Assessing recreational fisheries in an emerging economy: knowledge, perceptions and attitudes of catch-and-release anglers in India

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ABSTRACT

Across the globe, catch-and-release (C&R) angling represents a leisure activity indulged by millions. The practice of C&R is commonly advocated by conservation managers because of its potential to protect local fish populations from a range of anthropogenic threats, including over-fishing. In India, C&R angling in freshwaters has a history dating back to colonial times. Despite this, little is known about the current state of the sector. To address this, an online web-based survey was conducted to target C&R anglers who fish in Indian rivers to assess their knowledge, attitudes and perceptions relating to the national status of India's freshwater C&R fisheries. From a total of 148 responses, factors such as angling quality (score of 4.6/5.0); aesthetics of surroundings (4.6/5.0), presence of other wildlife (4.4/5.0), fishery management practices (4.6/5.0) and socioeconomic benefits (4.4/5.0) were evaluated. Over 65% (n=148) of the anglers reported an observed decrease in the quality of fishing (e.g. a reduction in the size and/or numbers of fish available for capture). Respondents also considered deforestation (score of 4.2/5.0), water abstraction (4.4/5.0), pollution (4.4/5.0), hydropower projects (4.2/5.0) and destructive fishing techniques (4.7/5.0) as factors which threaten both the habitat and species they target. C&R practitioners were largely united regarding the benefits and willingness to contribute both their time and financial input to support conservation initiatives (score of 4.7/5.0). The current study provides the first overview of the status of C&R angling in India and explores challenges, opportunities, and priorities for future resource management.

Keywords: mahseer, conservation**,** Asia, developing country, freshwater, sport fishing

1. Introduction

Apart from being an important protein source and facilitating vital ecosystem functions (Dugan et al., 2006; Welcomme et al., 2010; Brummet et al., 2013), freshwater fish also provide recreational benefits (Pinder and Raghavan, 2013). Recreational (catch-and-release (henceforth C&R)) fishing, defined as "a non-commercial activity that captures fishes for purposes other than nutritional needs" (Granek et al., 2008; Cowx et al., 2010) is a highly indulged pastime, both in developed and developing countries. C&R has a very high participation rate (Cooke and Cowx, 2004; Granek et al., 2008; Cowx et al., 2010) and its popularity is expected to grow in developing countries and emerging economies owing to increased wealth of their societies (FAO, 2012). For example, despite the popularity of recreational angling in India during colonial times, it is only in the past two decades that C&R angling has gained national popularity, and now represents a fast expanding market (see Everard and Kataria, 2011). Indeed, an increasing number of tour operators are offering angling as part of their wildlife and tourism packages to two of the nation's biodiversity hotspots, the Himalayas and the Western Ghats (Everard and Kataria, 2011). Of particular attraction to international anglers are the mahseers (*Tor* spp.); often considered to be the world's hardest fighting fish (TWFT, 1984), both foreign and domestic anglers frequent the upper Ganges catchment (in the Himalayas) and the Cauvery (in the Western Ghats) in pursuit of these fish.

Despite contributing a multitude of key ecological functions and societal benefits (WWF, 2006; Collen et al., 2014), freshwater ecosystems, especially rivers, comprise one of the most endangered and poorly protected ecosystems on earth (Dudgeon, 2011; Cooke et al., 2012). Multiple interacting threats including habitat alteration/loss, alien species, overexploitation, pollution and climate change (Xenopoulos et al., 2005; Dudgeon et al., 2006; Strayer and

Dudgeon, 2010; Vörösmarty et al., 2010; McDonald et al., 2011) are widely cited as contributing to the precarious state of global freshwater biodiversity. Since freshwater fishes are integral to ecosystem function and are also a source of food and livelihood to millions (Dugan et al., 2006; Welcomme et al., 2010; Brummet et al., 2013; Reid et al., 2013), they are considered a critical component of freshwater biodiversity. Freshwater fishes are nevertheless one of the most threatened vertebrate taxa on earth (Reid et al., 2013), with more than 36% (of the 5785 species assessed by the IUCN) at the risk of extinction and over 60 species having already gone extinct since 1500 (Carrizo et al., 2013).

Despite varying levels of threat as a result of escalating anthropogenic pressures (Vishwanath et al. 2010; Dahanukar et al., 2011), India supports notably high levels of freshwater fish diversity and endemism. National fishery focused conservation and management policies have often suffered from setbacks due to jurisdictional issues, oversights, and implementation of top-down approaches (Raghavan et al., 2011); poor enforcement of existing laws (Raghavan et al., 2013) and community-based conservation initiatives often failing to protect river stretches outside their own jurisdiction (Gupta, 2013). Furthermore, the Indian Wildlife (Protection) Act, 1972, the highest legal instrument for wildlife conservation in the country (Dahanukar et al., 2011; Raghavan et al., 2013), affords no mention of freshwater fish. Additionally, very few studies on C&R angling and its potential benefits are available from India (Everard and Kataria, 2011; Pinder and Raghavan, 2013). This paper seeks to enhance current understanding of the status of recreational angling by assessing the knowledge, attitudes and perceptions of both international and domestic anglers practicing C&R angling in India.

2. Methods

Prior to any data collection a pilot survey was carried out. The questions formulated were based on the concerns and opinions of C&R anglers fishing in India (N. Gupta, pers. comm. with C&R anglers). Randomly selected international and domestic respondents (n=25) from India-specific angling forums were requested to complete the survey and pinpoint any problems with its content (Andrews et al., 2003). A web-based survey was used (running for six months from November 2013 to April 2014) to facilitate quicker response times, increased response rates, and reduced costs (Oppermann, 1995; Lazar and Preece, 1999; Andrews et al., 2003). The survey design was based on a series of 23 questions (see supplementary material). Information on the fishing locations and target fish species of interest to anglers was first determined. Further, (a) preferred fishing techniques; (b) factors influencing the angling experience; (c) changes in quality of the angling experience over of the course of angling at a particular location; (d) threats to target species and fishing locations; (e) awareness of the anglers on the conservation status (International Union for Conservation of Nature/IUCN Red List of Threatened Species) of target species; (f) various conservation strategies which the C&R anglers felt was needed for the protection of target species; (g) economics of C&R angling through the amount of money spent (in US$) annually by the anglers on angling and related activities; (h) perception on the benefit of C&R angling as a conservation strategy; (i) willingness to pay for, and get involved in a conservation initiative; and (j) anglers willingness to contribute time and money towards such initiatives was also ascertained. An option for additional comments was also provided at the end of the survey to obtain views and opinions of anglers fishing in Indian waters. The respondents scored each criterion on a scale of 1-5, in ascending order of preference, and the mean score calculated and represented in a tabular form.

To assess international participation, the survey was advertised globally to target anglers spanning different method disciplines. The notification of the survey was posted on global/domestic conservation and angling websites and forums, published in international/national fishing and angling magazines/newsletters, and posted on social media (Facebook, Twitter) sites. All known India-specific angling forums were also targeted. The survey was advertised every fortnight to maintain interest. No changes were made to the survey questions during the course of data collection (Zhang, 2000) and care was taken to allow only one response per individual angler to avoid dual submission (Hasler et al., 2011) by thoroughly reviewing the responses to spot any duplicate submissions.

Angling quality/experience was defined as the availability of fish (numbers/size) available for capture. The aesthetics of surroundings denoted the environment of the angling location. The presence of other wildlife refers to the visual presence of flora and fauna during angling activities. Fishery management practice considers effort applied by local fisheries/forest department towards the protection and conservation of fish communities. Local stakeholders' involvement and transparent sharing of C&R angling revenue dealt with the engagement of and financial benefits to local communities. Camp infrastructure considers the accommodation available to C&R anglers.

3. Results and discussion

A total of 148 responses were obtained and analysed from anglers specifically targeting fishing locations in India, (i.e., United Kingdom/UK + India) (see Figure 1). In comparison to anglers from the UK, Indian/domestic anglers chose highly diverse and multiple fishing sites distributed across the country (see Table 1).

Many species targeted by C&R anglers in India have shown a declining trend of population and are listed as threatened in the IUCN Red List, (e.g. *Tor khudree*, *T. malabaricus* and *T. putitora*, all assessed as 'Endangered'; the goonch catfish, *Bagarius bagarius* assessed as 'Near Threatened'; and *Schizothorax richardsonii* assessed as 'Vulnerable'), for none of these species has recreational C&R angling so far been mentioned as a threat (see species specific accounts in the IUCN Red List of Threatened Species). This has also been the case with most threatened fish species targeted by recreational anglers around the world (see Cooke et al., in press).

Apart from angling quality, aesthetics of surroundings and camp infrastructure (all directly related to C&R angling experience), ecological factors such as presence of other wildlife, fishery management practices, and the inclusion of, and financial benefits to local communities were valued by C&R anglers (see Table 1). This not only highlights the ecological and social awareness among C&R anglers, but demonstrates alignment with the current objectives of river and fish conservation policies in the region. Such awareness has the potential to assist in the co-engagement of key stakeholders (Everard and Kataria, 2011) and bridge the gap between social, economic and biological dimensions of river ecosystem conservation (Cowx and Portocarrero-Aya, 2011). Indeed, an opportunity could exist where C&R anglers could become involved in future conservation programmes, and possibly assist in monitoring, data collection, enforcement and lobbying at local levels (Granek et al., 2008; Cowx et al., 2010).

'Angling quality and experience' is a key driving force for any C&R angler (Arlinghaus, 2006; Granek et al., 2008). The responses obtained regarding decrease in this experience and

quality is a cause of concern not only for ecology and conservation, but also for the human dimensions of the fishery (Hunt et al., 2013). It has been suggested that any conservation assistance from anglers could rely heavily on the satisfactory fulfilment of an angler's leisure experience (Granek et al., 2008), and that a C&R angler's 'angling experience' depends on the well-being of the fishes they primarily target (Arlinghaus, 2006; Granek et al., 2008). Therefore, a decline in stocks is likely to have a profound effect on the quality of this personal experience, and subsequently impact the overall socioeconomic viability of the fishery (Danylchuk and Cooke, 2011).

The perceptions of UK anglers on the major anthropogenic threats to angling quality (see Table 1) were consistent with those recorded in the scientific literature (Vishwanath et al., 2010; Dahanukar et al., 2011). However, 7% of domestic anglers disagreed with some of the identified threats. There could be many possible reasons for this (see Arlinghaus et al., 2007; Hunt et al., 2013) including a) international anglers being more environmentally conscious than domestic anglers, or b) domestic anglers being conditioned to accepting such threats as normal and therefore do not classify them to be such major issues.

A substantial proportion (26%) of anglers from both groups (n=148) were unaware of the conservation status (IUCN Red List) of target fish species. Strict environmental guidelines for C&R angling, including those that deal with threatened species (see Cooke et al., in press) need to be enforced by the Department of Fisheries and/or the Department of Forest and Wildlife, and also by the angling associations who can influence the behaviour of their members and guests. In addition, voluntary regulations and informal institutions could also play a pivotal role in enforcing guidelines (Cooke et al., 2013).

Both UK and domestic anglers highlighted the top three strategies required for conserving the target species as education; effective anti-poaching patrol and improved legislation (see Table 1). Despite only 16% of anglers highlighting education as important, the 'spirit of the river' initiative developed to educate anglers in Mongolia about best-practice catch-and-release techniques for the Taimen (*Hucho taimen*) is an example of how education can also support conservation of threatened species targeted in recreational fisheries (Bailey, 2012). Although there is some legislation (Indian Fisheries Act and various State inland fisheries acts) to protect freshwater fishes in India, effective enforcement is considered to be limited (see Raghavan et al., 2011). The interest of anglers in conserving their target habitats and fish species opens up opportunities for developing participatory enforcement mechanisms based on existing legislations (see Pinder & Raghavan, 2013).

In considering the value of 'stocking' as a potential conservation tool, domestic anglers scored this more highly (4.2/5.0) than UK anglers (3.5/5.0). The comments associated with this question were of particular interest as UK anglers expressed awareness of the potential for genetic pollution and the need for decisions on stocking policy to be informed by the historical and current population status of a species within catchments (Hickley and Chare, 2004; Everard and Kataria, 2011; Pinder and Raghavan, 2013). Stocking for angling species has been carried out in major river systems of India (Pinder and Raghavan, 2013), and this could have influenced the responses of domestic anglers. However, comparatively higher awareness among UK anglers could be another reason, as the spread of knowledge regarding the associated issues with stocking of fish species is still in its infancy in India. Indeed, the IUCN Guidelines for Reintroductions and other Conservation Translocations explicitly suggests that reintroduction should be beneficial to the species in question and the ecosystem it occupies, and should only be carried out after focused scientific research (IUCN/SSC,

2013). Hence, stock augmentation for the sole purpose of increasing angler catches (numbers and/or size of fish) should be avoided. This is particularly true of the mahseers for which satisfactory knowledge pertaining to population genetics across India (and beyond) is still lacking (Pinder and Raghavan, 2013).

Along with socio-economic benefits, the efficacy of C&R fishery management in conserving fish populations has been demonstrated in many regions of the world (Arlinghaus, 2006; Granek et al., 2008). Therefore, the high agreement rate (99%; n=148) of anglers that C&R fisheries have the potential to form effective conservation measures was not surprising (see Table 2). Hence, both groups (UK and domestic) expressed personal willingness to contribute their own time and money to support conservation initiatives within the rivers they fish. Willingness to pay (WTP) represents a successful model of protecting fish populations (Gozlan et al., 2013; Rogers, 2013) and enhance recreational fishery performance (Kenter et al., 2013). Added protection of river reaches can also enhance biodiversity and associated ecosystem services (Kenter et al., 2013). There is also potential for the revenue generated through C&R angling initiatives to feedback to local communities, and further strengthen societal support for future river and fish conservation strategies (Everard and Kataria, 2011).

4. Conclusions

Both UK and domestic anglers fishing in India have demonstrated conservation awareness and a willingness to support local conservation initiatives. This is important as the industry is in an expansion phase in the country, and such collaborative opportunities could assist ongoing and future river and fish conservation strategies. However, there are concerns among C&R anglers that biodiversity managers and policy makers would initiate strict management

of C&R angling activities in Indian rivers. This is because there are serious concerns that some C&R anglers cause more risk than benefits to the fish species they target, especially threatened species (Gupta et al., in press). Further, domestic anglers were comparatively unaware of the genetic risks of stocking (see Table 1). This highlights the importance of spreading awareness through education. This can be facilitated by the existing angling organizations among its members through angling workshops and literature. Additionally, Indian anglers are interested in a much greater diversity of rivers and fish species (see Table 1). This is a positive sign from a national perspective and demonstrates that C&R benefits beyond mahseer, the Cauvery and Ganges.

Apart from having a current global value in billions (in US$) (FAO, 2012) C&R angling has also generated substantial income for national economies (Cooke and Suski, 2005; Cowx et al., 2010; Danylchuk and Cooke, 2011; Everard and Kataria, 2011). Economic benefits in the year 2005 alone were estimated at US$2 billion in Canada, US$800 million in New Zealand, US$150 million in Argentina, and US$10-15 million in Chile (Arismendi and Nahuelhual, 2007). The amount of money spent by anglers fishing Indian rivers represents an emerging economy, and could play a decisive role for fish conservation by bringing both social and economic benefits for local communities and associated stakeholders. Everard and Kataria (2011) noted that a single 5-day angling tour for three anglers on the Ramganga River in 2007 generated US$ 1,220; and in 2010 (February-April), US$ 7,800 was spent by anglers in this region on purchases and accommodation alone (Everard and Kataria, 2011). Such monetary incentives could motivate locals people to participate voluntarily in fish tourism, and assist in the protection of threatened species from illegal fishing techniques (Everard and Kataria 2011; Pinder and Raghavan, 2013).

As the industry expands, there remains a need to maintain transparency during the profit sharing stages, and ensure the marginalization of any particular group of stakeholders is avoided. C&R anglers frequenting the Indian rivers have expressed concern over the acceptable distribution of angling derived revenue by some angling tourism operators (see Gupta at al. in review). One way to overcome this would be to set up community conservation units (CCUs) within local villages, the members of whom could interact with local angling associations and ensure that appropriate dividends reach their communities. With the current perilous state of Indian rivers and their associated biodiversity, there is an urgent need for alternate conservation strategies, and C&R anglers as a local stakeholder group could potentially provide such an opportunity.

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References

Andrews, D., Nonnecke, B., Preece, J., 2003. Electronic survey methodology: A case study in reaching hard to involve Internet Users. Int. J. Hum. Comput. Interact. 16, 185–210.

Arismendi, I., Nahuelhual, L., 2007. Non-native Salmon and Trout Recreational Fishing in Lake Llanquihue, Southern Chile: Economic Benefits and Management Implications. Rev. Fish. Sci. 15, 311–325.

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

309 Arlinghaus, R., Cooke, S.J., Lyman, J., Policansky, D., Schwab, A., Suski, C., Sutton, S.G.,
310 Thorstad, E.B., 2007. Understanding the Complexity of Catch-and-Release in
311 Recreational Fishing: An Integrative Synthesis of Global Knowledge from Historical,
312 Ethical, Social, and Biological Perspectives. Rev. Fish. Sci. 15, 75–167.

313 Bailey, D.H., 2012. Collaborative Conservation of Taimen (*Hucho taimen*) Through
314 Education and Awareness Khovsgol Aimag Mongolia. Theses, Diss. Prof. Pap. Pap.
315 203.

316 Brummet, R.E., Beveridge, M.C.M., Cowx, I.G., 2013. Functional aquatic ecosystems, inland
317 fisheries and the Millennium Development Goals. Fish Fish. 14, 312–324.

318 Carrizo, S. F., Smith, K. G., Darwall, W.R.T., 2013. Progress towards a global assessment of
319 the status of freshwater fishes (Pisces) for the IUCN Red List: application to
320 conservation programmes in zoos and aquariums. Int. Zoo Yearb. 47, 46–64.

321 Collen, B., Whitton, F., Dyer, E.E., Baillie, J.E.M., Cumberlidge, M., Darwall, W.R.T.,
322 Pollock, C., Richman, N.I., Soulsby, A.M., Bohm, M., 2014. Global patterns of
323 freshwater species diversity, threat and endemism. Glob. Ecol. Biogeogr. 23, 40-51.

324 Cooke, S.J., Paukert, C., Hogan, Z., 2012. Endangered river fish: factors hindering
325 conservation and restoration. Endanger. Species Res. 17, 179–191.

326 Cooke, S.J., Cowx, I.G., 2004. The Role of Recreational Fishing in Global Fish Crises.
327 Biosci 54, 857

328 Cooke, S.J., Hogan, Z.S., Butcher, P.A, Stokesbury, M.J.W., Raghavan, R., Gallagher, A.J.,
329 Hammerschlag, N., Danylchuk, A.J., in press. Angling for endangered fish: conservation
330 problem or conservation action? Fish Fish. doi: 10.1111/faf.12076

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

334 Cooke, S. J., Suski, C. D., Arlinghaus, R., Danylchuk, A.J., 2013. Voluntary institutions and
335 behaviours as alternatives to formal regulations in recreational fisheries management.
336 Fish Fish. 14, 439–457.

337 Cowx, I.G., Arlinghaus, R., Cooke, S.J., 2010. Harmonizing recreational fisheries and
338 conservation objectives for aquatic biodiversity in inland waters. J. Fish Biol. 76, 2194–
339 215.

340 Cowx, I.G., Portocarrero Aya, M., 2011. Paradigm shifts in fish conservation: moving to the
341 ecosystem services concept. J. Fish Biol. 79, 1663–80.

342 Dahanukar, N., Raghavan, R., Ali, A., Abraham, R., Shaji, C.P., 2011. The status and
343 distribution of freshwater fishes of the Western Ghats. In: Molur, S., Smith, K.G.,

344 Daniel, B.A., Darwall, W.R.T (compilers) The status and distribution of freshwater
345 biodiversity in the Western Ghats, India. IUCN Cambridge and Zoo Outreach
346 Organization. Coimbatore. 116p.

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

349 Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.-I., Knowler, D.J., Lévêque, C.,
350 Naiman, R.J., Prieur-Richard, A.-H., Soto, D., Stiassny, M.L.J., Sullivan, C.A., 2006.
351 Freshwater biodiversity: importance, threats, status and conservation challenges. Biol.
352 Rev. Camb. Philos. Soc. 81, 163–82.

353 Dudgeon, D., 2011. Asian river fishes in the Anthropocene: threats and conservation
354 challenges in an era of rapid environmental change. J. Fish Biol. 79, 1487–1524.

355 Dugan, P., Dey, M.M., Sugunan, V.V., 2006. Fisheries and water productivity in tropical
356 river basins: Enhancing food security and livelihoods by managing water for fish. Agric.
357 Water Manag. 80, 262–275.

358 Everard, M., Kataria, G., 2011. Recreational angling markets to advance the conservation of a
359 reach of the Western Ramganga River, India. Aquat. Conserv. Mar. Freshw. Ecosyst. 21,
360 101–108.

361 FAO., 2012. Recreational fisheries. FAO Technical Guidelines for Responsible Fisheries, No
362 13. Food and Agricultural Organization of the United Nations, Rome. 176p.

363 Gozlan, R.E., Burnard, D., Andreou, D., Britton, J.R., 2013. Understanding the threats posed
364 by non-native species: public vs. conservation managers. PLoS One 8, e53200.

365 Granek, E.F., Madin, E.M.P., Brown, M. A., Figueira, W., Cameron, D.S., Hogan, Z.,
366 Kristianson, G., de Villiers, P., Williams, J.E., Post, J., Zahn, S., Arlinghaus, R., 2008.
367 Engaging recreational fishers in management and conservation: global case studies.
368 Conserv. Biol. 22, 1125–34.

369 Hasler, C.T., Colotelo, A.H., Rapp, T., Jamieson, E., Bellehumeur, K., Arlinghaus, R.,
370 Cooke, S.J., 2011. Opinions of Fisheries Researchers, Managers, and Anglers towards
371 Recreational Fishing Issues: An Exploratory Analysis for North America. Am. Fish.
372 Soc. Symp. 75, 51–74.

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

375 Hunt, L.M., Sutton, S.G., Arlinghaus, R., 2013. Illustrating the critical role of human
376 dimensions research for understanding and managing recreational fisheries within a
377 social-ecological system framework. Fish. Manag. Ecol. 20, 111–124.

378 IUCN/SSC, 2013. Guidelines for Reintroductions and Other Conservation Translocations.
379 Version 1.0. Gland, Switzerland: IUCN Species Survival Commission, viiii + 57 pp.

Kenter, J.O., Bryce, R., Davies, A., Jobstvogt, N., Watson, V., Ranger, S., Solandt, J.L., Duncan, C., Christie, M., Crump, H., Irvine, K.N., Pinard, M., Reed, M.S., 2013. The value of potential marine protected areas in the UK to divers and sea anglers. UNEP-WCMC, Cambridge, UK.

Lazar, J., Preece, J., 1999. Designing and implementing Web-based surveys. J. Comput. Inf. Syst. 39, 63–67.

McDonald, R.I., Green, P., Balk, D., Fekete, B.M., Revenga, C., Todd, M., Montgomery, M., 2011. Urban growth, climate change, and freshwater availability. Proc. Natl. Acad. Sci. U. S. A. 108, 6312–7.

Oppermann, M., 1995. E-mail surveys: Potentials and pitfalls. Mark. Res. 7, 28.

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

Raghavan, R., Ali, A., Dahanukar, N., Rosser, A., 2011. 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.

Raghavan, R., Dahanukar, N., Tlusty, M.F., Rhyne, A.L., Kumar, K.K., Molur, S., Rosser, A.M., 2013. Uncovering an obscure trade: Threatened freshwater fishes and the aquarium pet markets. Biol. Conserv. 164, 158–169.

Reid, G.M., MacBeath, T.C., Csatadi, K., 2013. Global challenges in freshwater-fish conservation related to public aquariums and the aquarium industry. Int. Zoo Yearb. 47, 6–45.

Rogers, A.A., 2013. 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.

Strayer, D.L., Dudgeon, D., 2010. Freshwater biodiversity conservation: recent progress and future challenges. J. North Am. Benthol. Soc. 29, 344–358.

TWFT, 1984. The quest for the legendary fish. Trans World Fishing Team. International Book Distributors. 160p.

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

Vörösmarty, C.J., McIntyre, P.B., Gessner, M.O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S.E., Sullivan, S.A., Liermann, C.R., Davies, P.M., 2010. Global threats to human water security and river biodiversity. Nature 467, 555–61.

Welcomme, R.L., Cowx, I.G., Coates, D., Béné, C., Funge-Smith, S., Halls, A., Lorenzen, K., 2010. Inland capture fisheries. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 365, 2881–96.

WWF, 2006. Free-flowing rivers Economic luxury or ecological necessity? World Wildlife Fund, 44p.

Xenopoulos, M.A., Lodge, D.M., Alcamo, J., Märker, M., Schulze, K., Van Vuuren, D.P., 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. Glob. Chang. Biol. 11, 1557–1564.

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

427 **Table 1**: Summary of responses obtained from recreational anglers fishing in the Indian rivers
428

Criteria	**UK anglers (n= 40)**	**Domestic anglers (n=108)**
Preferred fishing locations (rivers)	(a) Cauvery: 75% (b) Kali: 6% (c) Ramganga: 19%	Assi Ganga, Barak, Beas, Bhadra, Bhagirathi, Bhakra, Bhatsa, Bhavani, Bhilangana, Bhima, Cauvery, Damodar, Gambur, Ganga, Giri, Godavari, Indrayani, Jaldhaka, Jia Bharali, Kali, Kallada, Kamini, Kosi, Krishna, Manjira, Mula, Narmada, Nira, Pavana, Ramganga, Rangeet, Ravi, Saryu, Shimsha, Subansiri, Sutlej, Teesta, Tirthan, Tons, Tungabhadra, Ulhas, Wardha, Warna and Yamuna
Preferred target fish species	(a) *Tor* spp: 82% (b) *Bagarius bagarius*: 18%	(a) *Barbodes carnaticus, Ctenopharyngodon idella, Gibelion catla, Hypselobarbus* spp, *Oncorhynchus mykiss, Salmo trutta, Schizothorax richardsonii, Labeo calbasu, Labeo rohita, Channa marulius, C. striata, Etroplus suratensis, Oreochromis* spp, *and Wallago attu*: 61% (b) *Tor* spp: 26% (c) *Bagarius bagarius*: 13%
Fishing techniques (score from 1-5, where 5 = most preferred; mean score)	(a) Bait (live/dead): 3.6 (b) Lure/spinner: 3.6 (c) Fly fishing: 3.2	(a) Bait (live/dead): 3.6 (b) Lure/spinner: 4.1 (c) Fly fishing: 2.2
Factors influencing angling experience (score from 1-5, where 5 = strongly agree; mean score)	(a) Angling quality: 4.8 (b) Aesthetics of surroundings: 4.7 (c) Presence of other wildlife: 4.5 (d) Fishery management practices: 4.8 (e) Inclusion of, and financial benefit to local communities: 4.6 (f) Camp infrastructure: 3.6	(a) Angling quality: 4.4 (b) Aesthetics of surroundings: 4.4 (c) Presence of other wildlife: 4.2 (d) Fishery management practices: 4.4 (e) Inclusion of, and financial benefit to local communities: 4.1 (f) Camp infrastructure: 3.7

Criteria	UK anglers (n=40)	Domestic anglers (n=108)
Changes in quality of angling experience at the angling locations	(a) Negative change: 75% (b) Positive change: 25%	(a) Negative change: 65% (b) Positive change: 35%
Threats to target fish species and fishing locations (score from 1-5, where 5 = strongly agree; mean score)	(a) Deforestation: 4.2 (b) Water abstraction: 4.6 (c) Hydropower projects: 4.3 (d) Water pollution: 4.3 (e) Destructive fishing techniques: 4.8	(a) Deforestation: 4.2 (b) Water abstraction: 4.2 (c) Hydropower projects: 4.1 (d) Water pollution: 4.5 (e) Destructive fishing techniques: 4.6
Awareness regarding conservation status of target species (score from 1-5, where 5 = strongly aware; mean score)	3.3	3.4
Conservation strategies for target species (score from 1-5, where 5 = strongly agree; mean score)	(a) Afforestation: 4.1 (b) Legislation: 4.7 (c) Scientific research: 4.0 (d) Anti-poaching patrol: 4.8 (e) Harsher fines: 4.5 (f) Education: 5.0 (g) Stocking: 3.5	(a) Afforestation: 4.0 (b) Legislation: 4.5 (c) Scientific research: 4.6 (d) Anti-poaching patrol: 4.8 (e) Harsher fines: 4.6 (f) Education: 4.8 (g) Stocking: 4.2
Perceptions on angling as a conservation strategy	(a) Yes: 100% (b) No: 0%	(a) Yes: 97% (b) No: 3%
Willingness to pay for and support conservation action (score from 1-5, where 5 = very interested; mean score)	4.5	4.8

Table 2: Dominant responses obtained from C&R anglers (UK + Indian; n=148) regarding the benefits of angling as a tool for conservation of threatened fish species in India

Activity during C&R angling	Benefits to threatened fish species	Reasons
Monitoring	(a) Protection against poachers	(a) Discourages poaching activities
	(b) Helps build recognition for the species	(b) Limits poaching
	(c) Helps raise conservation awareness among the wider C&R angling community	(c) Provides more eyes on the water
	(d) Keeps track of fish counts, species diversity and habitat status	
	(e) Helps assess the health and quality of the fishery, if applicable	
Prolonged presence along rivers	(a) Effective bankside protection	(a) Deterrent to poachers
	(b) A source of first-hand information on natural and anthropogenic factors affecting fish species	(b) More easily accessible information regarding fish species
Revenue generation	(a) Future conservation work	(a) Local availability of funds
	(b) Formation of local anti-poaching patrol parties	(b) Economic influence by financially supporting local communities
Involvement of local stakeholders	(a) Formation of local groups targeting the conservation of fish species	(b) Creation of local job opportunities and training
		(c) Local awareness and education
		(d) Spreading understanding of the high value of protecting fish species for sustainable recreational purposes
		(e) Resulting political influence

Table 3: Angling locations in the three most important river systems targeted by survey respondents (see Fig 1)

River	Location	Coordinates
Cauvery	Bheemeshwari[1]	12.312N, 77.274E
Cauvery	Dodamakalli[1]	12.334N, 77.181E
Cauvery	Forbes Sagar/WASI Lakes	12.973N, 77.641E
Cauvery	Galibore[1]	12.282N, 77.374E
Cauvery	Krishna Raja Sagar (KRS) Dam	12.413N, 76.574E
Cauvery	Valnur (Kodagu)	12.354N, 75.873E
Jia Bharali	Tezpur	26.933N, 92.834E
Ramganga	Bikhyasen	29.695N, 79.260E
Ramganga	Ramnagar	29.605N, 79.092E

[1]recreational fisheries is now closed (see Pinder and Raghavan, 2013)

Supplementary material: catch-and-release angling survey questionnaire

This questionnaire aims to investigate the available positive support from the catch-and-release angling community for river and fish conservation on a global scale. The data gathered will be used for an article which will highlight a possible two-pronged approach where research scientists and catch-and-release anglers work together to bring about conservation benefits.

1) What is your age?

Under 18
Between 18 - 24
Between 25 - 34
Between 35 - 44
Between 45 - 54
Between 55 - 64
Over 65

2) Sex

Male
Female

3) Nationality

4) Which of these international/national organizations do you have affiliation(s) with?

Wildlife Association of South India (WASI)
Mahseer Trust
The Himalayan Outback
Coorg Wildlife Society (CWS)
WWF
Angling Trust
AIGFA
MSAA
IGFA
The Billfish Institute
Other:

5) On average, how many angling excursions do you make per year in your own country?

None
1 - 3
4 - 6
7 - 10
11 - 20
Over 20

6) On average, how many angling excursions do you make per year outside your own country?

None
1 - 3
4 - 6
7 - 10
11 - 20
Over 20

7) Which of these continents have you visited for recreational angling activities?

North America
South America
Australia
Asia
Africa
Europe
Antarctica

8) Which of these Asian countries have you visited for recreational angling activities?

India
Malaysia
Sri Lanka
Nepal
Indonesia
Other:

9) If in India, which of these rivers do you target?

Cauvery
Kali
Ramganga
Other:

10) In Asia, which of these are your main target fish species?

Mahseer
Cat fishes (Goonch)
Marine species
Other:

11) Which of these do you prefer as your angling method? (Please provide a score from 1 - 5, where 5 is the most favored)

1 2 3 4 5

Bait
Live/dead bait

Lure/spinner
Fly

12) Regarding your angling experience, are the below-mentioned factors important to you?

Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree

Angling quality
Aesthetics of surroundings
Other wildlife
Catch and release (suitable fishery management practices)
Camp infrastructure
Inclusion of, and financial benefit to local communities

13) Have you observed a change in angling quality over the years?

Yes
No

14) What are these changes?

Positive changes
Negative changes
No change

15) In your opinion, are the below-mentioned threats impacting your target fish species, and your leisure experience?

Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree

Deforestation
Water abstraction
Hydro projects (flow regulation)
Water pollution
Destructive fishing techniques

16) Do you feel the below-mentioned conservation efforts need to be implemented to protect and conserve the fish biodiversity in the region?

Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree

Afforestation
Legislation protecting threatened species
Scientific research (enhance understanding of population trends and key habitat requirements)
Effective anti-poaching patrol
Harsher fines for culprits
Education
Stocking

17) Have you witnessed destructive fishing techniques first hand?

Yes
No

18) How much money do you spend annually towards recreational angling activities (in £)?

0
1 - 3000
3001 - 6000
6001 - 9000
9001 - 12000
Above 12001

19) How aware are you of the conservation status (IUCN Red List) of the fish species you target?

Strongly unaware
Unaware
Neither aware nor unaware
Aware
Strongly aware

20) Do you think that recreational angling can benefit the conservation of threatened species?

Yes
No

Please explain your answer to the above.

21) How willing would you be to get involved in a conservation initiative in your angling region?

Very interested
May be
Not at all interested

22) Would you be willing to contribute your time and money for such an initiative?

Yes, time and money both
Yes, but only time
Yes, but only money
Neither time nor money

23) Any additional comments

Figure 1

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