

**LETTER**

# Sharper eyes see shyer lizards: Collaboration with indigenous peoples can alter the outcomes of conservation research

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**Abstract**

Our ecological studies on large varanid lizards in a remote region of tropical Australia reveal a direct benefit to collaboration with local indigenous people. Although they worked together, in pairs, western scientists and indigenous rangers found lizards with different behavioral phenotypes (“personalities”). The resultant broader sampling of the lizard population enabled us to detect positive effects of a conservation management intervention. Those effects would not have been evident from the subset of animals collected by western scientists, and hence, involvement by researchers from both cultures critically affected our conclusions and paved the way for large-scale deployment of a novel conservation initiative in Northern Australia.

**KEYWORDS**

animal behavior, ethnozoology, indigenous engagement, invasive species, taste aversion

**1 | INTRODUCTION**

Involving indigenous communities in biodiversity research has been advocated for pragmatic as well as ethical reasons (organizations such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; see also Brondizio & Le Tourneau, 2016; Department of Industry, Innovation and Science 2013; Lyver & Tylianakis, 2017; Sobrevila, 2008). For example, local villagers may be able to find animals and plants that are not discoverable by “outsiders” (Basset et al., 2004; Martin, Lee Agama, Beaman, & Nais, 2002), and locals who participate in research activities may be more committed to subsequent conservation and management (Sobrevila, 2008; Van Heist et al., 2015). Indigenous

engagement may add value to research for another reason also. The attributes of individual observers (e.g., visual acuity, training, climatic compatibility) affect their ability to find wild animals (Lotz and Allen 2017; Fitzpatrick, Preisser, Ellison, & Elkinton, 2009; Rodda, 1993), and people from different backgrounds possess different abilities in this respect (for environmental, cultural and genetic reasons: Minkov, 2011; Taylor, 1981; Yi et al., 2010). Intriguingly, such biases may concern the types as well as the numbers of animals found. The methods of indigenous hunters may bias their collections toward specific age classes or sexes of animals (Shine, 1986) but even if people from different cultures use the same method at the same time, they may find different types of animals within a population. For example,

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if males are larger and less cautious than females, they may be more obvious to an untrained observer than are smaller, more cryptic females (Biro & Dingemanse, 2009; Härkönen, Hårding & Lunneryd, 1999). Both sexes might be equally obvious to a trained observer. Such variation may be especially significant in conservation research, the results of which can alter environmental practices on a global scale and determine the survival of vulnerable species; the stakes are high.

In the present paper, we describe a case where culturally determined divergences affected the outcome of a major field experiment in conservation biology. The invasion of cane toads (*Rhinella marina*) through tropical Australia has caused catastrophic declines in populations of vulnerable predators that are fatally poisoned if they attempt to eat a large specimen of this toxic anuran (Doody et al., 2009; Shine, 2010). In an attempt to buffer the impact of cane toads on large varanid lizards (yellow-spotted monitors, *Varanus panoptes*), we attached radio transmitters to free-ranging lizards on a remote floodplain in north-western Australia, and exposed the animals to small (nonlethal) cane toads so they could develop a conditioned taste aversion (CTA) response to this prey type before the arrival of the toad invasion (which is dominated by lethally large toads; Brown, Kelehear, & Shine, 2013). We then monitored the survival of CTA-trained versus untrained lizards over the next 18 months and found a major effect of our manipulation. By the end of the study, only 3% of untrained lizards had lived longer than 110 days versus 56% of trained lizards (Ward-Fear, Pearson, Brown, Rangers, & Shine, 2016). The research team included participants from two distinct ethnic backgrounds, which unintentionally produced a case study highlighting social dimensions of conservation research.

## 2 | METHODS

Our study involved collaboration between an expert research team (University of Sydney), a government wildlife management agency (Department of Biodiversity, Conservation and Attractions, Western Australia) and an indigenous community (rangers from the Balangarra Aboriginal Corporation). To catch these large (up to 1.6 m total length and 7 kg; Pianka & King, 2004) lizards, teams of two people (one western scientist and one indigenous ranger) searched the Oombulgurri floodplain on ATV-bikes, over a 3-year period (2014–2017). Ten participants ranged in age from 25 to 50 years, with no significant difference in mean age between the groups. Western “Scientists” were professional, nonindigenous ecologists, and reptile specialists who spend extensive field time in Northern Australia conducting wildlife research. Indigenous “Rangers” were Australian-Aboriginal Traditional Owners of the region. They had lived and hunted in similar environments throughout their lives but had not been trained in specific

faunal survey techniques until the beginning of this study (see Supporting Information Methods for more detail).

Lizards were located in the field, captured by hand, and processed (measured, weighed, marked, and fitted with VHF transmitters) back at our field laboratory. During processing and in subsequent radio telemetry, we recorded lizard behaviors in a standardized fashion (See Supporting Information Methods and Table S2 for further details on all measures and protocols).

## 3 | RESULTS

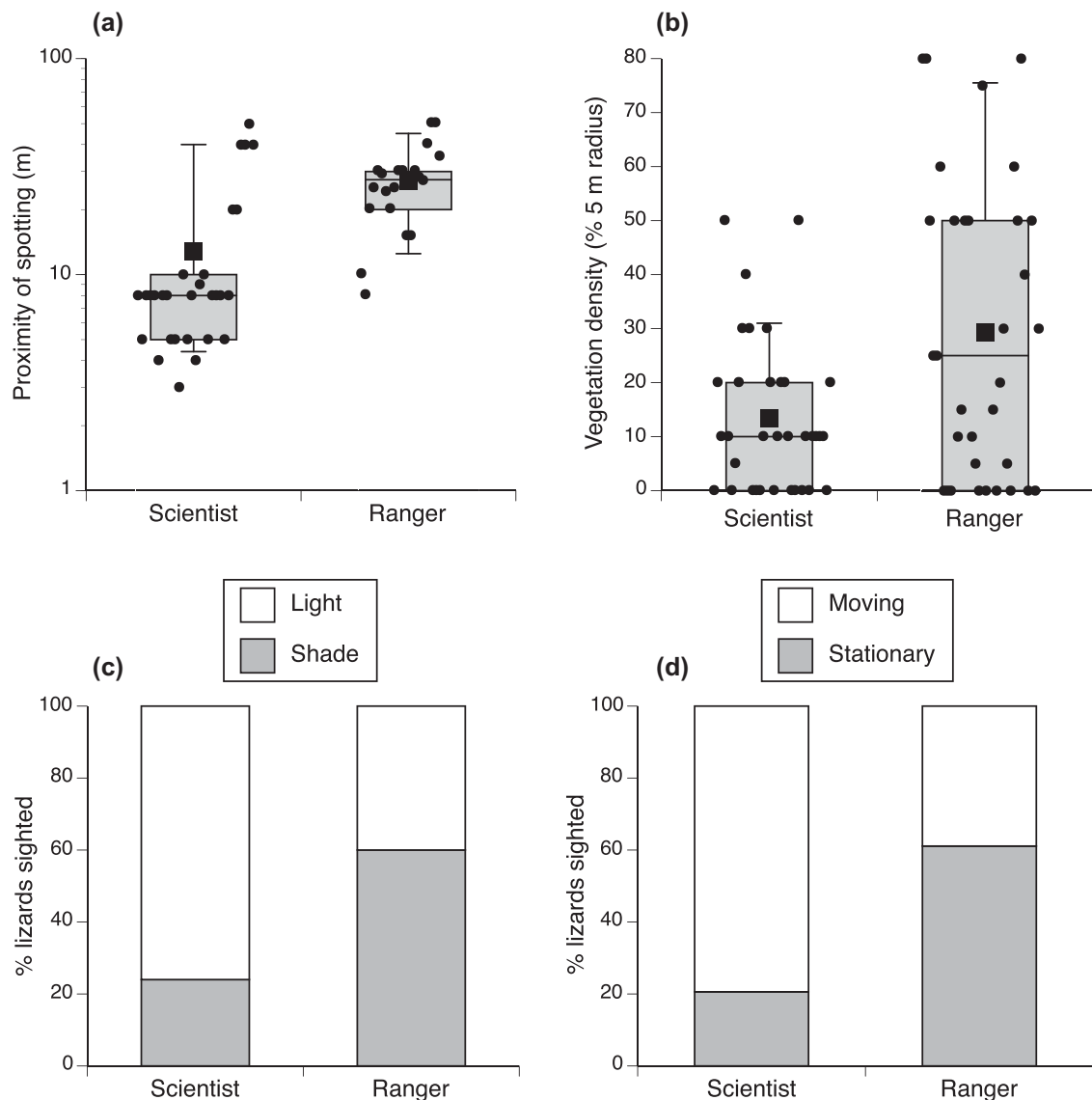
Strong behavioral consistencies within individuals and high variation among individuals demonstrated the presence of behavioral phenotypes (Sih, Bell, Johnson, & Ziemba, 2004), that is, lizards exhibited a spectrum of boldness and this behavioral dimension was correlated with individual variation in ecological traits and microevolutionary fitness (Ward-Fear et al., 2018).

The lizards found by indigenous rangers did not differ significantly from those found by their western colleagues in terms of mean body sizes, body condition, or sex ratios (all  $P > 0.15$ ). However, the rangers saw lizards from a greater distance ( $P < 0.0001$ , see Supporting Information Table S1 for detailed statistical report; Figure 1a), in more dense vegetation ( $P = 0.0030$ ; Figure 1b), under poor light levels ( $P = 0.01$ ; Figure 1c), and more frequently when the lizard was stationary (and hence, cryptic) rather than active ( $P = 0.0007$ ; Figure 1d). On a standardized “boldness” score (amount of struggling during handling), the lizards found by rangers were more docile than those found by western scientists ( $P = 0.039$ ; a trait that was highly repeatable is positively correlated with other measures of “shyness,” and is associated with an individual’s ecology; Ward-Fear et al., 2018). In summary, the rangers detected lizards that were shyer and more difficult to see than were those detected by western scientists.

Reflecting these ecological and behavioral divergences, the ranger-caught lizards were less vulnerable to natural predators after release than were the scientist-caught lizards (survival duration:  $P = 0.004$ ; Figure 2b). The ranger-caught lizards also benefited more from CTA training. Among CTA-trained lizards, those caught by rangers were less likely to be fatally poisoned by eating a wild cane toad than those that had been caught by scientists, whereas untrained lizards of these two groups were equally vulnerable ( $P = 0.039$ ; Figure 3).

## 4 | DISCUSSION

The correlation between a lizard’s behavior (boldness vs. shyness) and its fate after invasion of toxic cane toads is consistent with our previous analyses showing links between boldness



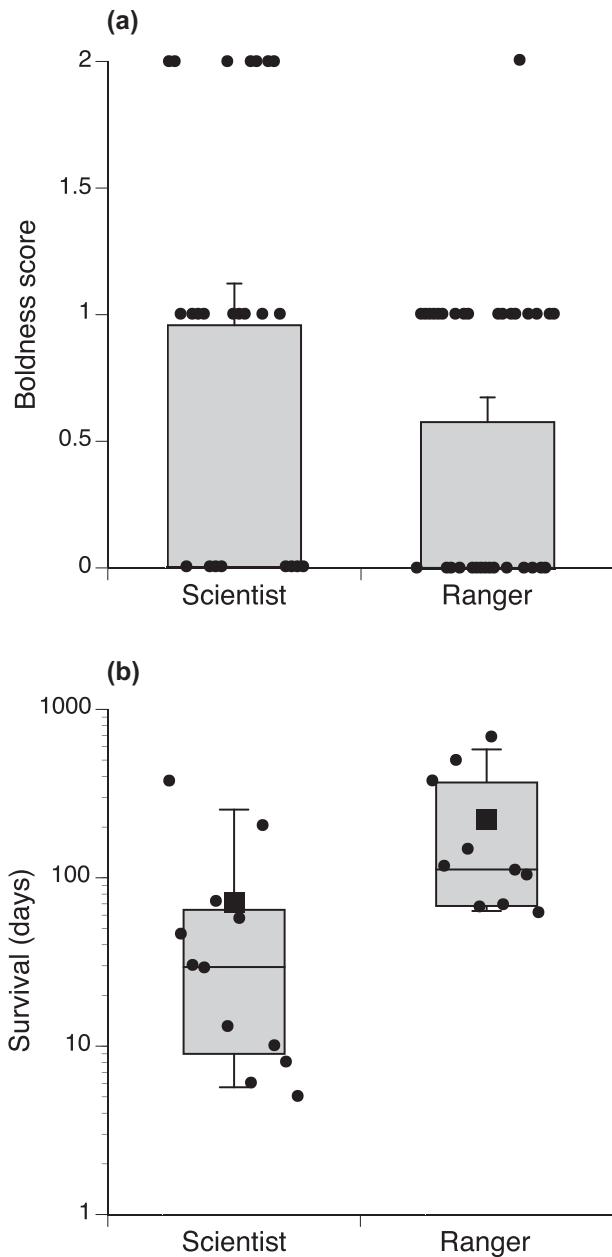
**FIGURE 1** Comparisons of conditions under which lizards were initially sighted in the field by “Scientists” and indigenous “Rangers”: (a) proximity to lizard in meters; (b) density of ground-cover vegetation (>30 cm high) surrounding the lizard (% of quadrat with a 5 m radius); (c) intensity of light directly on lizard (light or shade); (d) whether the lizard was stationary or moving (i.e., walking or running). Sighting was deemed more difficult if lizards were further away, in more dense vegetation, in shade, and/or stationary. Continuous variables shown as means, medians, interquartile ranges, SE, and data distribution; categorical variables shown as proportions

and traits such as home range sizes and habitat use (Ward-Fear et al., 2018). More generally, studies on many species of animals have reported that shyness correlates with (1) increased reliance on crypsis in response to predator presence (Hulthen, Chapman, Nilsson, Hollander, & Bronmark, 2014), (2) lower vulnerability to predation (Hulthen et al., 2017), and (3) reluctance to consume novel prey (Reale, Reader, Sol, McDougall, & Dingemanse, 2007). The current study demonstrates that boldness also affects susceptibility to a biological invasion by influencing an individual’s readiness to learn to avoid toxic prey.

Our most exciting result, however, involves the scientific and conservation benefits of a cultural diversity within a

research team. The responses of ranger-caught lizards to CTA training were critical to the main aim of our study: to test whether or not aversion training could enhance the survival of vulnerable native fauna (Ward-Fear et al., 2018). The success of that trial already has led to the rollout of CTA training on a landscape scale to reduce the ecosystem impacts of invasive cane toads across northern Australia. Indigenous collaboration is central to this conservation intervention.

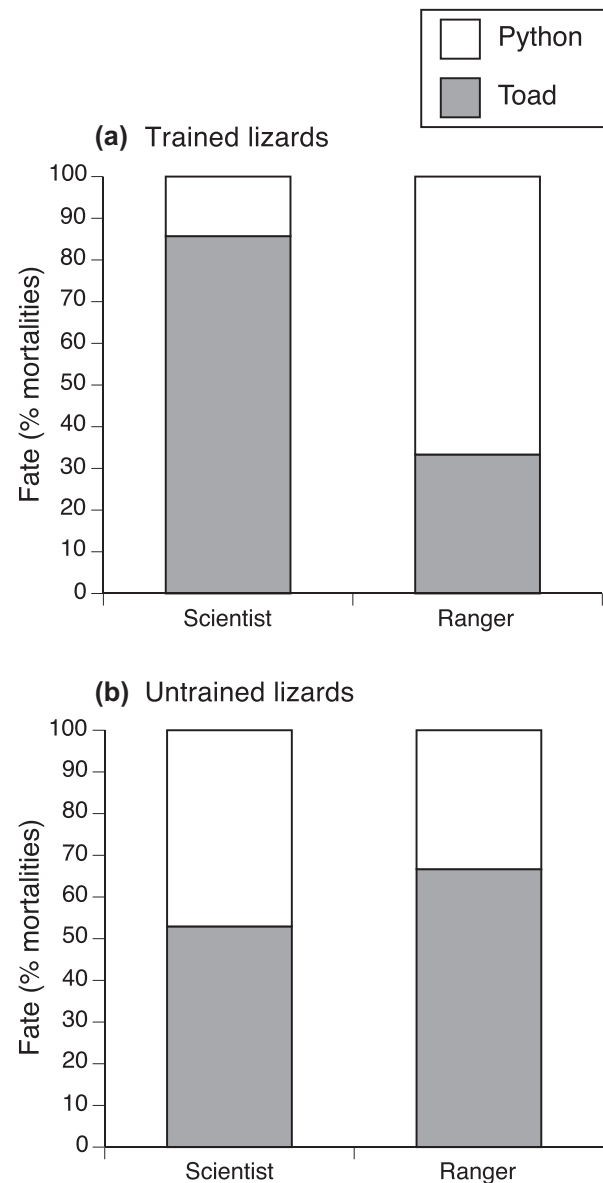
Similar benefits of cultural diversity for research and conservation programs may be widespread, although rarely documented. We encourage researchers to engage the skills of indigenous peoples through meaningful collaborations. Many types of field-based research could benefit from that diversity



**FIGURE 2** Lizard boldness and its consequences for survival under natural predation regimes: a comparison between lizards sighted by scientists *versus* indigenous rangers. (a) As a proxy for boldness, we use the amount of struggling during standardized handling; higher struggle indices correlate with greater boldness. Results are depicted as mean boldness score with SE and data distribution. Panel (b) depicts survival in days from a lizard's capture until it was consumed by a large python. Box and whisker plots depict means, medians, interquartile ranges, SE, and data distribution. Note that lizards killed by toad poisoning have been omitted from this analysis of “natural predation”

of cultural input, not only for ethical reasons but also because the input from Traditional Owners can improve the program's overall ability to sample the ecosystems under investigation.

Our study provides empirical evidence to support a recommendation that has generally been advocated on moral



**FIGURE 3** Differences between the cause of mortality for lizards detected by scientists *versus* indigenous rangers as a function of lizards' conditioned taste aversion (CTA) training history. The upper panel (a) shows mortality data for “trained” individuals (that had eaten a small, non-lethal toad for CTA training) and the lower panel (b) shows mortality data for “untrained” individuals (that had not eaten a small toad). During the study, lizards died either because they ingested a wild, toxic cane toad or because they were eaten by their natural predators, large pythons (*Aspidites melanocephalus* or *Liasis olivaceus*). CTA-trained lizards that died from ingesting a wild toxic toad were deemed to have lower learning capabilities than those that were killed by pythons

grounds: the value of cultural diversity in research teams. The integration of indigenous knowledge into natural resource management has been criticized as a fashionable trend (Wohling, 2009), at times amounting to little more than an exercise in “box-ticking” (Bohensky and Maru 2011). In

an era of political correctness, “cultural diversity” is often valued through the lens of ideology (sometimes bordering on tokenism). In contrast, our study shows direct scientific advantages to cultural diversity in research teams and to genuine collaboration among people from differing races and backgrounds.

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## AUTHOR CONTRIBUTIONS

G.W.-F., R.S., and D.P. conceived the project; G.W.-F., D.P., M.B., and B.R. collected data; G.W.-F., M.B., and B.R. managed the field component and developed aspects of the study; G.W.-F., M.B., and R.S. analyzed data; and R.S. and D.P. supervised the project. All authors contributed to final interpretation and manuscript preparation.

## CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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