



CONTRIBUTED PAPER

Longitudinal assessment of illegal leopard skin use in ceremonial regalia and acceptance of *faux* alternatives among followers of the Shembe Church, South Africa

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Abstract

Despite having protected status, poaching for the illegal trade and traditional use remains a primary threat to leopards (*Panthera pardus*) across southern Africa. Addressing this threat is challenging, not only because it is difficult to uncover and monitor illicit behavior, but because law enforcement and alternative intervention strategies need to account for cultural and political sensitivities to prove effective and sustainable. With up to 4 million followers in southern Africa, the recently-established Nazareth Baptist “Shembe” Church represents the principal culturo-religious use of illegal leopard skins in the world. This longitudinal study used in-person questionnaires ($n = 8,600$) and telephone follow-ups ($n = 2,300$) with Shembe followers to explore socio-economic and experiential factors related to the desirability and possession of illegal leopard skins before and after receiving a *faux* alternative through the Furs for Life (FFL) intervention program. Proportional possession of authentic skins was relatively low among followers who received *faux* skins (21%), with declines of 7 and 13% in subsequent authentic skin acquisition and desirability, respectively. Logistic regression models revealed that authentic skin possession, both before and after receiving a *faux* skin, was primarily related to employment status. Desire for authentic skins increased with recipient age, but decreased with improved knowledge of leopard population status since receiving the *faux* skin. Followers who were dissatisfied with *faux* skins were likely to express a continued desire for authentic skins. Most followers (95%) were, however, satisfied with the *faux* alternative, having retained and worn it at gatherings, with little noticeable damage or perceived societal judgment. These results support the FFL intervention as a means of protecting leopards: Although authentic skins were still acquired, demand decreased significantly over 3 years with shifts in perception favoring *faux* leopard skin alternatives.

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KEYWORDS

conservation intervention, follow-up questionnaires, *Panthera pardus*, religion, sustainability, traditional use, wildlife trade

1 | INTRODUCTION

Recent declines in global wildlife populations are primarily driven by anthropogenic effects (Di Marco, Venter, Possingham, & Watson, 2018), but changing human behavior is seldom the focus of conservation research (Schultz, 2011). Effective mitigation against over-harvesting of biological resources, destruction of habitat, climate change, and illegal wildlife trade is vital for successful conservation and maintenance of functioning natural ecosystems. However, the anthropogenic nature of these threats suggests that actions to modify human behavior and social systems through innovative solutions and adaptive policy are increasingly necessary (Baruch-Mordo, Breck, Wilson, & Broderick, 2009; Dobson, De Lange, Keane, Ibbett, & Milner-Gulland, 2019) and across multiple scales, from the governance of global markets to the behavior of individual consumers (Ostrom, 2009).

As key ecological components of natural ecosystems, wild carnivore mythology appears throughout human history in cultural, political, and religious symbology (Benavides, 2013). Felid skins are particularly revered for their beauty (as in the twentieth-century fashion fur trade [Ramchandani & Coste-Maniere, 2017]) and for their symbolic association with power and status (e.g., jaguars and Olmec royalty [Saunders, 1994]; lions and Maasai warriors [Dolrenry, Hazzah, & Frank, 2016]; tigers and Tibetan Buddhists [Yeh, 2012]). Traditional consumption of felid skins can and has adapted to changing culture in the face of species decline, notable efforts include Tibetan monks protecting snow leopards from the illegal trade (Li et al., 2014) and efforts by “lion guardians” to reduce the cultural hunting of lions (Dolrenry et al., 2016). Yet strong international demand for felid skins and bones remains an ongoing challenge (Nijman et al., 2019). Nevertheless, ongoing respect for traditional uses of wildlife derivatives often directly conflicts with international environmental policy and impedes local enforcement (e.g., protected species used in traditional Asian or African medicine, whose practitioners are often legally recognized [Nijman et al., 2019]).

Across Africa, wild felids including cheetah (*Acinonyx jubatus*), lion (*Panthera leo*) and leopard (*Panthera pardus*) are vulnerable to extirpation, facing threats of habitat loss, prey depletion, conflict with humans, and harvest for local or international trade (Loveridge, Wang, Frank, & Seidensticker, 2010). Southern Africa's leopards

are particularly at risk; with >62% of their distribution falling outside of protected areas (Jacobson et al., 2016), a close association with humans across pastoral landscapes, and their adaptability to a shifting prey base, leopards are threatened by retaliatory conflict, legal trophy hunts (Loveridge et al., 2010) and mostly illegal use in traditional practices (Warchol, Zupan, & Clack, 2003). Leopard derivatives (e.g., bones, claws, teeth, and fat) are used in traditional African medicine (Cook, 2009), spiritual divination, and enchantment (Williams & Whiting, 2016). Leopard skins are particularly sought for their reverence in ceremonial regalia among traditional royalty (e.g., Zulu, Barotse, Swazi, and Ngoni kingdoms [Harries, 1993]) and, more recently, the burgeoning “Shembe” Church (Marinovich, 2018).

The Nazareth Baptist “Shembe” Church, founded in 1910 by Prophet Isiah Shembe, is an amalgamation of traditional Zulu and Christian belief (Tishken, 2015) with an estimated 4 million followers predominantly in the Gauteng and KwaZulu-Natal provinces of South Africa (Marinovich, 2018). Shembe religion holds that every man is the *inkosi* (king) of his household and, therefore, eligible to wear leopard skin, a long-standing symbol of Zulu royalty (Papini, 2004; Tishken, 2015). As leopards are protected locally by South African Threatened or Protected Species (TOPS) regulations and internationally under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I, any person wishing to possess or trade leopard skins requires a permit issued by the relevant authority. To date, however, no permits have been issued to any Shembe followers. Leopard skin adornments are worn and traded openly at Shembe gatherings, where enforcement is absent, presumably because of political sensitivities linked to the policing of traditional practices. The combined effect of this illegal skin trade on extant leopard populations is unknown, though likely substantial (Mann et al., 2017; Naude et al., 2020).

To reduce demand for leopard skins within the Shembe community, Panthera (NGO) launched its Furs for Life (FFL) initiative in 2013. Collaborating with digital designers and textile manufacturers, FFL created high-quality, durable, and realistic *faux* leopard skin shoulder capes (*amambatha*; Figure 1). Panthera invested considerable time and effort in establishing trustworthy and mutually respectful relationships with Shembe leaders who have endorsed the use of *faux* skins by



FIGURE 1 Shembe men dancing at the eBuhleni of July 2017. Indicated are: (a) headbands or *umqhele* made of spotted cat skins; (b) antelope skins tailored into shoulder capes and artificially “spotted” with ink; (c) other spotted cats skins (e.g., serval and cheetah) tailored into shoulder capes; (d) authentic leopard skins tailored into shoulder capes; (e) drums, vuvuzelas adopted into the ceremony; (f) Furs for Life (FFL) *faux* leopard skins tailored into shoulder capes or *amambatha*; (g) traditional Zulu Nguni (cow hide) shields called *igqoka* or *ihawu*; ostrich feather headdresses; (I) belts, (j) ankle and (k) arm bands made of spotted cat skin; (l) bare feet on holy ground; (M) holy white surplices or *umnazaretha* worn by Nazerites on church grounds; (n) Nguni (cow hide) back skirts or *iBheshu*; (o) traditional Zulu swatches (fly-whisks) or *izimboko* (fighting sticks) and (p) *isinene* waist-round skirts of banded animals skins (e.g., genet, mongoose, and polecat species). Image published with permission from these dancers

followers at religious ceremonies. The FFL program has since distributed more than 18,500 *amambatha* to Shembe followers at gatherings across South Africa.

This study estimated the success of the FFL intervention in reducing the possession of and desire for authentic leopard skins. Longitudinal questionnaires with recipients of *faux* skins (2013–2018) explored socio-economic and experiential factors that may be related to the possession of and desire for an authentic skin before (2013–2015) and after (2018–2019) receiving a *faux* alternative. Social psychological theories such as the Cognitive Hierarchy, Theory of Reasoned Action, Theory of Planned Behavior, and the Value-Belief-Norm Theory (Fishbein & Ajzen, 2011; Homer & Kahle, 1988; Stern, 2018; Vaske & Manfredi, 2012), suggest that an individual’s socio-economic characteristics and cognitions (e.g., perceptions, beliefs, attitudes) can predict their behavioral intentions (e.g., desire for skins) and actual behaviors (e.g., possessing skins). Findings are discussed in the context of scalable conservation intervention

strategies, enforcement of environmental policy, and the unaddressed global impacts from traditional uses of wildlife.

2 | METHODS

2.1 | Ethics statement

The research was approved by the University of Cape Town, Faculty of Science Research Ethics Committee (#FSREC83). As many respondents were non-literate and to ensure comprehension, all respondents were read a consent clause in Zulu or English before providing verbal consent (Appendix S1, Supporting Information). Where respondents withheld or withdrew consent, questionnaires were terminated. Respondent identities were maintained as an independent, secure, and numerically coded dataset to prevent reissuing *faux* skins and ensure anonymity.

2.2 | Study area

In-person face-to-face questionnaires were conducted while distributing *faux* skins at Shembe gatherings held throughout the KwaZulu-Natal, Gauteng, Mpumalanga, and Eastern Cape provinces of South Africa (Figure 2). Gatherings ranged from small weekly congregations (<100 followers) to large annual observances (>50,000 followers). Gatherings held at eBuhleni, Nhlankakazi, Nongoma, and Eshowe have deep ceremonial significance, are presided over by Shembe leadership, and attract followers from across southern Africa. Telephone follow-up questionnaires were conducted with a random subset of *faux* skin recipients (ensuring adequate regional representation).

2.3 | Survey design and sampling

A total of 8,600 semi-structured questionnaires were conducted at least twice a year between February 2013 and February 2018 (pre-FFL). These participants were approached opportunistically through convenience sampling before receiving a *faux* skin during their distribution, with a 100% response rate. Thereafter (post-FFL), 2,300 semi-structured, follow-up questionnaires were conducted by telephone between June 2018 and October 2019 with all Shembe followers who had received their *faux skin* within the first 3 years of distribution (2013–2015), had taken part in the original FFL questionnaire, and indicated a willingness to partake in the follow-up questionnaire. Of 3,021 attempted call-backs, 2,300 were contactable (76%), with a 100% response rate.

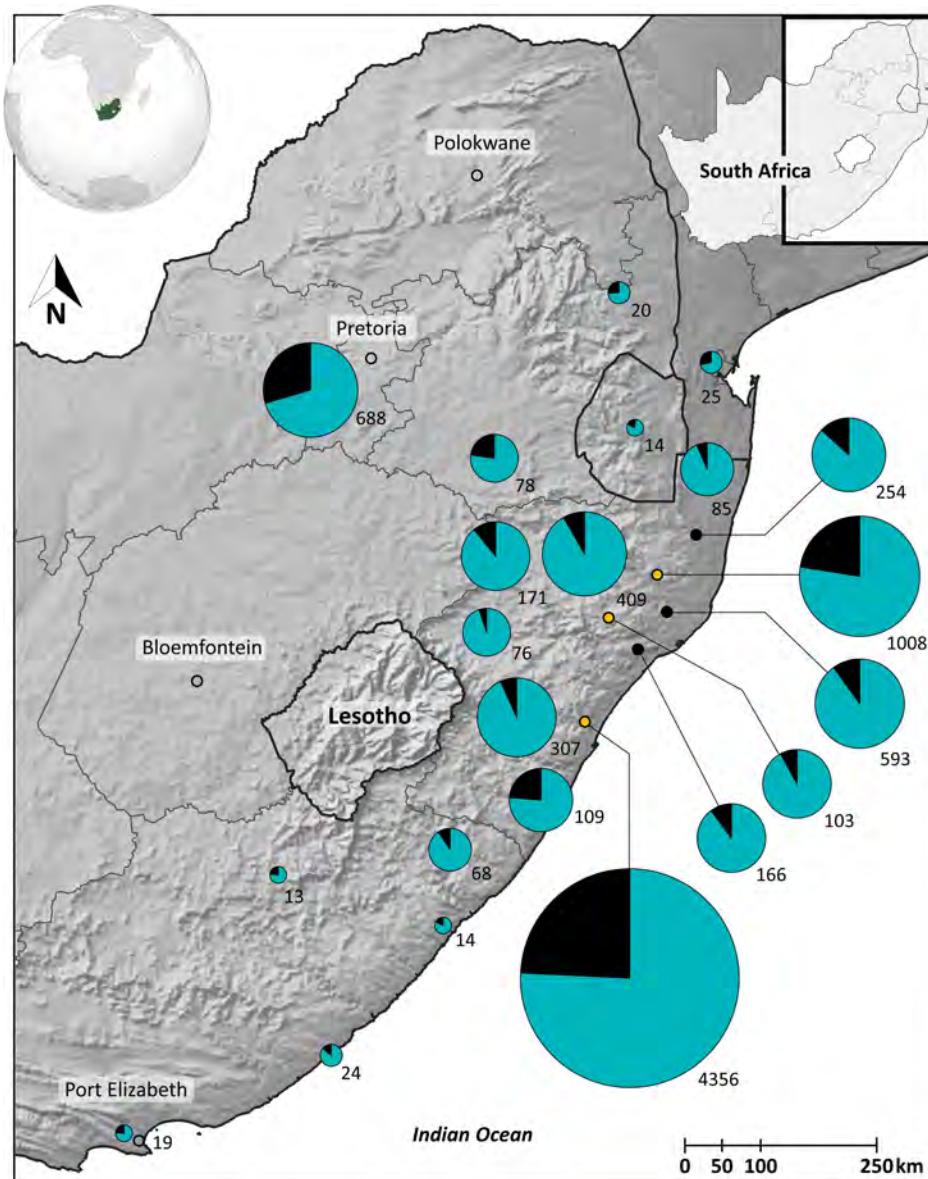


FIGURE 2 Map of the study area in eastern South Africa. Questionnaires were conducted throughout the landscape, where regional summary pie-chart size (and sample size; bottom right) indicates the number of pre-Furs For Life (FFL) questionnaires conducted (2013–2018; turquoise) and the proportion of those contacted for the post-intervention follow-up questionnaire 3 years later (2018–2019; black). Indicated also are locations of three of the largest Shembe gatherings (yellow), namely Nongoma (north), Eshowe (central), and eBuhleni (south)

Questionnaires (pre- and post-FFL intervention) were pilot-tested with 100 respondents to optimize questions before study commencement and not included in subsequent analyses. All questionnaires were conducted in Zulu or English by a single interviewer to minimize bias (Browne-Nuñez & Jonker, 2008). Transcripts underwent further translation and back-translation by two independent translators to increase their accuracy and reliability (Behling & Law, 2000). Respondents answered questions with minimal assistance and there were no missing data.

2.4 | Analyses

A subset of the pre-FFL questions was repeated in the post-FFL follow-up questionnaire (Appendix S1, Supporting Information). All analyses were conducted in R (R Core Team, 2019). Variable frequencies were categorized by questionnaire before comparing pre- and post-intervention frequencies through univariate χ^2 -tests of independence (Table S2, Supporting Information).

Binary logistic regressions were performed to explore the contribution of relevant socio-economic and experiential factors that may be related to possession of and desire for an authentic leopard skin pre-FFL (that is, at the time of receiving a *faux* skin) and their subsequent acquisition of and desire for an authentic leopard skin (post-FFL). Responses to predictive factors for each question were modeled through logistic regression (generalized linear model with a binomial distribution and logit-link) using the *glmulti* package and the best models were selected by minimizing the Akaike information criterion (AIC; Calcagno & de Mazancourt, 2010; Tables S2–S5, Supporting Information). Variance inflation factors and decomposition proportions were tested in top models to investigate multicollinearity among the predictors (Fox & Weisberg, 2011) and any outliers, influential observations, and heteroskedasticity (Appendices S2–S5, Supporting Information). Model fit was assessed using the log-likelihood ratio ($p \leq .05$), global goodness-of-fit tests (Hosmer–Lemeshow [H–L]; $p \geq .05$), and pseudo- R^2 estimates (Hu, Shao, & Palta, 2006). An odds ratio (OR) with robust standard errors (Wooldridge, 2010) was calculated for each predictor using “heteroscedasticity and autocorrelation consistent” estimators implemented in the *sandwich* package (Zeileis, 2006). The relative contribution of each factor in the respective model was determined using both univariate and unique predictive power (pseudo- R^2), whereas factor-level contribution and direction were interpreted through ORs.

Testing the relative success of the FFL intervention required establishing trends between authentic leopard skin possession and subsequent acquisition, as well as

desirability among *faux* skin recipients pre- and post-intervention. Using a subset of pre-FFL questionnaire responses ($n = 6,300$; all pre-FFL questionnaire responses [2013–2018] less the follow-up questionnaire subset [2013–2015]), the best-fitting authentic leopard skin possession model was validated through estimating the number of authentic skins possessed in a randomized known dataset ($n_{\text{training}} = 5,000$; $n_{\text{test}} = 1,300$). This validated model was then used to predict the number of authentic leopard skins in possession pre-FFL ($n = 2,300$; 2013–2015) and the number acquired post-FFL ($n = 2,300$; 2018–2019). Predicted values were compared to their respective observed (known) frequencies through univariate χ^2 -tests of independence. Authentic skin desirability was similarly assessed using the best-fitting, randomized validation model for pre-FFL desirability. The relative effect of the FFL intervention could thus be interpreted through significant deviations from these predicted trends.

3 | RESULTS

3.1 | Respondent characteristics

Pre-FFL respondents ($n = 8,600$) were male and 11–83 years of age (Table 1). The majority had secondary education (60%), were unemployed (57%), and were uncertain of both South African leopard population status (51%) and the illegality of unpermitted authentic leopard skin possession (68%), but believed the government should protect leopards (88%). Few respondents (16%) knew of anyone who had been convicted for authentic leopard skin possession, and most were willing to wear *faux* skin alternatives to gatherings (93%).

Post-FFL follow-up respondents who had received a *faux* skin ($n = 2,300$) were a broadly representative subset of the pre-FFL questionnaire respondents (Table 2) with no significant difference in the proportional representation of age classes between questionnaires ($\chi^2_6 = 1.971$; $p = .922$). The majority had secondary-level formal education (57–60%), which was slightly higher (2% tertiary education) than pre-FFL respondents ($\chi^2_3 = 7.804$; $p = .05$). Although the majority of respondents were still unemployed (52–59%), the proportion was slightly lower in the pre-FFL questionnaire ($\chi^2_1 = 21.4$; $p < .001$).

Knowledge about South African leopard population status differed between questionnaires ($\chi^2_3 = 544.3$; $p < .0001$) with a higher proportion of post-FFL respondents either uncertain ($\chi^2_1 = 353$; $p < .001$) or believing the population was declining ($\chi^2_1 = 484$; $p < .001$) compared to the pre-FFL questionnaire. Post-FFL

TABLE 1 Respondent characteristics and derived socio-economic or experiential factors considered in the pre-Furs for Life questionnaire ($n = 8,600$; 2013–2018)

Parameter	Level	Count (proportion)
Leopard skin	Possession	1782 (21%)
	Desirability	3,014 (35%)
Age class	11–20	747 (9%)
	21–30	1919 (22%)
	31–40	2,183 (25%)
	41–50	1,532 (18%)
	51–60	1,393 (16%)
	61–70	567 (7%)
	71–80	259 (3%)
Formal education level	None	1,525 (18%)
	Primary	1,628 (19%)
	Secondary	5,190 (60%)
	Tertiary	257 (3%)
Employment status	None	4,878 (57%)
	Temporary	1709 (20%)
	Permanent	2013 (23%)
Leopard population status	Uncertain	4,414 (51%)
	Increasing	745 (9%)
	Stable	1,362 (16%)
	Decreasing	2079 (24%)
Government intervention	Yes	7,532 (88%)
Legality and permitting	Uncertain	5,807 (68%)
	Yes	1,555 (18%)
	No	1,238 (14%)
Knowledge of conviction	Yes	1,351 (16%)
Will wear <i>faux</i> skin	Yes	8,014 (93%)

respondents (87%) still believed the South African government should protect leopards, with no significant difference between questionnaires ($\chi^2_1 = 0.23$; $p = .632$). The proportion of respondents who believed it was legal to possess an authentic leopard skin without a permit differed significantly between questionnaires ($\chi^2_2 = 163.6$; $p < .0001$), as fewer considered it legal or were uncertain of its legality ($\chi^2_1 = 11.48$; $p < .001$; $\chi^2_1 = 122$; $p < .001$, respectively) in the post-FFL questionnaire. There was also a significantly greater proportion of respondents in the post-FFL questionnaire who reported knowing someone who had been convicted for possessing an authentic leopard skin without a permit ($\chi^2_1 = 27.46$; $p < .001$), but no significant change in the proportion proclaiming willingness to wear *faux* skins ($\chi^2_1 = 0.32$; $p = .572$).

Furthermore, 98% of respondents still possessed *faux* skins 3 years after receiving them, with 94% claiming to have used *faux* skins during this time. Only 22 respondents (<1%) reported noticeable damage, and 108 (<5%) felt “looked down on” for wearing *faux* skins. Most respondents (95%) were satisfied with their *faux* leopard skin.

3.2 | Pre-intervention authentic leopard skin possession

The pre-FFL questionnaire ($n = 8,600$) indicated that 1,782 respondents (21%) possessed authentic leopard skins (Table 1). After model ranking and selection, authentic skin possession among Shembe respondents was best explained (Nagelkerke pseudo $R^2 = 0.82$) by a model including all factors (Table S2, Supporting Information), which presented a good fit (H–L test: $Z_8 = 3.637$; $p = 0.888$) and 96% accuracy in classifying test data (threshold = 0.80; area under the curve [AUC] = 0.97). Respondents with permanent or temporary employment had 91- and 50-times higher respective odds of possessing authentic leopard skins than those who were unemployed (Table 3). Those who believed it is legal to possess an authentic leopard skin without a permit and the South African leopard population is increasing had 21- and 9-times higher odds, respectively, of possessing an authentic leopard skin than those who were uncertain in both cases. Increasing age class after 21–30 years was associated with an increased likelihood of possessing an authentic leopard skin, whereas believing South African leopard populations are decreasing, knowing someone who has been convicted for authentic leopard skin possession, having tertiary education, and believing the South African government should protect leopards were associated with a reduction in the likelihood of possessing an authentic leopard skin. Employment status exhibited the strongest univariate predictive power (55%), with unique explanatory power (16%) close to that of all other factors combined: government intervention (40%, 8%); legality and permitting (30%, 6%); leopard population status (19%, 2%); age class (13%, 2%); formal education (2%, 0.4%); and knowledge of conviction (0.4%, 0.1%).

3.3 | Pre-intervention desire for an authentic leopard skin

The pre-FFL questionnaire ($n = 8,600$) indicated that 3,014 respondents (35%) still desired an authentic leopard skin after receiving their *faux* alternative (Table 1).

TABLE 2 Socio-economic and experiential factors included in predictive modeling of authentic leopard skin possession and desirability in the pre-FFL questionnaire subset ($n = 2,300$; 2013–2015) and post-FFL follow-up questionnaire ($n = 2,300$; 2018–2019), wherein individuals were repeat interviewed 3 years after receiving a *faux* skin

Parameter	Level	Pre-FFL	Post-FFL	χ^2_{df}	<i>p</i> value
Leopard skin	Possession	496 (22%)	765 (33%)	78.50 ₁	<.001***
	Acquisition	–	343 (15%)	33.68 ₁	<.001***
	Desirability	911 (40%)	630 (27%)	76.50 ₁	<.001***
Age class	11–20	62 (3%)	75 (3%)	1.08 ₁	.298 ^{ns}
	21–30	444 (19%)	442 (19%)	0.00 ₁	.970 ^{ns}
	31–40	567 (25%)	565 (25%)	0.00 ₁	.973 ^{ns}
	41–50	451 (20%)	446 (19%)	0.02 ₁	.882 ^{ns}
	51–60	406 (18%)	403 (18%)	0.01 ₁	.938 ^{ns}
	61–70	278 (12%)	258 (11%)	0.76 ₁	.383 ^{ns}
	71–80	92 (4%)	89 (4%)	0.02 ₁	.879 ^{ns}
	81–90	–	22 (1%)	–	–
Formal education level	None	482 (21%)	482 (21%)	0.00 ₁	.971 ^{ns}
	Primary	416 (18%)	405 (18%)	0.15 ₁	.700 ^{ns}
	Secondary	1,328 (58%)	1,302 (57%)	0.56 ₁	.456 ^{ns}
	Tertiary	74 (3%)	111 (5%)	7.30 ₁	.007**
Employment status	None	1,354 (59%)	1,197 (52%)	21.40 ₁	<.001***
	Temporary	380 (17%)	514 (22%)	24.60 ₁	<.001***
	Permanent	566 (25%)	589 (26%)	0.560 ₁	.454 ^{ns}
Leopard population status	Uncertain	1,243 (54%)	617 (27%)	3530 ₁	<.001***
	Increasing	233 (10%)	187 (8%)	5.31 ₁	.021*
	Stable	427 (19%)	399 (17%)	1.08 ₁	.300 ^{ns}
	Decreasing	397 (17%)	1,097 (48%)	484 ₁	<.001***
Government intervention	Yes	1990 (87%)	2002 (87%)	0.23 ₁	.632 ^{ns}
Legality and permitting	Uncertain	1,150 (67%)	1,181 (51%)	122 ₁	<.001***
	Known	431 (19%)	344 (15%)	11.48 ₁	<.001***
	Unknown	319 (14%)	775 (34%)	248.3 ₁	<.001***
Knowledge of conviction	Yes	387 (17%)	530 (23%)	27.46 ₁	<.001***
Will wear <i>faux</i> skin	Yes	2,126 (92%)	2,137 (93%)	0.32 ₁	.572 ^{ns}
Still possesses <i>faux</i> skin	Yes	–	2,258 (98%)	–	–
Using <i>faux</i> skin	Yes	–	2,176 (94%)	–	–
<i>Faux</i> skin damaged	Yes	–	22 (1%)	–	–
<i>Faux</i> skin judgment	Yes	–	108 (5%)	–	–
<i>Faux</i> skin satisfaction	Yes	–	2,183 (95%)	–	–

Abbreviations: FFL, Furs for Life; ^{ns}, non-significant.

* $p \leq 0.05$.

** $p \leq 0.01$.

*** $p \leq 0.001$.

Authentic leopard skin desirability among Shembe followers at the time of the FFL intervention was best explained ($R^2 = 0.56$) by a model that excluded authentic skin possession, willingness to wear *faux* skins at

gatherings, and formal education as non-significant predictors (Table S3). The model presented a good fit ($Z_9 = 0.729$; $p = .682$) and 81% accuracy (threshold = 0.50; AUC = 0.88). The desire for authentic leopard skins

TABLE 4 Binary logistic regression model of socio-economic and experiential factors predicting the likelihood of a Shembe follower expressing a desire for an authentic leopard skin pre-FFL intervention (complete pre-FFL questionnaire: $n = 8,600$; 2013–2018; dependent variable: no = 0, yes = 1)

Parameter	Explanatory power (%)					95% CI				
	Univariate	Unique	β	SE	Wald	df	p value	Odds ratio	Lower	Upper
Intercept	-	-	-0.80	0.17	-4.80	1	<.001***	0.45	0.33	0.61
Age class (11–20)										
21–30	29	18	0.01	0.19	0.07	1	.944 ^{ns}	1.01	0.71	1.45
31–40			0.62	0.18	3.49	1	<.001***	1.86	1.33	2.62
41–50			1.68	0.18	9.21	1	<.001***	5.37	3.81	7.65
51–60			2.99	0.20	14.77	1	<.001***	19.86	13.84	28.86
61–70			4.41	0.28	15.69	1	<.001***	82.07	49.85	138.39
71–80			3.72	0.28	13.10	1	<.001***	41.33	23.44	75.23
Leopard population status (uncertain)										
Increasing	19	21	1.99	0.18	11.13	1	<.001***	7.33	5.31	10.27
Stable			-0.85	0.11	-8.01	1	<.001***	0.43	0.34	0.53
Decreasing			-2.24	0.11	-21.01	1	<.001***	0.11	0.08	0.13
Knowledge of conviction (no)										
Yes	9	12	-2.89	0.16	-17.98	1	<.001***	0.06	0.04	0.08
Legality and permitting (uncertain)										
Yes	8	31	1.01	0.10	10.31	1	<.001***	2.75	2.25	3.38
No			-1.26	0.13	-9.77	1	<.001***	0.28	0.22	0.36
Leopard skin possession										
Will wear <i>faux</i> skin										
Formal education level										
Model										
AIC	4,082	Concordance	0.87	Nagelkerke R^2				0.56		
Sensitivity	77%	Optimum threshold	0.50	Likelihood ratio test				$\chi^2 = -3,342$; $df = 12$; $p < .001$ ***		
Specificity	82%	Accuracy	81%	Global goodness of fit test				$z = 0.729$; $df = 9$; $p = 0.682$		

Abbreviation: ^{ns}, non-significant.
*** $p \leq 0.001$.

increased by age after 21–30, with those 51–60, 61–70, and 71–80 having 20-, 82-, and 41-times higher respective odds than 11–20 years (Table 4). Belief that the South African leopard population is increasing and it is legal to possess an authentic leopard skin without a permit resulted in 7- and 3-times higher odds, respectively, for respondents reporting their desire for an authentic leopard skin, whereas believing the population is stable or decreasing, claiming to know of someone who has been convicted for leopard skin possession, and believing it is illegal to possess one without a permit were associated with a small reduction in the desire for an authentic leopard skin. Age class exhibited the strongest univariate predictive power (29%), followed by leopard population status (19%), knowledge of conviction (9%), and legality and permitting (8%). Legality and permitting had the highest unique explanatory power (31%), followed by leopard population status (21%), age class (18%), and knowledge of conviction (12%).

3.4 | Post-intervention authentic leopard skin acquisition

Post-FFL follow-up questionnaires (2018–2019) with a subset of respondents ($n = 2,300$) who received *faux* skins between 2013 and 2015 indicated that 343 (15%) had since acquired authentic leopard skins (Table 2), representing a significantly smaller proportion of individuals than in the pre-FFL questionnaire ($\chi^2_1 = 33.68$; $p < .001$). Acquisition of an authentic leopard skin since the FFL intervention was best explained ($R^2 = 0.61$) by a model that excluded the highest level of formal education and age class (Table S4, Supporting Information). The model presented a good fit ($Z_8 = 8.183$; $p = .969$) and 89% accuracy (threshold = 0.50; AUC = 0.88). Respondents who improved their employment status (11%) since the FFL intervention and were dissatisfied with their *faux* alternative (5%) had 80- and almost 13-times higher respective odds of subsequently acquiring authentic leopard skins compared to those who had lost or sustained the same level of employment and been satisfied with *faux* skins (Table 5). Already possessing (22%) or having previously expressed a desire for authentic skins (40%) showed two times higher odds of subsequent authentic leopard skin acquisition. Respondents who had gained knowledge regarding the legality and permitting requirements for possession (20%), and better understood the status of the South African leopard population (30%) since receiving their *faux* skin were less likely to acquire an authentic leopard skin. Respondents whose employment status improved had the strongest univariate predictive power (39%) and unique explanatory power (35%) for acquiring

an authentic skin, which was more than for all other factors combined: legality and permitting knowledge gained (13%, 4%); *faux* skin dissatisfaction (10%, 7%); knowledge of conviction gained (3%, <1%); awareness of leopard population status gained (2%, <1%); authentic leopard skin desire (2%, 1%); and existing possession (<1%, <1%).

3.5 | Post-intervention desire for an authentic leopard skin

Post-FFL follow-up questionnaires indicated that 281 respondents (13%) no longer desired authentic leopard skins (Table 2), representing a significant proportional reduction between questionnaires in respondents who expressed a desire for an authentic leopard skin ($\chi^2_1 = 76.5$; $p < .001$). The desire for authentic leopard skins among Shembe respondents 3 years since receiving their *faux* skin was best explained ($R^2 = 0.46$) by a model including all factors (Table S5, Supporting Information), which presented a good fit ($Z_9 = 0.729$; $p = .682$) and 73% accuracy (threshold = 0.50; AUC = 0.82). Respondents who believed the leopard population in South Africa was increasing, expressed dissatisfaction with their *faux* alternative, and were 71–80 years of age had 2-, 24-, and 19-times higher respective odds of still desiring an authentic leopard skin compared to those who were uncertain of leopard population status, satisfied with *faux* skins, and of the youngest age class (Table 6). Believing the leopard populations status was stable or decreasing, knowing it is illegal to possess an authentic leopard skin without a permit, knowing someone who has been convicted, and already possessing an authentic skin were all associated with reduced likelihood of desiring an authentic leopard skin, relative to those who were uncertain of population status or permitting requirements, had no knowledge of conviction, and did not possess authentic leopard skins. Leopard population status exhibited the strongest univariate predictive (27%) and unique explanatory power (28%), followed by: *faux* dissatisfaction (8%, 7%); age class (7%, 5%); legality and permitting (4%, 2%); knowledge of conviction (<1%, 1%); and authentic skin possession (<1%, 2%).

3.6 | Furs for life success

Authentic leopard skin possession and desirability models (Table 7) were validated using pre-FFL questionnaire data (2015–2018; $n_{\text{training}} = 5,000$; $n_{\text{test}} = 1,300$) where known counts of authentic skin possession (235 skins) and desire (430 respondents) were accurately estimated as 248 skins (CI: 234, 265) and 414 respondents

TABLE 5 Binary logistic regression model of socio-economic and experiential factors predicting the likelihood of a Shembe follower acquiring an authentic leopard skin post-FFL intervention (follow-up questionnaire: $n = 2,300$; 2013–2018; dependent variable: no = 0, yes = 1)

Parameter	Explanatory power (%)							Odds ratio	95% CI		
	Univariate	Unique	β	SE	Wald	df	p value		Lower	Upper	
Intercept	–	–	–	–2.83	1.02	–2.77	1	.006**	0.06	0.01	0.25
Employment status gained (no)	Yes	39	35	4.38	0.43	10.08	1	<.001***	79.48	36.54	198.76
Legality and permitting Knowledge gained (no)	Yes	13	4	–2.40	0.51	–4.70	1	<.001***	0.09	0.03	0.24
Faux skin satisfaction (yes)	No	10	7	2.52	0.41	6.21	1	<.001***	12.47	5.87	29.42
Knowledge of conviction gained (no)	Yes	3	<1	1.59	0.99	1.61	1	.108 ^{ns}	4.92	1.20	29.60
Leopard population status knowledge gained (no)	Yes	2	<1	–0.70	0.27	–2.57	1	.010*	0.50	0.28	0.86
Leopard skin desire (no)	Yes	2	1	0.81	0.25	3.27	1	.001**	2.24	1.35	3.77
Leopard skin possession (no)	Yes	<1	<1	0.68	0.26	2.61	1	.009**	1.98	1.12	3.48
Age class	–	–	–	–	–	–	–	–	–	–	–
Formal education level gained	–	–	–	–	–	–	–	–	–	–	–
Model	AIC	443	Concordance	0.87	Nagelkerke R^2			0.61			
	Sensitivity	75%	Optimum threshold	0.50	Likelihood ratio test			$\chi^2 = -380$; $df = 7$; $p < .001$ ***			
	Specificity	89%	Accuracy	89%	Global goodness of fit test			$z = 8.183$; $df = 8$; $p = .969$			

Abbreviation: ^{ns}, non-significant.

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

(CI: 390, 437), respectively ($\chi^2_1 = 0.43$; $p = .512$; $\chi^2_1 = 0.37$; $p = .542$). The pre-FFL authentic skin possession prediction was 519 skins (confidence intervals [CI]: 495, 541), which did not differ significantly ($\chi^2_1 = 0.67$; $p = .414$) from the known count of 496 skins (Table 2), whereas the post-FFL authentic skin acquisition known count was 343 skins, which was significantly lower ($\chi^2_1 = .04$; $p < .0001$) than the predicted 467 skins (CI: 445, 491). Pre-FFL authentic leopard skin desirability was predicted for 851 respondents (CI: 819, 885), which was nearly significantly lower ($\chi^2_1 = 3.31$; $p = .069$) than the known count of 911 respondents, whereas the post-FFL authentic skin desirability known count was 621 respondents and the predicted count was 644 respondents (CI:

614, 674), which were not significantly different ($\chi^2_1 = 0.58$; $p = .448$).

4 | DISCUSSION

Successful conservation strategies require an understanding of human behaviors and how they may influence species ecology. This interaction is crucial to the conservation and sustainable use of threatened populations, while also preserving the rich cultural identity these species inspire (Manfredo & Dayer, 2004). A longitudinal study of Shembe Church followers in South Africa was employed to explore the socio-economic and experiential factors

TABLE 6 Binary logistic regression model of socio-economic and experiential factors predicting the likelihood of a Shembe follower expressing a desire for an authentic leopard skin post-FFL intervention (follow-up questionnaire: $n = 2,300$; 2013–2018; dependent variable: no = 0, yes = 1)

Parameter	Explanatory power (%)						95% CI			
	Univariate	Unique	β	SE	Wald	df	p value	Odds ratio	Lower	Upper
Intercept	-	-	1.38	0.41	3.35	1	<.001***	3.99	1.57	10.27
Leopard population status (uncertain)	27	28	0.89	0.33	2.70	1	.007**	2.43	1.33	4.58
Stable			-1.01	0.22	-4.58	1	<.001***	0.36	0.24	0.56
Decreasing			-2.67	0.21	-12.81	1	<.001***	0.07	0.05	0.10
Faux skin satisfaction (yes)	8	7	3.18	0.48	6.58	1	<.001***	24.00	10.72	59.64
Age class (11–20)	7	5	0.29	0.39	0.75	1	.456	1.33	0.55	3.27
31–40			0.46	0.38	1.19	1	.233	1.58	0.65	3.85
41–50			-0.32	0.38	-0.85	1	.394	0.72	0.29	1.78
51–60			-0.10	0.39	-0.26	1	.794	0.90	0.36	2.26
61–70			0.79	0.43	1.83	1	.067	2.21	0.84	5.86
71–80			2.92	0.71	4.10	1	<.001***	18.56	5.39	68.42
81–90			-0.42	0.75	-0.56	1	.575	0.66	0.12	3.67
Legality and permitting (uncertain)	4	2	-0.01	0.23	-0.06	1	.949	0.99	0.59	1.65
No			-0.77	0.19	-4.15	1	<.001***	0.46	0.32	0.66
Formal education level (none)	1	1	0.31	0.25	1.21	1	.225	1.36	0.81	2.28
Primary			-0.29	0.21	-1.34	1	.182	0.75	0.49	1.14
Secondary			-0.53	0.44	-1.21	1	.225	0.59	0.25	1.35
Tertiary			-0.54	0.19	-2.82	1	.005**	0.58	0.39	0.85
Knowledge of conviction (no)	<1	1	-1.04	0.20	-5.19	1	<.001***	0.35	0.23	0.54
Leopard skin possession (no)	<1	2	-1.04	0.20	-5.19	1	<.001***	0.35	0.23	0.54
Model	AIC	Concordance			Nagelkerke R^2		0.46			
Sensitivity	73%	Optimum threshold			Likelihood ratio test		$\chi^2 = -699$; $df = 18$; $p < .001$ ***			
Specificity	73%	Accuracy			Global goodness of fit test		$z = 0.729$; $df = 9$; $p = .682$			

Abbreviation: ns, non-significant.

* $p \leq .10$.

** $p \leq .01$.

*** $p \leq 0.001$.

TABLE 7 Predictive modeling using socio-economic and experiential factors to determine (1) the expected number of authentic leopard skins in possession pre-intervention and (2) the expected number of authentic leopard skins acquired post-intervention, as well as the expected number of followers who claim a desire for authentic leopard skins (3) pre- and (4) post-intervention. Indicated also are the pair-wise chi-squared tests, degrees of freedom and *p* values comparing known and estimated counts between models

Model	Step	<i>n</i>	Count			Comparison	
			Known	Estimate	CI	χ^2_{df}	<i>p</i> value
Possession ¹	Model (training)	5,000	–	–	–	–	–
	Validation (test)	1,300	235	248	234–265	0.43 ₁	.512 ^{ns}
	Pre-intervention	2,300	496	519	495–541	0.67 ₁	.414 ^{ns}
Acquisition ²	Post-intervention	2,300	343	467	445–491	23.04 ₁	<.001 ^{***}
	Model (training)	5,000	–	–	–	–	–
	Validation (test)	1,300	430	414	390–437	0.37 ₁	.542 ^{ns}
Desirability ³	Pre-intervention	2,300	911	851	819–885	3.31 ₁	.069 [†]
Desirability ⁴	Post-intervention	2,300	621	644	614–674	0.58 ₁	.448 ^{ns}

Abbreviation: ^{ns}, non-significant.

[†] *p* ≤ .10.

^{***} *p* ≤ .001.

relating to authentic leopard skin possession and desirability before, and 3 years after, receiving a *faux* alternative. As part of the FFL program, *faux* skin recipients were educated about impacts of the illegal skin trade on extant leopard populations and legislation regarding the purchase of authentic skins. This article shows that these interventions reduced both desirability for and possession of authentic leopard skins while improving perceptions towards *faux* skin alternatives.

Through distributing >18,500 *faux* skins, the FFL intervention program has successfully contributed to reducing the acquisition of authentic leopard skins among *faux* skin recipients by 7% post-FFL, representing significantly less acquisition than predicted. Crucial to the longevity of such interventions and subject to self-report and social desirability biases, most recipients (95%) were satisfied with their *amambatha*, reporting they still owned (98%) and had used it in the 3 years (94%), with little noticeable damage (<1%) or societal judgment (<5%). Determining the relative success of such conservation intervention strategies is challenging, with many studies having neither a satisfactory baseline nor the long-term monitoring data (Brooks, Franzen, Holmes, Grote, & Mulder, 2006; de Vries, 2005; Waylen, Fischer, MCGowan, Thirgood, & Milner-Gulland, 2010). Given the considerable size of the Shembe Church, the logistical scale of widespread demand-reduction, and the cultural sensitivities at play, achieving acceptance of *faux* alternatives in 3 years represents early progress towards a successful longer-term intervention. Our findings provide both a baseline and short-term longitudinal assessment of the FFL intervention, defining success not only quantitatively, but also by the degree of cultural acceptance. Authentic leopard skin desirability among *faux* skin

recipients decreased by 13% post-intervention, as predicted, suggesting that authentic skin acquisition is not strictly proportional to the desire for authentic skins.

The persistence of authentic skin desirability prompted further investigation into factors related to authentic skin possession and acquisition post-intervention. Possession of authentic leopard skins among *faux* skin recipients before the FFL program was primarily related to employment status and, to a lesser degree, limited knowledge or disregard for the illegality of unpermitted leopard skin possession, increasing age, and the belief that the South African leopard population is increasing. In contrast, the subsequent acquisition of authentic leopard skins was mainly related to improved employment status. Such clear economic predictors (employment status or change therein) emphasize the importance of both social prestige and age in the hierarchical structure of the Shembe Church (Marinovich, 2018), a classic indicator for many societal hierarchies where wealth and age are default symbols of respect (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013). That age was such a strong predictor for possession before the FFL intervention, but became nonsignificant in post-FFL authentic skin acquisition while employment persisted, is important. This suggests not only that age-related cultural inertia to *faux* skin acceptance is transient, given time to experience the alternative, but also, that authentic skin value may not be innately cultural or religiously driven. It follows that any social prestige gained through possession relates to money spent rather than the inherent value of authentic skins as symbols of traditional hierarchy. By revealing these substantial economic drivers at play under demand for traditional use, these findings direct Panthera's future intervention strategies towards market-based behavioural

change (e.g., creating a competitive market for high-value *faux* skins) in addition to appealing for Shembe leadership to denounce real leopard skin use and ongoing social engagement and conservation awareness programs. Identifying how economic factors relate to social status are pivotal to understanding the use of and demand for leopard skins among followers, and indeed any illicit use of wildlife products, as it likely limits the success, sustainability, and scalability of intervention strategies (de Young, 1993).

Respondents who expressed dissatisfaction with the *faux* product or a desire for authentic skins were more likely to have acquired an authentic skin after receiving a *faux* alternative, but these were few (<5%) and declined between questionnaires, respectively. Interestingly, respondents who already possessed an authentic skin in addition to their *faux* alternative (3%) were more likely to acquire an additional authentic skin post-FFL intervention. Although this may represent authentic skin replacement, it more likely indicates authentic skin resale trade, inflated individual accessibility to leopard products, or an increased desire for authentic skins once experienced, despite owning a *faux* alternative. Attempting to change values linked to financial release, trade incentives, and cultural inertia is challenging to any conservation intervention (Dickman & Hazzah, 2015). Improving conservation knowledge and awareness, however, are more susceptible to change (Nilsson, Baxter, Butler, & McAlpine, 2016; Thomas, Teel, Bruyere, & Laurence, 2019) and thus form an overarching goal for the FFL's educational program.

Authentic leopard skin desirability decreased among *faux* skin recipients post-intervention. This decline was predicted and related primarily to improved knowledge of possession legality, permitting requirements, and leopard population status across age classes. In accordance with social-psychological theory (Stern, 2018), respondents with tertiary education, improved knowledge about convictions, and belief that leopard populations are declining were less likely to have acquired an authentic leopard skin post-FFL intervention. Most respondents (88%) were in support of government intervention to protect leopards, which may facilitate further implementation of educational programs. Although conservation awareness is unlikely to eliminate the desire for authentic leopard skins or any traditional use outright, given the entrenched value placed on authentic cultural and religious symbols of devotion or prestige (Beverland & Farrelly, 2010; Geertz, 2016), they are nonetheless fundamental to effecting individual behavioral change. Such change is pro- rather than retro-active, cultivating a societal sense of intrinsic value and transgenerational equity of wildlife that is vital to intervention sustainability.

Intervention studies carry inherent biases and limitations that must be considered when interpreting results.

Importantly, only Shembe followers who approached *faux* skin distributors were sampled. Nevertheless, their responses provide valuable insights into the likely proportion of possession and probable factors related to the desire for authentic leopard skins among all Shembe followers. In addition, most respondents reported a willingness to wear *faux* skin alternatives to gatherings (93%) and were satisfied with their *amambatha* (95%), with only 15% reporting acquisition of an authentic leopard skin in the 3 years since receiving their *faux* alternative. Results were also likely affected by possible self-report and social desirability biases in the interview process (i.e., the NGO Panthera provided the *faux* skins and also conducted these questionnaires in person), as well as the relatively limited time since the intervention (Sutherland, 2020). Future research should address these issues in addition to identifying how these intervention strategies may benefit the many other "at risk" species forming part of the complete Shembe ceremonial regalia.

Regardless, this study is among the first to: (a) describe leopard skin use as ceremonial regalia among followers of the Shembe Church, one of the largest open displays of illegal wildlife exploitation for traditional use in southern Africa, and (b) explore why followers continue using leopard skin derivatives even after knowing the illegality and conservation implications of their actions. Leopard offtake to support traditional demand for skins is hypothesized to exceed the capacity of the South African leopard population (Swanepoel, Lindsey, Somers, van Hoven, & Dalerum, 2013), while the transnational trade supplying this demand is likely placing considerable pressure on leopard populations throughout southern Africa (Mann et al., 2017; Naude et al., 2020). Despite established TOPS and CITES regulations affording extensive legislative protection to leopards, effective local and regional enforcement is complex and hindered by the scale of use and the culturo-political landscape. This study shows that *faux* alternatives are acceptable to Shembe followers, significantly contributing to reductions in authentic leopard skin acquisition and desirability through FFL interventions. Results also highlight the lack of knowledge regarding the required permitting for leopard skin possession and trade among Shembe followers, as well as cognizance of the link between end-user demand and threatened leopard populations. By continuing to address these disparities, the FFL education program has shown reasonable reductions in acquisition behavior. A lack of comparable conservation intervention studies globally makes contextualizing the FFL success challenging, but highlights the importance of such retrospective assessment and continuous monitoring as part of intervention strategies.

Demand reduction strategies, including continued provisioning of suitable alternatives, improved education, and increased enforcement, are essential to addressing a growing culturo-religious demand for wildlife products that exacerbates illegal harvest and trade. Success, however, will ultimately depend on finding the balance between improved transnational policy that effectively conserves wildlife populations while maintaining respect for cultural value and practices.

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

V.N., G.B., G.W.J., T.D., and M.R. conceived the study and designed the experimental protocols with input from J.O.R. Data were collected by V.N., T.D., G.W.J., and X.M. Analyses were conducted by V.N., X.M., M.N., and M.R. All authors discussed and interpreted the data. V.N., G.B., L.H., M.N., N.N., J.O.R., and J.B. contributed critically to the writing of the manuscript and gave final approval for publication.

ETHICS STATEMENT

The research was approved by the University of Cape Town, Faculty of Science Research Ethics Committee (#FSREC83).

DATA ACCESSIBILITY STATEMENT

The data and code that support the findings of this study are openly available in ZivaHub, a UCT-based Figshare repository at <https://doi.org/10.25375/uct.12404048>.

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SUPPORTING INFORMATION

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

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