghaus, R., T. Mehner, and I. G. Cowx. Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. *Fish Fish.*, **3**: 261–316 (2002).

Arlinghaus, R., R. Tillner, and M. Bork. Explaining participation rates in recreational fishing across industrialised countries. *Fish. Manag. Ecol.*, **22**: 45–55 (2014).

Bower, S. D., V. M. Nguyen, A. J. Danylchuk, T. D. Beard Jr, and S. J. Cooke. Inter-sectoral conflict and recreational fisheries of the developing world: Opportunities and challenges for co-operation. **In**: *Enhancing Stewardship in Small-Scale Fisheries: Practices and Perspectives* (McConney, P., R. Medeiros, and M Pena., Eds.). Barbados: Too Big To Ignore (TBTI) and Centre for Resource Management and Environmental Studies, The University of the West Indies, Cave Hill Campus. CERMES Technical Report No. 73(2014).

Brownscombe, J. W., S. D. Bower, W. Bowden, L. Nowell, J. D. Midwood, N. Johnson, and S. J. Cooke. Canadian recreational fisheries: 35 Years of social, biological, and economic dynamics from a national survey. *Fisheries*, **39**: 251–260 (2014).

Casselman, S. J. *Catch-and-Release Angling: A Review with Guidelines for Proper Fish Handling Practices*. Peterborough, Ontario: Fish & Wildlife Branch, Ontario Ministry of Natural Resources, 26 pp. (2005).

Clapp, D. F., and R. D. Clark Jr. Hooking mortality of smallmouth bass caught on live minnows and artificial spinners. *North Am. J. Fish Manag.*, **9**: 81–85 (1989).

Cooke, S. J., and I. G. Cowx. The role of recreational fishing in global fish crises. *Bioscience*, **54**: 857–859 (2004).

Cooke, S. J., Z. Hogan, P. A. Butcher, M. J. W. Stokesbury, R. Raghavan, A. J. Gallagher, N. Hammerschlag, and A. J. Danylchuk. Angling for endangered species: Conservation problem or conservation action? *Fish Fish.*, DOI: 10.1111/faf.12076 (in press).

Cooke, S. J., D. P. Philipp, K. M. Dunmall, and J. F. Schreer. The influence of terminal tackle on injury, handling time, and cardiac disturbance of rock bass. *North Am. J. Fish Manag.*, **21**: 333–342 (2001).

Cooke, S. J., and H. L. Schramm. Catch-and-release science and its application to conservation and management of recreational fisheries. *Fish Manag. Ecol.*, **14**: 73–79 (2007).

Cooke, S. J., and C. D. Suski. Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? *Aquat. Conserv: Mar. Freshw. Ecosyst.*, **14**: 299–326 (2004).

Cooke, S. J., and C. D. Suski. Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources? *Biodivers. Conserv.*, **14**: 1195–1209 (2005).

Cowx, I. G., R. Arlinghaus, and S. J. Cooke. Harmonizing recreational fisheries and conservation objectives for aquatic biodiversity in inland waters. *J. Fish Biol.*, **76**: 2194–2215 (2010).

Dahanukar, N., R. Raghavan, A. Ali, R. Abraham, and C. P. Shaji. The status and distribution of freshwater fishes of the Western Ghats, p. 116. **In**: *The Status and Distribution of Freshwater Biodiversity in the Western Ghats, India*. (Molur, S., K. G. Smith, B. A. Daniel, and W. R. T. Darwall, compilers). Cambridge/Coimbatore: IUCN/Zoo Outreach Organization (2011).

Danylchuk, A. J., and S. J. Cooke. Engaging the recreational angling community to implement and manage aquatic protected areas. *Conserv. Biol.*, **25**: 458–64 (2011).

Danylchuk, A. J., C. D. Suski, J. W. Mandelman, K. J. Murchie, C. R. Haak, A. M. L. Brooks, and S. J. Cooke. Hooking injury, physiological status and short-term mortality of juvenile lemon sharks (*Negaprion bevirostris*) following catch-and-release recreational angling. *Conserv. Physiol.*, **2**: 1–10 (2014).

Dinesh, K., M. C. Nandeesha, P. Nautiyal, and P. Aiyappa. Mahseers in India: A review with focus on conservation and management. *Indian J. Anim. Sci.*, **80**: 26–38 (2010).

Everard, M., and G. Kataria. Recreational angling markets to advance the conservation of a reach of the Western Ramganga River, India. *Aquat. Conserv.: Mar. Freshw. Ecosyst.*, **21**: 101–108 (2011).

FAO. *Recreational Fisheries. FAO Technical Guidelines for Responsible Fisheries, No. 13*. Rome: FAO. 176 pp. (2012).

Fernandes, L., J. Day, A. Lewis, S. Slegers, B. Kerrigan, D. Breen, D. Cameron, B. Jago, J. Hall, D. Lowe, J. Innes, J. Tanzer, V. Chadwick, L.Thompson, K. Gorman, M. Simmons, B. Barnett, K. Sampson, G. De'ath, B. Mapstone, H. Marsh, H. Possingham, I. Ball, T. Ward, K. Dobbs, J. Aumend, D. Slater, and K. Stapleton. Establishing representative no-take areas in the Great Barrier Reef: Large-scale implementation of theory on marine protected areas. *Conserv. Biol.*, **19**: 1733–1744 (2005).

Freire, K. M. F., M. L. Machado, and D. Crepaldi. Overview of inland recreational fisheries in Brazil. *Fisheries*, **37**: 484–494 (2012).

Gozlan, R. E., D. Burnard, D. Andreou, and J. R. Britton. Understanding the threats posed by non-native species: Public vs. conservation managers. *PLoS One*, **8**: e53200(2013).

Granek, E. F., E. M. P. Madin, M. A. Brown, W. Figueira, D. S. Cameron, Z. Hogan, G. Kristianson, P. de Villiers, J. E. Williams, J. Post, S. Zahn, and R. Arlinghaus. Engaging recreational fishers in management and conservation: Global case studies. *Conserv. Biol.*, **22**: 1125–1134 (2008).

Gupta, N., P. Nautiyal, A. Borgohain, K. Sivakumar, V. B. Mathur, and M. A. Chadwick. Catch-and-release angling as a management tool for mahseer conservation in India. *Oryx*, DOI: http://dx.doi.org/10.1017/S0030605314000787 (in press).

Gupta, N., R. Raghavan, K. Sivakumar, and V. B. Mathur. Freshwater Fish Safe Zones (FFSZs): A prospective conservation strategy for river ecosystem in India. *Curr. Sci.*, **107**: 949–950 (2014).

Gupta, N., R. Raghavan, K. Sivakumar, V. B. Mathur, and A. C. Pinder. Assessing recreational fisheries in an emerging economy: Knowledge, perceptions and attitudes of catch-and-release anglers in India. *Fish. Res.*, **165**: 79–84 (2015).

Gupta, N., K. Sivakumar, V. B. Mathur, and M. A. Chadwick. The "tiger of Indian rivers": Stakeholders' perspectives on the golden mahseer as a flagship fish species. *Area*, **46**: 389–397 (2014).

Gupta, N., K. Sivakumar, V. B. Mathur, and M. A. Chadwick. Terrestrial protected areas and managed reaches conserve threatened

freshwater fish in Uttarakhand, India. *PARKS*, **21**(1): 89–101 (2015).

Hamilton, F. *An Account of the Fishes Found in the River Ganges and Its Branches*. Edinburgh: Hurst, Robinson, and Co. (1822).

Hasler, C. T., A. H. Colotelo, T. Rapp, E. Jamieson, K. Bellehumeur, R. Arlinghaus, and S. J. Cooke. Opinions of fisheries researchers, managers, and anglers towards recreational fishing issues: An exploratory analysis for North America. *Am. Fish Soc. Symp.*, **75**: 51–74 (2011).

Henry, G. W., and J. M. Lyle. *The National Recreational and Indigenous Fishing Survey*. Orange, NSW: NSW Department of Primary Industries (2003).

Hickley, P., and S. Chare. Fisheries for non-native species in England and Wales: Angling or the environment? *Fish Manag. Ecol.*, **11**: 203–212 (2004).

Hora, S. L. Knowledge of the ancient hindus concerning fish and fisheries of India. *J. Asiat. Soc. Lett.*, **17**: 145–169 (1951).

Jensen, O. P., D. J. Gilroy, Z. Hogan, B. C. Allen, T. R. Hrabik, B. C. Weidel, S. Chandra, and J. V. Zanden. Evaluating recreational fisheries for an endangered species: A case study of taimen, *Hucho taimen*, in Mongolia. *Can J. Fish. Aquat. Sci.*, **66**: 1707–1718 (2009).

Jentoft, S., J. J. Pascuel-Fernandez, R. De La Cruz Modino, and M. C. R. Gonzalez-Ramallal. What stakeholders think about marine protected areas: Case studies from Spain. *Hum. Ecol.*, **40**: 185–197 (2012).

Jung, S. B. *Subhan and I: My Adventures with the Angling Legend of India*. New Delhi: Roli Books (2012).

Knight, J. D., A. Rai, and R. K. P. D'souza. On the identities of *Barbus mussullah* Sykes and *Cyprinus curmuca* Hamilton with notes on the status of *Gobio canarensis* Jerdon (Teleostei: Cyprinidae). *Zootaxa*, **3750**: 201–215 (2014).

Lewin, W. C., R. Arlinghaus, and T. Mehner. Documented and potential biological impacts of recreational fishing: Insights for management and conservation. *Rev. Fish. Sci.*, **14**: 305–367 (2006).

Madhusudan, M. D., K. Shanker, A. Kumar, C. Mishra, A. Sinha, R. Arthur, A. Datta, M. Rangarajan, R. Chellam, G. Shahabuddin, R. Sankaran, M. Singh, U. Ramakrishnan, and P. D. Rajan. Science in the wilderness: The predicament of scientific research in India's wildlife reserves. *Curr. Sci.*, **91**: 1015–1019 (2006).

Mahseer Conservancy. <www.mahseerconservancy.com> accessed 12th September 2014 (2014).

Nautiyal, P. A review on the art and science of the Indian mahseers (game-fish) in the 19th-20th century – road to extinction or conservation? *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.*, **84**: 215–236 (2014).

Ng, H. H. *Bagarius bagarius*. IUCN Red List of Threatened Species. Version 2014.2 <www.iucnredlist.org> accessed 25th August 2014 (2010).

Nguyen, V. M., M. A. Rudd., S. G. Hinch, and S. J. Cooke. Recreational anglers' attitudes, beliefs, and behaviors related to catch-and-release practices of Pacific salmon in British Columbia. *J. Environ. Manage.*, **128**: 852–865 (2013).

Ogale, S. N. Mahseer breeding and conservation and possibilities of commercial culture. The Indian experience. **In**: *Cold Water Fisheries in the Trans-Himalayan Countries* (Petr, T., and D. B. Swar, Eds.). FAO Fisheries Technical Paper 431. Rome: FAO (2002).

Ogale, S. N., and C. V. Kulkarni. Breeding of pond-raised hybrids of mahseer fish, *Tor khudree* (Sykes) and *T. tor* (Ham). *J. Bombay Nat. Hist. Soc.*, **84**: 332–335 (1987).

Payer, R. D., R. B. Pierce, and D. L. Pereira. Hooking mortality of walleyes caught on live and artificial baits. *North Am. J. Fish Manag.*, **9**: 188–192 (1989).

Pereira, J. M., M. Petrere-Jr, and R. A. Ribeiro-Filho. Angling sport fishing in Lobo-Broa reservoir (Itirapina, SP, Brazil). *Braz J. Biol.*, **68**: 721–31 (2008).

Pinder, A. C., and R. Raghavan. Conserving the endangered Mahseers (*Tor* spp.) of India: The positive role of recreational fisheries. *Curr. Sci.*, **104**: 1472–1475 (2013).

Pinder, A. C., R. Raghavan, and R. Britton. The legendary hump-backed mahseer *Tor* sp. of India's River Cauvery: An endemic fish swimming towards extinction. *Endangered Species Res.*, **28**: 11–17 (2015).

Pinder, A. C., R. Raghavan, and R. Britton. Efficacy of angler catch data as a population and conservation monitoring tool for the flagship Mahseer fishes (*Tor* spp) of Southern India. *Aquat. Conserv: Mar. Fresh Ecosys.*, (in press). DOI: 10.1002/aqc.2543

Raghavan, R., A. Ali, N. Dahanukar, and A. Rosser. Is the Deccan mahseer, *Tor khudree* (Sykes 1839) (Pisces: Cyprinidae) fishery in the Western Ghats Hotspot sustainable? A participatory approach to stock assesment. *Fish. Res.*, **110**: 29–38 (2012).

Rocklin, D., H. Levrel, M. Drogou, J. Herfaut, and V. Gerard. Combining telephone surveys and fishing catches self-report: The French sea bass recreational fishery assessment. *PLoS One*, **9**: e87271(2014).

Rogers, A. A. Social welfare and marine reserves: Is willingness to pay for conservation dependent on management process? A discrete choice experiment of the Ningaloo Marine Park in Australia. *Can. J. Agric. Econ.*, **61**: 217–238 (2013).

Schaeffer, J. S. Performance of barbed and barbless hooks in a marine recreational fishery. *North Am. J. Fish Manag.*, **22**: 229–235 (2002).

Sehgal, K. L. Coldwater fish and fisheries in the Indian Himalayas: Rivers and streams. **In**: *Fish and Fisheries at Higher Altitudes: Asia*. FAO Fisheries Technical Paper. No. 385. Rome: FAO (1999a).

Sehgal, K. L. Coldwater fish and fisheries in the Western Ghats, India. **In**: *Fish and Fisheries at Higher Altitudes: Asia*. FAO Fisheries Technical Paper. No. 385. Rome: FAO (1999b).

Siewert, H. F., and J. B. Cave. Survival of released bluegill, *Lepomis macrochirus*, caught on artificial flies, worms, and spinner lures. *J. Freshw. Ecol.*, **5**: 407–411 (1990).

Song, A., and R. Chuenpagdee. Exploring stakeholders' images of coastal fisheries: A case study from South Korea. *Ocean Coast Manag.*, **100**: 10–19 (2014).

Taylor, M. J., and K. R. White. A meta-analysis of hooking mortality of nonanadromous trout. *North Am. J. Fish Manag.*, **12**: 760–767 (1992).

Vishwanath, W., H. H. Ng, R. Britz, L. K. Singh, S. Chaudhry, and K. W. Conway. The status and distribution of freshwater fishes of the Eastern Himalaya region, p. 90. **In**: *The Status and Distribution of Freshwater Biodiversity in the Eastern Himalaya* (Allen, D. J., S. Molur, and B. A. Daniel, compilers). Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation (2010).

Wilde, G. R., M. I. Muoneke, P. W. Bettoli, K. L. Nelson, and B. T. Hysmith. Bait and temperature effects on striped bass hooking mortality in freshwater. *North Am. J. Fish Manag.*, **20**: 810–815 (2000).

Zhang, Y. Using the internet for survey research: A case study. *J. Am. Soc. Inf. Sci.*, **51**: 57–68 (2000).