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SHORT COMMUNICATION

Stakeholder perceptions of human–predator conflict in the South African fly-fishing industry

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Abstract

Human–wildlife conflict in African aquaculture and fisheries is poorly understood. We investigated this conflict through a questionnaire aimed at owners and managers of fly-fishing properties in South Africa. While perceptions of losses varied, all respondents reported losses to predators. Resulting mitigation measures, including lethal control, were employed mostly against cormorants (*Phalacrocorax* spp.) and otters (*Aonyx capensis* and *Hydrictis maculicollis*). Given that fly-fishing properties potentially provide valuable habitat for protected species such as otters, our results highlight a need for improved mitigation measures and exploring alternative options of potentially generating income from tourism associated with the presence of charismatic predators.

Résumé

Les conflits entre l'homme et la faune dans l'aquaculture et la pêche en Afrique sont mal compris. Nous avons analysé ce conflit à l'aide d'un questionnaire destiné aux propriétaires et aux responsables d'établissements de pêche à la mouche en Afrique du Sud. Bien que les perceptions des pertes soient différentes, toutes les personnes interrogées ont déclaré avoir subi des pertes dues à des prédateurs. Les mesures d'atténuation qui en ont résulté, y compris le contrôle létal, ont été employées principalement contre les cormorans (*Phalacrocorax* spp.) et les loutres (*Aonyx* capensis et *Hydrictis maculicollis*). Étant donné que les établissements de pêche à la mouche offrent potentiellement un habitat précieux pour des espèces protégées telles que les loutres, nos résultats soulignent la nécessité d'améliorer les mesures d'atténuation et d'explorer d'autres moyens de générer des revenus à partir du tourisme associé à la présence de prédateurs charismatiques.

1 | INTRODUCTION

Aquaculture and fishing industries have a long history of human–wildlife conflict, with piscivorous species considered either an active threat or at least a nuisance with regard to fish stocks (Burr et al., 2020; Cook et al., 2022; Cummings et al., 2019). While conflict between inland fishing interests (commercial, subsistence and recreational) and predators such as spotted-necked otters (*Hydrictis maculicollis*) (Akpona et al., 2015), African clawless otters (*Aonyx capensis*) (Butler, 1994; Ergete et al., 2018) and white-breasted cormorants (*Phalacrocorax carbo lucidus*) (Linn & Campbell, 1992) are known to occur in parts of Africa, little is known about the extent and effects of such conflicts as compared to many other parts of the world.

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South Africa has a well-established and widespread inland fly-fishing industry that provides jobs and income to some of the poorest and most rural regions of the country (du Preez & Lee, 2010). Fly-fishing is mostly centred on hatchery-reared rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) and most fishing properties employ a put-and-take system. Stocked trout face many challenges to their survival including competition with conspecifics, angling, as well as injury or mortality from piscivorous predators. Indeed, recent work demonstrated that trout form a substantial part of the diets of both African clawless- and spotted-necked otters foraging on fly-fishing properties (Jordaan et al., 2019, 2020). Furthermore, densities of African clawless otter are substantially higher on some of these properties, when compared to nearby natural areas (Majelantle et al., 2021). African clawless otters are considered near threatened in southern Africa (Okes et al., 2016) and spotted-necked otters vulnerable (Ponsonby et al., 2016), with both species classified as Near Threatened globally (Jacques et al., 2015; Reed-Smith et al., 2015). Fly-fishing properties likely provide valuable habitats for otters and other piscivorous species, but their utilisation of these habitats could be in jeopardy if these predators are perceived as serious threats to stocked fish.

We therefore aimed to explore the perceptions of stakeholders in the South African fly-fishing industry towards fish predators using a questionnaire. While we expected that industry stakeholders experience some losses to fish predators and implement some preventative measures to limit such losses, our key questions focused on (a) what the perceived extent of fish loss to predators is; (b) which predators are perceived as posing the biggest risk to fish stocks; and (c) what, if any, preventative measures are implemented. Understanding of these questions is not only important for quantifying the extent of human–wildlife conflict in this industry but also to direct future assessments and mitigation actions in Africa.

2 | METHODS

The questionnaire we developed was arranged into sections, comprising 33 questions, with an estimated completion time of 10–15 min. The first section of five questions addressed the background and demographics of respondents and included questions on their experience (e.g. how long they had been involved in the fly-fishing industry, their current role etc.). This was followed by a section of 12 questions related to the location of the fishing property, the size(s) of waterbodies, species of fish stocked, stocking frequency and stocking density. The third section of 11 questions was aimed at understanding the respondents' perception of fish depredation and predators on their property. This included a question requesting respondents to rate on a Likert scale the threat posed by a series of common piscivorous predators, including otters, water mongoose (*Atilax paludinosus*), cormorants, herons (*Ardea* spp.) and fish eagles (*Haliaeetus vocifer*). Accordingly, respondents rated the perceived threat level of the respective predators on a level of 1–5, with 1 constituting no threat, while 5 constituted a very high threat to fish stocks. It further included questions on whether respondents implemented any preventative measures, and a description of these. Lastly, this section also included two questions exploring respondents' opinions on any of the fish predators as drawcards for tourists and guests. The final section of the questionnaire consisted of three questions exploring the fishing practices on the relevant properties, specifically if catch-and-release angling was practiced and the regularity thereof. The complete questionnaire is available as Supplementary Material in Data S1.

We identified fly-fishing properties in 2017 by means of Internet searches as well as referrals. Property managers/owners (hereafter 'stakeholders') were invited to participate via e-mail, followed by telephone calls if no response was received via e-mail. Stakeholders had the option of completing the online version of the questionnaire or be interviewed telephonically in English or Afrikaans. The same questionnaire was used for both the online and telephonic versions, and all telephone interviews were conducted by the first author who captured all responses.

Demographic associations with differences in the perceptions of respondents were investigated by means of chi-square tests. When the expected values of contingency table cells were smaller than 5, a Fisher's exact test was used. We similarly used chi-square tests (or Fischer's exact tests) to investigate whether there were demographic differences in the reported presence/absence of individual predator species. Responses to open-ended questions were categorised to analyse potential differences related to respondent demographics. Google Forms was used to capture responses while Microsoft Excel 2013 and SPSS version 24.0 (IBM Corp, 2016) were used to sort and analyse the data. Unless stated otherwise, quantitative results are reported as means ± standard deviations.

3 | RESULTS AND DISCUSSION

A total of 22 responses were obtained from the 98 fly-fishing properties contacted. Three responses were completed online, while 19 responses were obtained by telephone interview. The majority of respondents were male (86%), older than 40 years (77%) and had been involved in the fly-fishing industry for 10 or more years (64%). Represented properties were scattered over six provinces, but the majority of responses came from the provinces of Mpumalanga (32%) and KwaZulu-Natal (32%) and varied in size (mean 1059.8 ± 293.46 hectares), number of dams present (mean 5.16 ± 0.94) and sizes of dams (mean 68,700 ± 22,300 m^2). A river or stream was present on 68% of the properties. Stocking practices were similarly variable and where estimates were provided ($n = 19$) were categorised as less than twice a year (42%) and greater than or equal to twice a year (58%). A Fisher's exact test revealed no significant differences in stocking practices across different provinces ($p > 0.05$). Catch-and-release angling was practiced by all but one property manager. Despite the relatively small sample size we present here, novel views on predators and fish stocks were limited after the first 10 responses. The point at which data collection no longer yields any novel or relevant

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information is defined by many as 'saturation' (Dworkin, 2012), a concept used by many scholars to determine sample size when conducting qualitative research (Mason, 2010). Therefore, the results reported are likely to provide a reasonable representation of the perceptions of, and mitigation measures employed by, fly-fishing property managers in South Africa regarding piscivorous predators.

All respondents reported experiencing fish losses to predators. Respondents had varying perceptions as to the extent of predator-induced fish losses—33% of respondents perceived losses to be small, 38% as medium and 29% perceived losses as extensive in relation to other sources of fish losses, such as disease or angling induced mortality. Otters (*A. capensis* and *H. maculicollis*) obtained a mean perceived threat level of 3.12 (SE 0.25), cormorants (mostly *P. c. lucidus*) 3.33 (SE 0.29), fish eagles 1.74 (SE 0.23) and herons (mostly *Ardea cinerea*) 2.00 (SE 0.27) (Figure 1). These findings are in line with those of Kloskowski (2011), who correspondingly reported cormorants (*P. carbo*) to be the most widely targeted species at Polish pond fisheries, with lethal controls being the most popular mitigation measure, while most damage to pond fisheries were attributed to otters (*L. lutra*) and cormorants (*P. carbo*). Human–wildlife conflict involving otters have been reported on all continents where otters occur (e.g. Adámek et al., 2003; Akpona et al., 2015; Freitas et al., 2007), while cormorants are similarly notorious for their conflicts with the fish industry (Dehnhard et al., 2021; Marzano et al., 2013). Cormorants are known to forage either singly or communally in groups (Linn & Campbell, 1992) and foraging in a flock likely increase both the perceived and actual damage done by these birds. Reasons for the generally low perceived threat posed by herons likely include their mostly solitary foraging behaviour and reported tendency to drive away other birds that could compete with them for resources (Cook, 1978). Similarly, African fish eagles are highly territorial and resident pairs will actively defend their territories against other fish eagles (Krueger, 1997), making it unlikely that fish eagle numbers will be high enough on fly-fishing properties to present a serious threat to fish stocks.

Experienced respondents (10 years or more involvement in the fly-fishing industry) rated fish losses as extensive in 43% of responses, while none of the less experienced respondents perceived losses as being extensive. Fischer's exact tests revealed no significant overall differences in the reported level of fish losses in terms of respondent experience, geographic location, stocking frequency, river/stream presence or perceived attractive value of predators ($p > 0.05$).

Respondents believed that fish predators attract guests or contribute to guest experience in 59% of the responses, while 23% felt that predators did not attract guests, and 18% of the respondents were unsure of the attractive value of predators. However, of the respondents that believed fish predators to have attractive value, only 46% considered this attraction to fully or to some extent compensate for predator-induced fish loss, while 54% felt that it did not compensate for fish losses. Dumalisile et al. (2005) reported that 90% of tourist respondents reported interest in seeing otters and were willing to pay a fee for a trained guide to show them otters, concluding that otters have the potential to enhance ecotourism in their study area (Eastern Cape Wild Coast, South Africa).

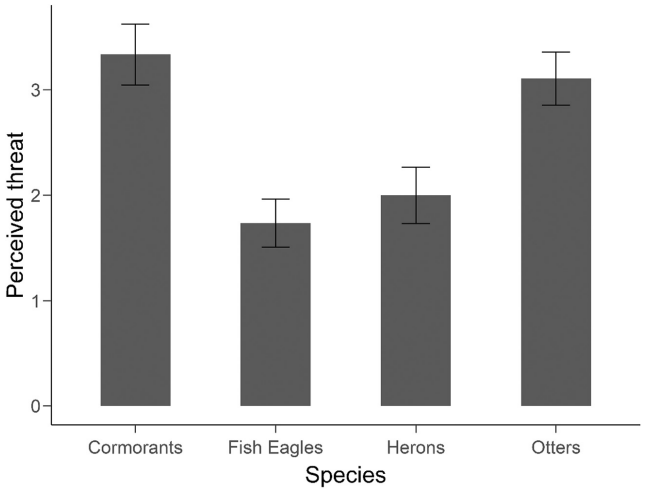

FIGURE 1 Mean perceived threat of various predators to fish stocks. Threat was rated on a scale of 1–5, with 1 being no threat and 5 being a very large threat. Error bars represent standard error.

Fifty-five percentage of the respondents reported employing mitigation measures to reduce predation and 45% of respondents reported not employing mitigation measures. Mitigation measures varied greatly, with some respondents using multiple means—of the 12 respondents that reported employing preventative measures, 50% employed lethal measures (shooting to kill), 58% used scaring tactics (non-lethal shooting, human patrols and other scaring devices) and 25% used physical barriers (such as fencing and nets) to deter predators. Cormorants were reported as targets by all respondents who said they employ mitigation measures, while 36% reported to target otters, and 36% reported to target other piscivorous predators (e.g. herons and fish eagles). Lethal action (i.e. shooting to kill) (employed by six respondents) was mainly aimed at cormorants (83% of responses) and to a lesser extent otters (33%). Mitigation measures were employed by 38% of respondents with a stocking frequency of less than twice a year and 64% of respondents with a stocking frequency greater than or equal to twice a year. Fischer's exact tests revealed no significant relationships between respondents' use of mitigation measures with either respondent experience, geographic location, stocking frequency, reported level of fish losses or perceived attractive value of predators ($p > 0.05$). Preventative measures against fish predators are often considered to be ineffective, highly variable in efficacy or too costly (e.g. Bregnballe et al., 2015; Quick et al., 2004). The efficiency of culling predators in this context as a mitigation strategy remains to be quantified and is likely to be temporary (Chamberlain et al., 2013).

Our exploratory study illustrates that conflict with piscivorous predators is common in freshwater fisheries in South Africa and that cormorants and otters are perceived to pose the biggest threat to fish stocks. Control measures are not implemented throughout but,

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when implemented, include lethal measures. Our results suggest that there exists a need for suitable mitigation measures to alleviate human–predator conflict in this industry. Despite the negative impacts of trout introduced to Southern Africa for fly-fishing purposes (see review by Ellender & Weyl, 2014), the habitat that these properties provide to many indigenous species should be considered when environmental regulations pertaining to the fly-fishing industry are made. The seemingly common occurrence of otters on fishing properties points to the potential importance of suitable, albeit not natural, habitat provided by this form of land use. However, for these properties to provide a continuous habitat for piscivorous predators, ways of mitigating human–wildlife conflict that are both beneficial for predator conservation as well as the economics of the fishing property are needed. Here, the possibility of creating income from the presence of predators, and/or employing suitable long-term mitigation measures to reduce predator-induced damage requires attention from both the research community and all relevant stakeholders. Ultimately, in the face of a globally expanding human population, human–wildlife conflict remains one of the most extensive challenges to conservation efforts (Browne-Nuñez & Jonker, 2008; Dickman, 2010). Researching human–wildlife conflict in areas or industries where information is comparatively scarce will form a crucial part of addressing this conservation challenge.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Copies of the anonymised data set may be requested from the authors.

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REFERENCES

Adámek, Z., Kortan, D., Lepič, P., & Andreji, J. (2003). Impacts of otter (*Lutra* L.) predation on fishponds: A study of fish remains at ponds in the Czech Republic. *Aquaculture International*, *11*(4), 389–396. https://doi.org/10.1023/A:1025787330366

Akpona, A. H., Djagoun, C. A. M. S., Harrington, L. A., Kabré, A. T., Mensah, G. A., & Sinsin, B. (2015). Conflict between spotted-necked otters and fishermen in Hlan River, Benin. *Journal for Nature Conservation*, *27*, 63–71. https://doi.org/10.1016/j.jnc.2015.06.007

Bregnballe, T., Hyldgaard, A. M., Clausen, K. K., & Carss, D. N. (2015). What does three years of hunting great cormorants, *Phalacrocorax carbo*, tell us? Shooting autumn-staging birds as a means of reducing numbers locally. *Pest Management Science*, *71*(2), 173–179. https://doi.org/10.1002/ps.3782

Browne-Nuñez, C., & Jonker, S. A. (2008). Attitudes toward wildlife and conservation across Africa: A review of survey research. *Human Dimensions of Wildlife*, *13*(1), 47–70. https://doi.org/10.1080/10871200701812936

Burr, P. C., Avery, J. L., Street, G. M., Strickland, B. K., & Dorr, B. S. (2020). Piscivorous bird use of aquaculture and natural water bodies in Mississippi. *Journal of Wildlife Management*, *84*(8), 1560–1569. https://doi.org/10.1002/jwmg.21948

Butler, J. (1994). Cape clawless otter conservation and a trout river in Zimbabwe: A case study. *Oryx*, *28*(4), 276–282. https://doi.org/10.1017/S0030605300028684

Chamberlain, D. E., Austin, G. E., Newson, S. E., Johnston, A., & Burton, N. H. K. (2013). Licensed control does not reduce local cormorant *Phalacrocorax carbo* population size in winter. *Journal of Ornithology*, *154*(3), 739–750. https://doi.org/10.1007/s10336-013-0938-3

Cook, D. C. (1978). Grey herons *Ardea cinerea* holding feeding territories on the Ythan estuary. *Bird Study*, *25*(1), 11–16. https://doi.org/10.1080/00063657809476569

Cook, P., Hawes, J. E., Campos-Silva, J. V., & Peres, C. A. (2022). Human-wildlife conflicts with crocodilians, cetaceans and otters in the tropics and subtropics. *PeerJ*, *9*, 1–25. https://doi.org/10.7717/peerj.12688

Cummings, C. R., Lea, M. A., & Lyle, J. M. (2019). Fur seals and fisheries in Tasmania: An integrated case study of human-wildlife conflict and coexistence. *Biological Conservation*, *236*, 532–542. https://doi.org/10.1016/j.biocon.2019.01.029

Dehnhard, N., Langset, M., Aglen, A., Lorentsen, S. H., & Anker-Nilssen, T. (2021). Fish consumption by great cormorants in Norwegian coastal waters – A human-wildlife conflict for wrasses, but not gadids. *ICES Journal of Marine Science*, *78*(3), 1074–1089. https://doi.org/10.1093/icesjms/fsab004

Dickman, A. J. (2010). Complexities of conflict: The importance of considering social factors for effectively resolving human-wildlife conflict. *Animal Conservation*, *13*(5), 458–466. https://doi.org/10.1111/j.1469-1795.2010.00368.x

du Preez, M., & Lee, D. E. (2010). The contribution of trout fly fishing to the economy of Rhodes, north eastern cape, South Africa. *Development Southern Africa*, *27*(2), 241–253. https://doi.org/10.1080/03768351003740654

Dumalisile, L., Somers, M., Walters, M., & Nel, J. (2005). Tourists' willingness to pay to view otters along the wild coast, South Africa: A potential for increased ecotourism. *The Journal for Transdisciplinary Research in Southern Africa*, *1*(1), 10. https://doi.org/10.4102/td.v1i1.304

Dworkin, S. L. (2012). Sample size policy for qualitative studies using in-depth interviews. *Archives of Sexual Behavior*, *41*(6), 1319–1320. https://doi.org/10.1007/s10508-012-0016-6

Ellender, B. R., & Weyl, O. L. F. (2014). A review of current knowledge, risk and ecological impacts associated with non-native freshwater fish introductions in South Africa. *Aquatic Invasions*, *9*(2), 117–132. https://doi.org/10.3391/ai.2014.9.2.01

Ergete, E. A., Hailemariam, T. W., Balakrishnan, M., & Serfass, T. L. (2018). Fishermen knowledge and conflict with African clawless otters in and around Lake Tana, Ethiopia. *African Journal of Ecology*, *56*(2), 409–413. https://doi.org/10.1111/aje.12447

Freitas, D., Gomes, J., Luis, T. S., Madruga, L., Marques, C., Baptista, G., Rosalino, L. M., Antunes, P., Santos, R., & Santos-Reis, M. (2007). Otters and fish farms in the Sado estuary: Ecological and socio-economic basis of a conflict. *Hydrobiologia*, *587*(1), 51–62. https://doi.org/10.1007/s10750-007-0693-7

IBM Corp. (2016). *IBM SPSS Statistics for Windows, Version 24.0*. IBM Corp.

Jacques, H., Reed-Smith, J., & Somers, M. J. (2015). *Aonyx capensis*. *The IUCN red list of threatened species*. *e.T1793A21*. https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T1793A21938767.en

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Jordaan, R. K., Somers, M. J., Hall, G., & McIntyre, T. (2019). Plasticity and specialisation in the isotopic niche of African clawless otters foraging in marine and freshwater habitats. *Mammalian Biology*, *98*, 61–72. https://doi.org/10.1016/j.mambio.2019.07.006

Jordaan, R. K., Somers, M. J., Hall, G., & McIntyre, T. (2020). The diet of spotted-necked otters foraging in trout-stocked waters in Mpumalanga, South Africa. *African Zoology*, *55*(2), 141–148. https://doi.org/10.1080/15627020.2020.1741447

Kloskowski, J. (2011). Human-wildlife conflicts at pond fisheries in eastern Poland: Perceptions and management of wildlife damage. *European Journal of Wildlife Research*, *57*(2), 295–304. https://doi.org/10.1007/s10344-010-0426-5

Krueger, O. (1997). Population density and intra- and interspecific competition of the African fish eagle *Haliaeetus vocifer* in Kyambura game reserve, Southwest Uganda. *Ibis*, *139*(1), 19–24. https://doi.org/10.1111/j.1474-919x.1997.tb04499.x

Linn, A. I. J., & Campbell, K. L. I. (1992). Interactions between white-breasted cormorants *Phalacrocorax carbo* (Aves: Phalacrocoracidae) and the fisheries of Lake Malawi. *Journal of Applied Ecology*, *29*(3), 619–634.

Majelantle, T. L., Ganswindt, A., Jordaan, R. K., Slip, D. J., Harcourt, R., & McIntyre, T. (2021). Increased population density and behavioural flexibility of African clawless otters (*Aonyx capensis*) in specific anthropogenic environments. *Urban Ecosystems*, *24*, 691–699. https://doi.org/10.1007/s11252-020-01068-1

Marzano, M., Carss, D. N., & Cheyne, I. (2013). Managing European cormorant-fisheries conflicts: Problems, practicalities and policy. *Fisheries Management and Ecology*, *20*(5), 401–413. https://doi.org/10.1111/fme.12025

Mason, M. (2010). Sample size and saturation in Ph.D. studies using qualitative interviews. *Forum Qualitative Sozialforschung*, *11*(3). https://doi.org/10.17169/fqs-11.3.1428

Okes, N., Ponsonby, D., Rowe-Rowe, D., Avenant, N., & Somers, M. (2016). A conservation assessment of *Aonyx capensis*. In M. F. Child, L. Roxburgh, E. Do Linh San, D. Raimondo, & H. T. Davies-Mostert (Eds.), *The red list of mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust.

Ponsonby, D. W., Rowe-Rowe, D., Power, R. J., & Somers, M. J. (2016). A conservation assessment of *Hydrictis maculicollis*. In M. F. Child, L. Roxburgh, E. Do Linh San, D. Raimondo, & H. T. Davies-Mostert (Eds.), *The red list of mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust.

Quick, N. J., Middlemas, S. J., & Armstrong, J. D. (2004). A survey of antipredator controls at marine salmon farms in Scotland. *Aquaculture*, *230*(1–4), 169–180. https://doi.org/10.1016/S0044-8486(03)00428-9

Reed-Smith, J., Jacques, H., & Somers, M. J. (2015). *Hydrictis maculicollis. The IUCN red list of threatened species. e.T12420A2*. https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T12420A21936042.en

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