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Short Note

Using action cameras to estimate the abundance and habitat use of threatened fish in clear headwater streams

B Hannweg[1,2], SM Marr[2,3*], LE Bloy[1,2,3] and OLF Weyl[2,3]

[1] *Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa*
[2] *DSI/NRF Research Chair in Inland Fisheries and Freshwater Ecology, South African Institute for Aquatic Biodiversity, Grahamstown, South Africa*
[3] *Centre for Invasion Biology, South African Institute for Aquatic Biodiversity, Grahamstown, South Africa*
*Correspondence: erubescens@gmail.com

Snorkel and electrofishing surveys are the traditional baseline methods for fish surveys in clear headwater streams. However, action cameras provide a non-harmful alternative to monitor freshwater fish populations to develop informed conservation management initiatives. In this paper, estimates from photographs and videos from action cameras are compared with snorkel survey estimates of the density of a threatened endemic minnow species in a headwater stream, Eastern Cape, South Africa. Photograph-based relative abundances of fish summed over five microhabitats in each pool returned equivalent results to snorkel surveys, whereas the equivalent video-based abundance estimates were approximately 50% greater than the snorkel estimates. Therefore, photograph-derived estimates could be used as an alternative to snorkel surveys for fish population monitoring and habitat use studies in clear headwater streams.

Keywords: freshwater fish, MaxN, monitoring, photographs, snorkel surveys, underwater video analysis

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Freshwater fish are currently more impacted by human activities than are other faunal groups (Duncan and Lockwood 2001; Limburg et al. 2011). Threats, which include habitat degradation/fragmentation, water pollution, over-abstraction, and the introduction of non-native fish species (Cowx 2002), are compounded for species isolated within headwater streams owing to restricted geographical distributions (Ellender et al. 2017). The reason is that these small isolated populations are more vulnerable to extirpation and local extinctions than more widespread species. Knowledge of the distribution, behaviour and abundance of fish, particularly those of conservation concern, is important for evaluations of their conservation status (Bellan et al. 2008; Darwall et al. 2011) and to develop and direct conservation initiatives (Darwall et al. 2008; Darwall et al. 2011).

Fish populations in headwater streams have traditionally been monitored using electrofishing (Hickey and Closs 2006), seine netting (Anderson et al. 1995; Jordan et al. 2005), minnow traps (Kadye and Booth 2014) and snorkel surveys (Jordan et al. 2008; Ebner et al. 2009). Electrofishing, seine netting and trapping involve physically handling fish and could result in post-release mortality by increasing the risk of infection through the removal of their protective mucilaginous layer (Brydges et al. 2009), whereas electrofishing could result in bleeding at the gills, physiological stress, spinal injuries and even internal haemorrhaging (Snyder 2003). As a result, visual methods, such as snorkel surveys (Dolloff et al. 1996), and more recently action cameras, are the preferred survey methods for fish population assessments (Ebner and Morgan 2013), and studies of ecology, behaviour and habitat utilisation (Ebner et al. 2014), particularly for imperilled fish (Ebner et al. 2009).

In South Africa's Cape Fold Ecoregion (CFE), sensu (Abell et al. 2008), the imperilled conservation status of many headwater stream fish (Ellender et al. 2017) requires lower risk methods of assessing their abundance, distribution and habitat use (Ellender et al. 2012). Although underwater video analysis (UWVA) provides a useful alternative to snorkel surveys and electrofishing, abundance estimates are limited by the camera's field of view and are, therefore, generally reported as relative abundance estimates (Ellender et al. 2012). In addition, post-survey analysis of videos can be prohibitively time consuming (Cappo et al. 2003; Ebner et al. 2009). In an attempt to improve UWVA methods, we used headwater stream populations of Eastern Cape redfin *Pseudobarbus afer* (Peters, 1864) in the Swartkops River as a model system to: (1) compare different non-harmful methods of estimating freshwater fish abundance; (2) assess the utility of a 5–camera array to derive absolute abundance estimates; and (3) use UWVA to assess habitat use of

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