

1 **12 The Twin Challenges of Preventing Real and Perceived Threats to Human Interests**

2 Authors: Omar Ohrens¹, Francisco Santiago-Ávila¹ & Adrian Treves¹

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4 ¹ Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Wisconsin, USA

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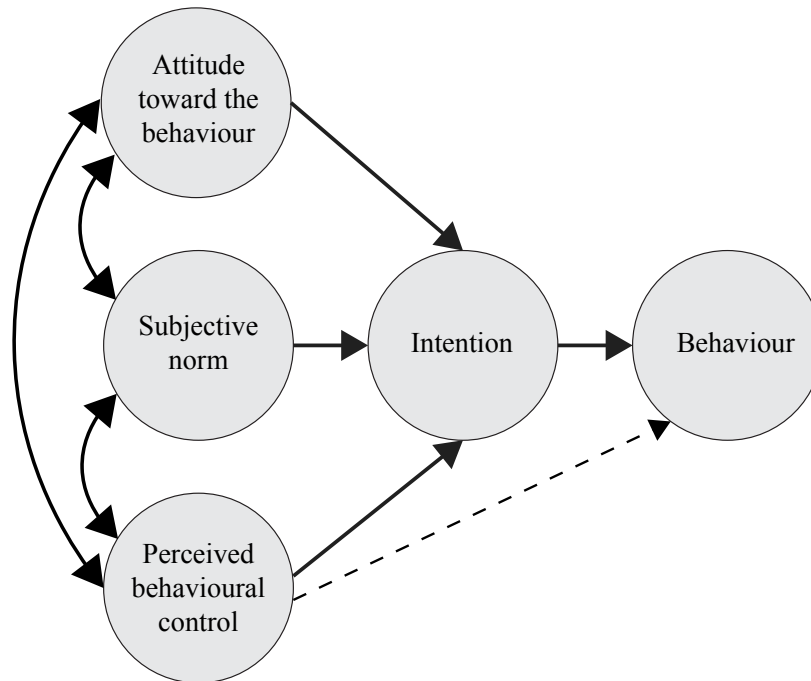
7 Humans and other species have historically competed over resources and space, resulting
8 many times in interspecies conflict. For example, humans have hunted or domesticated wild
9 herbivores for protein, which are also consumed by predators. This has led people to retaliatory
10 killing of carnivores, posing a major threat to their populations (Woodroffe & Ginsberg 1998;
11 Chapron et al. 2014). Although societies have developed mitigation strategies to reduce such
12 conflicts, the rise of social conflicts between people who value carnivores and those who do not
13 has sometimes affected the use of mitigation strategies, whether lethal or non-lethal (Treves &
14 Karanth 2003; Treves et al. 2006; Redpath et al. 2013; Treves & Bruskotter 2014; Woodroffe &
15 Redpath 2015). Differences in interests between people can lead to imposed solutions that
16 benefit some people over others, due to power relations or prevailing attitudes (Redpath et al.
17 2013; Treves et al. 2015). Because of this imbalanced decision making ability, a proposed
18 method may not be implemented as planned (Fishbein & Yzer 2003) or dismantled later
19 (Karanth & Madhusudan 2002), even when functionally effective.

20 Non-implementation highlights hidden cognitive mechanisms that have been described
21 by social psychologists' theories (e.g. Ajzen's Theory of Planned Behaviour (hereafter TPB); see
22 Text Box 12.1), in which a complex mix of social norms, emotions and external conditions can
23 influence people's decisions and actions (Fishbein & Yzer 2003; Wieckzorek Hudenko 2012;
24 Schlüter et al. 2017; Amit & Jacobson 2017). The cognitive dimensions of human behaviour

25 interact with both individual appraisals of effectiveness - which does not necessarily correlate
26 with functional effectiveness - and uncertainty about effectiveness to alter implementation. We
27 use the term effective (*powerful in effect; producing a notable effect*, www.oed.com) and
28 effectiveness because these allow us to address both the potential of individual actors to achieve
29 coexistence and the efficacy of technical devices to attain that goal. We do not use the term
30 efficacy as it is more limited (*not used as an attribute of personal agents* www.oed.com) and
31 avoid efficient because of its potential for confusion with feasible (*capable of being done,*
32 *accomplished or carried out; possible, practicable*). We also focus on evidence for effectiveness
33 of an intervention from actual experimental trials under working conditions (not under laboratory
34 conditions), not idealized claims of effectiveness that have not yet been realized through real-
35 world testing.

Text Box 12.1. *Theory of Planned Behavior* (adapted from Ajzen 1991)

This theoretical framework describes how intentions to perform certain behaviours are predicted by cognitive variables such as attitudes toward the behaviour (i.e. evaluation of the behaviour in question), subjective norms (i.e. social pressure to perform the behaviour), and perceived behavioural control (i.e. self-efficacy or perceived capacity to perform the behaviour).



37

38 Scientific research has shown that numerous methods of intervention can promote coexistence of
 39 people and carnivores (Inskip & Zimmermann 2009; Treves et al. 2009; McManus et al. 2015).

40 However, few have been scientifically evaluated along multiple criteria of effectiveness, cost-
 41 efficiency, environmental consequences, social acceptability (Shivik et al. 2003; Breitenmoser et

42 al. 2005; Inskip & Zimmermann 2009; Treves et al. 2009; Zarco-González & Monroy-Vilchis;

43 2014; McManus et al. 2015) and adequacy of implementation. Here, we lay out an integrative

44 framework for understanding the implementation of interventions for coexistence and conflict,

45 which includes both the effect in preventing future damages (functional effectiveness, 'FE'

46 hereafter) and the individual human perceptions of effectiveness of an intervention (perceived
47 effectiveness, 'PE' hereafter). In some cases, conflicting perceptions of effectiveness and
48 functional effectiveness can lead to negative outcomes for wildlife or property owners, where the
49 goals of conservation and coexistence with wild animals may be jeopardized. We expose the
50 cause-and-effect logic underlying decisions to intervene or not, where both explicit and hidden
51 mechanisms are considered. By understanding better how FE and PE relate, we believe the field
52 can avoid a sterile debate claiming that *people are irrational* on the one hand or that *technical*
53 *experts have no common sense* on the other hand. Avoiding such misunderstandings may
54 improve intervention design and implementation, conservation and coexistence efforts, policy,
55 conflict resolution, and scientific analysis of human wildlife-coexistence and conflict (HWCC).

56 **12.1 The theory behind FE and PE**

57 Functional effectiveness (FE) in our context of HWCC measures *whether the intervention*
58 *reduces future attacks by wildlife* (Treves et al. 2016). Because empirical measurement of
59 wildlife damage and its attribution to wildlife is a technical skill with a measurable rate of errors
60 (e.g. Plumer et al. 2018), FE differs markedly from human opinion of the effectiveness of an
61 intervention, to which we return below. Nevertheless, FE is difficult to evaluate rigorously.
62 Biomedical sciences have pioneered in experiments yielding strong inference about the FE of
63 interventions. For instance, randomized control trials (*gold-standard* hereafter; see Text Box
64 12.2), are the most robust methods to estimate the effectiveness of an intervention (Grimshaw et
65 al. 2000; Mukherjee 2010). Avoiding biases at several stages and reducing the effect of
66 confounding variables are indispensable advantages of this method. For instance, there has been
67 four recent reviews on the FE of methods to reduce carnivore predation on livestock, which
68 revealed diverse interpretations and standards of evidence (Miller et al. 2016; Treves et al. 2016;

69 Eklund et al. 2017; van Eeden et al. 2018). One of the main results of all four reviews was the
70 high variability in the effectiveness of interventions. Moreover, all four reviews concurred that
71 strong inference was scarce because of a lack of experimental controls. Because there has been
72 little consensus until now on standards of evidence for FE, at least one of the above reviews used
73 measures of PE (did the livestock owner report satisfaction or perceive reduction in losses of
74 livestock?). In the next section, we define PE so future research will maintain a clear separation
75 between FE and PE.

Text Box 12.2 *Definition of gold, silver and platinum-standard experiments (see Treves et al. 2016)*

Gold-standard

Random assignment of treatments and controls, without detectable biases in sampling, treatment, measurement, or reporting. It produces the strongest inference and evidence of effectiveness of an intervention. Examples of this were reported in Treves et al. (2016).

Silver-standard

Non-random assignment of treatments. Includes quasi-experimental designs with haphazard assignment of treatments, such as case-control or Before-After Control-Impact (hereafter BACI) designs. Produces weaker inference because of potential pre-existing differences between treatment and control replicates, and because of confounding temporal effects coincident with the treatments.

Platinum standard

A gold-standard experiment in which ‘blinding’ prevents intervenors from influencing measurers and vice versa, and other recommendations from Ioannidis (2005) are put in place by researchers, such as registered reports in which the methods are peer-reviewed before the experiment begins.

76

77 Because strong inference depends on careful experiments that oppose hypotheses (Platt
78 1964), Treves et al. (2016) emphasized that only a handful of studies in North America and
79 Europe had ever produced strong inference about interventions to prevent predation on livestock.
80 Although their goal was to review studies that fulfilled the *gold-standard* criteria, only two tests

81 of non-lethal method met that standard between 1973 and 2016 and zero for lethal methods of
82 intervention. Therefore, they had to relax the criteria to include silver-standard studies (a total 10
83 studies under this criteria) (see Text Box 12.2 for definition). Furthermore, a 2018 re-evaluation
84 of one of the tests of lethal methods led to its removal from the list of functionally effective
85 methods (Santiago-Ávila et al. 2018a), given concerns related to their identification of study
86 subjects (potential sampling bias) and the construction of their dependent variable (potential
87 measurement bias). In summary, we highlight the importance of implementing rigorous and
88 robust designs that measure functional effectiveness with strong inference. This will prevent
89 implementation of ineffective interventions that would lead to wasted resources and harm to
90 animals (wild and domestic) and, therefore, not promote coexistence. We also conclude that after
91 more than 40 years of studies with weak inference or flawed designs, societies seeking evidence-
92 based policy on wildlife control may find little certainty. That can lead to choices of
93 interventions based solely on PE.

94 By contrast with FE, PE is a cognitive state. Perceived effectiveness (PE) in the context
95 of HWCC measures *individual perceived reduction in damages of an intervention*. For example,
96 most readers would accept that two individuals could perceive the same effect differently from
97 each other and, neither PE may be identical to the scientific measurement of a functional effect.
98 The logical inference in both cases is that PE relies on subjective cues that can be accurate or
99 not. Human brains and senses are not scientific tools for unbiased measurement. For instance,
100 several studies have demonstrated the influence that factors like experience, context, cognition,
101 and perceptual biases (e.g. preconceived ideas about something) have on filtering individual
102 observations (Starr 1969; Kellert 1985; Slovic 1987; Finucane et al. 2000; Wieczoreck Hudenko
103 2012). In this section, we attempt to explain more precisely the conditions under which FE and

104 PE do and do not overlap, and the role that overlap plays in fostering or hindering coexistence
105 with others, especially nonhuman others.

106 **12.1.1 PE components and development of framework**

107 Differences of perception between two persons relates both to physical constraints on
108 perceptual abilities (e.g. sensory and motor constraints) and to psychological factors that
109 influence appraisals (Starr 1969; Slovic 1987). The field of psychology has a long history of
110 investigating appraisals and two major conclusions have emerged. Human brains make rapid
111 appraisals on the order of milliseconds, using more ancient regions of the brain such as the
112 amygdala (Whalen et al. 1998; Morris et al. 1999). Rapid appraisals (e.g. emotions - fear of
113 snakes) often have high survival value and are difficult to modulate by the slower, cortical
114 regions of the brain (Öhman & Mineka 2001; Barrett 2006; Lindquist et al. 2012). Fast
115 appraisals captured by the amygdala may even go unnoticed by the perceiver, who simply may
116 not be aware of the stimulus (i.e. unconscious pathway) (Esteves & Öhman 1993; Whalen et al.
117 1998). Human brains also make slower appraisals on the order of tenths of seconds, using more
118 recently evolved regions of the brain such as the frontal cortex (Ajzen 1991; Treves & Pizzagalli
119 2002; Kahnemann 2003). For instance, when humans face obstacles or threats, their preferred
120 solutions reflect both the rapid-affective (as simple as like or dislike) and slower-cognitive
121 responses (should I like or dislike this?), which may integrate numerous criteria that reflect both
122 the characteristics of the obstacle or threat, and the perceiver's own attributes including
123 experiences and perceived social norms (e.g. how others perceive the situation and what they
124 expect from the subject) (Kahnemann 2003; Wiczorek Hudenko 2012). The way the different
125 appraisals replace each other or integrate is not yet well understood generally and largely
126 unknown for HWCC. In summary, there is a mixed route of decision making relevant to

127 behaviour based on a rapid, automatic pathway (e.g. affective) combined with a slower, reasoned
128 one (e.g. conscious) (Kahnemann 2003).

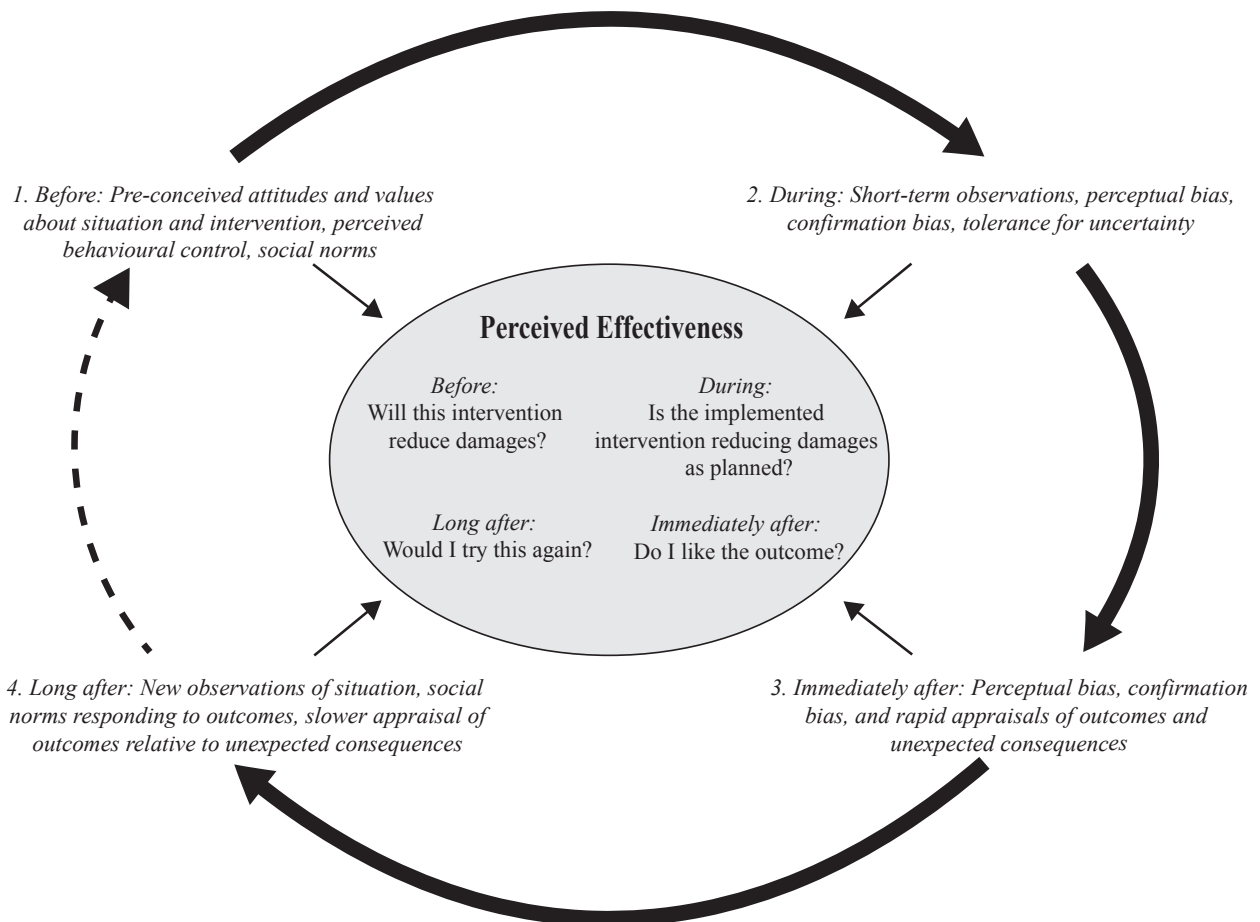
129 Building on the above research into cognition and behaviour, investigators of HWC
130 decision-making suggest that both cognitive (rational) and affective (emotional) components are
131 relevant and important in understanding human behaviour. This is significant given that
132 emotions (e.g. fear) will most likely predominate during these interactions and, therefore, would
133 influence human behaviour (Johansson & Karlsson 2011; Wiczorek Hudenko 2012; Frank et al.
134 2015; Sponarski et al. 2015). Thus, in our treatment of PE, we restrict ourselves to referring
135 simplistically and similarly to a mixture of affect (rapid responses) and cognition (slower
136 responses) rather than the exclusive use of one or the other.

137 Observers or non-evaluators may disagree with scientific measurement of FE and will,
138 therefore, behave differently from evaluators. For instance, confirmation bias can be understood
139 loosely as a tendency to ignore information that conflicts with pre-existing beliefs, and to focus
140 on information that conforms to a person's beliefs (Dunwoody 2007; Wiczorek Hudenko 2012).
141 Related but sometimes acting separately, humans may change their perceptions, and behaviours
142 that follow from those perceptions, if the bearer of the new message is familiar and trusted
143 *versus* unfamiliar or untrusted (Dunwoody 2007; Powell et al. 2007). For instance, trust and
144 familiarity have been addressed through research on social norms. Addressing HWCC explicitly,
145 Heberlein (2012) described norms as behavioural regularities and as being closely related to
146 one's role in a social group. Social norms can trump attitudes when it comes to shaping
147 behaviours and expectations (Kinzig et al. 2013). Further, norms of acceptable behaviour and
148 those enforced by social pressure can govern over alternate rules or motivations (e.g. laws or
149 mechanistic explanations for behaviour such as income needs), as in the case of illegal

150 behaviours (Jones et al. 2008; Marchini & Macdonald 2012). For example, social norms strongly
151 influenced the intention to kill jaguars in Brazil more so than retaliation due to livestock
152 predation. People's intention to kill carnivores was driven by the thought that peers kill
153 carnivores more than wealth of the respondent (Marchini & Macdonald 2012). Furthermore, the
154 decision to act may depend on the individual's perceived behavioural control over that action or
155 the phenomenon being perceived (Ajzen 1991; Fishbein & Yzer 2003; Amit & Jacobson 2017).
156 Discriminating the two cognitive mechanisms (social norms or behavioural control) may be very
157 difficult because of the hidden nature of cognitive processing that precedes action or inaction.
158 Finally, perceptions might change following an intervention event or before, during and after an
159 intervention took place. For example, a farmer may ask himself questions like: (1) *Will this*
160 *intervention reduce damages or threats?* (before implementation), (2): *Is this reducing damages?*
161 *(during)*, (3) *Do I like the outcome?*, *Were there any unexpected consequences?* (immediately
162 after), and; (4) *Would I try it again?* (longer after; see PE in Fig. 12.1). Some authors (Ajzen
163 1991; Fishbein & Yzer 2003) predict that events may produce changes in intentions or in
164 perceptions of behavioural control, with the effect that the original measures of these variables
165 no longer permit accurate prediction of behaviour.

166 Here, we build and expand on the TPB (Ajzen 1991) as well as more recent work on
167 behaviour change in the literature on human-environment interactions (Fishbein & Yzer 2003;
168 Wieczorek Hudenko 2012; Amit & Jacobson 2017; Schlüter et al. 2017;) to offer a schematic
169 figure both to illustrate the complexity of human cognition as it relates to PE, and as a heuristic
170 tool for partitioning the process of PE into more manageable components for analysis, as
171 discussed previously (Figure 12.1). For instance, Amit & Jacobson (2017) described an
172 expanded model adapted from Ajzen's TPB (1991) applied to human-carnivore conflict

173 mitigation strategies. This expanded model included additional factors such as emotions and
 174 situational variables (i.e. livestock mortality rates by carnivores, income from livestock
 175 production and size of the property) that may influence farmers' decision-making behaviour
 176 related to the adoption of an intervention or not. Here we simplify intervention choice or
 177 implementation down to the most important causal variables so that we can integrate FE and PE.
 178 Integration of both will help us to identify and understand the circumstances when they do or do
 179 not align and, therefore, focus on where and how we should put our efforts on interventions
 180 aimed at coexistence.



181
 182 **Figure 12.1** Perceived effectiveness framework adapted from social-psychological decision-
 183 making theories. In this adapted framework, human cognition variables are laid out

184 chronologically from the upper left running clockwise from pre-implementation of an
185 intervention to long-term post-implementation. The dashed arrow indicates the possibility of re-
186 starting the process adaptively if the implementers are not satisfied.

187

188 **12.1.2 Integrative Framework: Theory of Relationship between Functional and Perceived** 189 **Effectiveness**

190 So far, we have described the theory behind FE and PE independently. Now, we want to
191 integrate the two concepts to propose a hypothesis. Our hypothesis is that, a scientifically-proven
192 functionally effective intervention (high FE) is more likely to be adopted if $PE \geq FE$, than if $PE <$
193 FE . Alternatively, an ineffective intervention (FE low) is more likely to be adopted if $PE > FE$,
194 than if PE is low (Figure 12.2).

195

196 Figure 12.2. Hypothesis that integrates concepts of perceived and functional effectiveness

		PE	
		<i>Low</i>	<i>High</i>
FE	<i>Low</i>	Least likely to be adopted	More likely to be adopted
	<i>High</i>	Less likely to be adopted	Most likely to be adopted

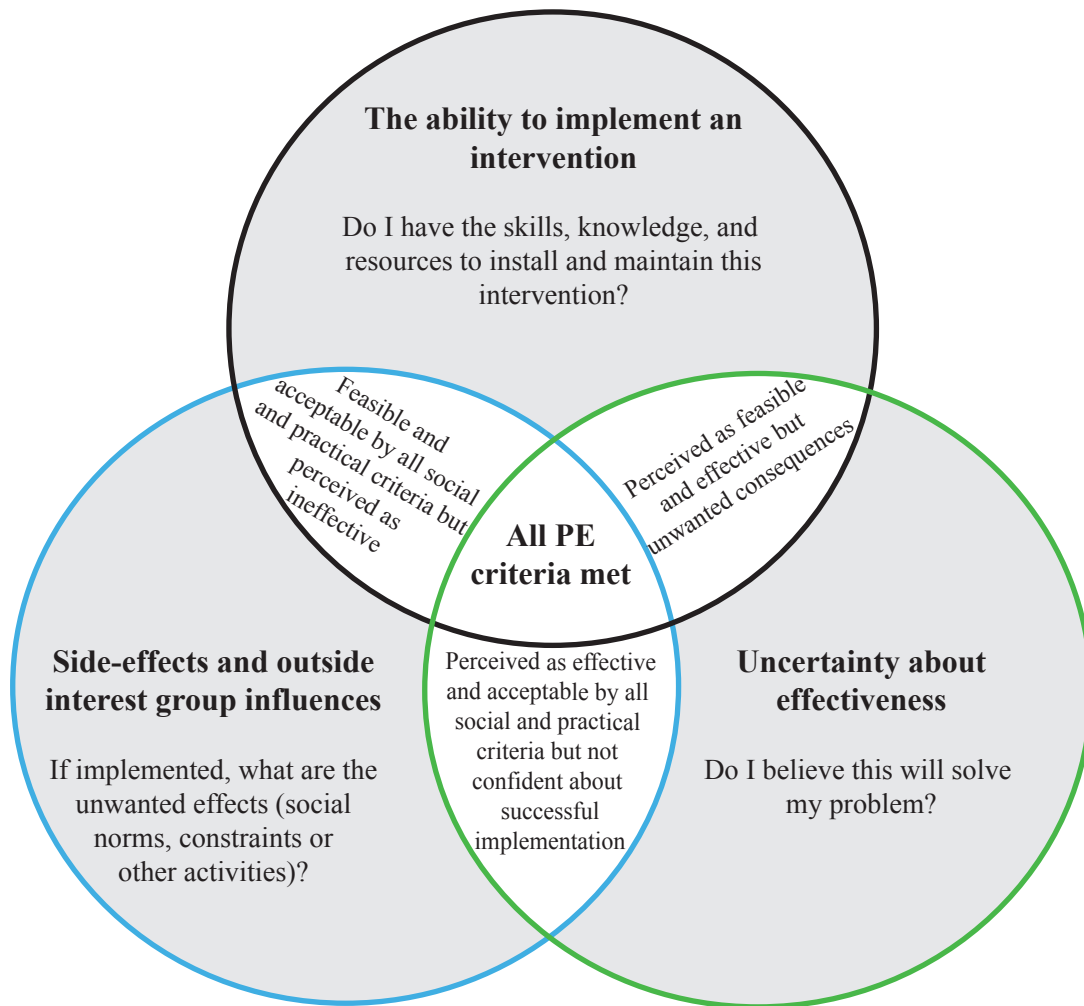
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198 This hypothesis highlights two cases of important conservation and coexistence concern.
199 We predict that (1), non-adoption of a functionally effective intervention, (high FE and low PE,
200 lower left in Figure 12.2) leads to political conflicts between researchers and stakeholders in
201 addition to adoption of another intervention method, which might in turn lead to (2), the adoption
202 of an ineffective intervention (low FE and high PE, upper right in Figure 12.2). We predict
203 outcome (2) leads to wasted resources and harm to animals without improving coexistence. In
204 both cases, our goal is to predict the factors that are influencing the decisions and suggest
205 outcomes for coexistence.

206 Here, we propose three cognitive processes that may influence PE and the decision to
207 implement an intervention: (1) uncertainty about FE, (2) ecological and social side-effects and
208 outside interest groups influences (e.g. social norms), and (3) ability to implement (e.g.
209 feasibility, behavioural control¹). These cognitive processes do not act separately, presenting
210 levels of overlap and correlation between them (Ajzen 1991; Fishbein & Yzer 2003; Amit &
211 Jacobson 2017). Nevertheless, all of the cognitive processes underlying PE might contribute to
212 the decision to act (implement an intervention), which we defined as an area where all three
213 processes overlap in Figure 12.3. Because two of the three cognitive processes have nothing to
214 do with FE (social norms and perceived behavioural control), we predict in many instances $FE \neq$
215 PE. We predict that FE is more likely to equal PE and that appropriate action would follow when
216 a trusted messenger demonstrates the intervention or testifies to its usefulness (Dunwoody 2007)
217 (reducing uncertainty), when unintended side-effects are minimized or eliminated, and when
218 resource or technical aid is provided to improve perceived control over the intervention.

219

¹ the degree to which an individual perceives the behaviour under their volitional control



220

221 **Figure 12.3.** Integrative framework for effectiveness of interventions regarding human-wildlife
 222 conflicts. Decision-making variables span different groups and levels, indicated by overlapping
 223 circles. The overlapped area indicates the co-occurrence of PE variables. Examples of questions
 224 are provided for each variable (circle) which might influence decision-making. The bottom right
 225 circle relating to uncertainty is meant to predict that FE (scientific evidence) is still filtered
 226 through a cognitive process relating to uncertainty if the FE applies to the subject in question.

227

228 A framework should guide the testing of a hypothesis, if the predictions are articulated
 229 properly and measured appropriately. Our integrative framework helps to explain why an

230 implementer may decline or dismantle an intervention that shows evidence of FE, because FE
231 does not address side-effects, social norms, or feasibility. Likewise, our framework helps to
232 explain why technical experts often disapprove of the actual methods in use by lay persons. For
233 instance, the implementation was feasible and accepted by social norms but the technical expert
234 may see a design flaw that precludes FE. Our framework would improve future coexistence if it
235 exposes mismatches between PE and FE so that intervention designers and implementers can
236 include persuasive interventions if needed.

237 Below we explore some cases in which $PE \neq FE$ yet FE is high. Our first example
238 addresses a non-lethal intervention in which social norms are favourable and uncertainty is low
239 but individuals seem to rate the feasibility (perceived control) as low. A proven intervention such
240 as Livestock Guarding Dogs (LGDs hereafter) can reduce livestock losses in a variety of
241 situations (Gehring et al. 2010; Treves et al. 2016), but many livestock owner's express concerns
242 about their ability to raise, maintain, and train such dogs or share the belief that these dogs do not
243 work on large, open pastures despite evidence of the contrary (Espuno et al. 2004). If we are
244 correct that other components of PE are moderate to highly conducive to adoption but a
245 perceived lack of behavioural control or ability to implement an LGD is widespread (issues and
246 assistance with proper training and caring for guarding dogs), then adoption might be promoted
247 by training and demonstration projects with owners.

248 Other methods of intervention seem to be perceived as feasible (high perceived
249 behavioural control) yet are not adopted widely. For example, in Sweden subsidized fencing to
250 protect livestock has not led to a widespread installation by farmers (Frank & Eklund 2017),
251 although individuals accepted the help initially and this intervention has substantial evidence of
252 FE (Karlsson & Sjöström 2011; Ängsteg et al. 2014). According to our hypotheses and its

253 predictive framework, some component of PE must be low or missing. We predict that a social
254 norm exists against the subsidized fencing or that after installation farmers are discovering side-
255 effects or infeasible aspects.

256 It is tempting for scholars to assume that when $PE \neq FE$, the lay person needs more
257 information (the information-deficit hypothesis). Our framework suggests instead that other
258 important cognitive processes may be blocking adoption and maintenance of the implemented
259 method. Uncertainty and novelty of methods can dampen adoption. For example, differences
260 between sites where FE experiments take place and the actual site of implementation could
261 elevate uncertainty. Small differences in livestock husbandry, carnivore species, or landscapes
262 can raise doubts about FE in even the most willing adopter. Even after implementation, a person
263 might abandon the method if outcomes are not as promised. Slower appraisals that arise from
264 unexpected outcomes, as well as dynamic social norms might lead to dismantling or defection of
265 implementers. Moreover, the farmer may oppose the general view of effectiveness due to
266 disagreement over conservation goals and might, therefore, dismiss and contest research
267 (Redpath et al. 2013; Woodroffe & Redpath 2015). Therefore, the presentation of information
268 and its acceptance by various audiences is best understood by studying the communication
269 process and participants, more than by the content of the communication.

270 It is widely believed that owners of domestic animals should be engaged actively in
271 decision-making to help build trust and meet PE criteria. For example, participant engagement
272 approaches have been described as helpful when promoting adoption of interventions (Treves et
273 al. 2006, 2009; Reed et al. 2008; Woodroffe & Redpath 2015). Nevertheless, it does not
274 necessarily follow that participants must be engaged in groups to decide on each other's
275 interventions. That might amplify social norm imposition (peer pressure) that could drive PE

276 further from FE. The ideal scenario for coexistence in HWCC is for both people and wildlife to
277 be protected with FE interventions that meet PE criteria. The ideal scenario would be researchers
278 measuring the cognitive components of PE before attempting an intervention. What we are
279 proposing here has not yet been fully tested but promising projects are underway (see Text Box
280 12.3 below).

281

282 **12.2 Case Studies on Perceived Effectiveness of Methods to Reduce Damages to Livestock**

283 We reviewed various case studies regarding PE of interventions with the goal of
284 comparing them with the proposed integrative framework, and then give guidance on how to
285 design a study to measure these components. We selected 3 studies where we addressed at least
286 one of the cognitive processes or components described in our integrative framework (see Text
287 Box 12.3).

288

289 *[Start Text Box 12.3]*

290

291 **Case study 1: Integrating proposed framework to improve coexistence between pumas and** 292 **people in Chile**

293 Research began by measuring attitudes among Aymara indigenous people in northern Chile
294 towards pumas and perceptions of methods to protect livestock. These baseline data revealed low
295 perceived behavioural control (owners felt they needed help to implement any intervention), that
296 non-lethal methods were viewed as an option by respondents (i.e. permissive social norms)
297 (Ohrens et al. 2016). Furthermore, researchers had very weak evidence about FE of any method
298 for the predator, the livestock, or the region. Subsequently, authors offered help to intervenors
299 (owners) by attempting a participatory intervention planning workshop (see methods in Treves et
300 al. 2009) to select a non-lethal method of their preference. This participatory process (i.e. local
301 engagement) might have helped to overcome PE about what would be effective and what would

302 not, given equal uncertainty among methods. Besides, researchers attempted to improve
303 participants' perceptions of behavioural control. Only one of 12 participants in the experiment
304 abandoned the project midway, the remaining 11 accepted the placebo control in a cross-over
305 (reverse-treatment) design, and after the end of the experiment all 11 requested to keep the light
306 deterrent device they had tested. Although this example attempted to integrate several criteria of
307 PE, it did not measure social norms explicitly and does not yet demonstrate long-term adoption.

308 **Case study 2: Lethal interventions against jaguars in Brazil**

309 The second study, done in Amazonia and Pantanal, Brazil (Marchini & Macdonald 2012),
310 measured social norms regarding lethal control of jaguars. To gather specific variables that could
311 help to predict behaviour and intentions to use lethal methods, the authors followed the TPB
312 (Ajzen 1991) and separated social norms into several components (e.g. descriptive norm, social
313 identity) to measure cognitive aspects of coexistence or illegal killing of jaguars. The authors
314 concluded that peer group pressures and other social norms (cultural beliefs about men and
315 jaguars) were important predictors of the intention to kill jaguars, independently from wealth or
316 economic losses, which did not predict that intention well. Apparently, respondents believed that
317 killing jaguars would save cattle despite lack of evidence of FE (low uncertainty about the
318 method), and that belief was amplified by social norms. Nevertheless, farmers who expressed an
319 intention to kill jaguars reported substantial variation in their ability to do so (Marchini &
320 Macdonald 2012). In sum, implementation (illegally killing a jaguar) was predicted strongly by
321 behavioural control and the expected positive social benefits of doing so. In such a situation,
322 measuring FE or intervening to raise uncertainty about the effectiveness of killing jaguars to
323 protect cattle may be irrelevant. Conservationists aiming at coexistence should address the social
324 norm affecting those individuals who intended to kill jaguars or report the ability of those
325 individuals to act on their beliefs.

326 **Case study 3: Perceived effectiveness of interventions in South Africa**

327 We combined two studies that similarly presented measurements on uncertainty of effectiveness,
328 and retention of interventions over time. The first study, from McManus et al. (2015), applied a
329 pseudo-control design to measure the effect of lethal interventions compared to subsequent non-
330 lethal ones. The authors found that livestock losses and related costs declined after implementing
331 a variety of different non-lethal methods. Therefore, FE of non-lethal was concluded to be higher
332 than FE of lethal methods. Follow-up interviews revealed that 6 of the 11 farmers continued the
333 effective non-lethal methods 12 months after the team stopped measuring livestock losses.
334 However, after 36 months only 4 of 11 farmers continued the effective non-lethal interventions.
335 The reasons that 7 farmers abandoned the non-lethal methods included unexpected outcomes
336 (dog that may have killed livestock was shot by neighbour), ability to implement (farmer found
337 easier to implement lethal method) and uncertainty of effectiveness (lethal method perceived
338 more effective). We infer that FE was not sufficient to assure long-term adoption of a non-lethal
339 method. Several components of PE resurfaced over time and a lower FE method supplanted the
340 method with higher FE (McManus et al. 2015).

341 The second study conducted by Rust et al. (2013) applied a quasi-experimental design
342 (before-and-after), without controls, to measure attitudes of farmers to the performance of LGDs
343 in protecting livestock from cheetahs as well as costs associated with their implementation.
344 Researchers documented that LGDs were perceived as cost-effective in reducing livestock
345 predation by carnivores. Mean perceived annual predation for the total participating farms
346 (n=70) were reduced by 33 to 100% after LGD placement. The authors reported that from a total
347 of 97 LGDs, 22% (n=21 dogs) were removed from farms. Reasons for dog removal were mostly
348 reported to be related to farmer's perception of dog's behaviour and capacity (uncertainty of
349 effectiveness) followed by a few cases that were related to owner's capacity to implement dog

350 training or husbandry properly (ability to implement). Again, an FE method in the short-term
351 proved to have longer-term problems in a minority of cases or at least the PE of the method
352 diminished over time.

353 *[End Text Box 12.3]*
354
355

356 Our three examples have highlighted incongruities between PE and FE but do not serve
357 to test our hypothesis rigorously. We lack a study of FE combined with measures of PE at the
358 same site that are both focused on the same intervention, regardless of how many subjects
359 benefited from the intervention (i.e. a continuous measure of FE). With a sufficient sample of
360 respondents, such a study could test our hypothesis by correlating PE to each PE component and
361 to individual experiences of FE across subjects.

362 Alternately, we would need a study across many sites that compares aggregated PE
363 measures for each site to the binary variable of FE (i.e. was it effective at that site or not?).
364 Under those conditions, the intervention does not need to be the same across sites because site-
365 specific PE and FE are being compared to each other (within-subject correlation). Such a study
366 would provide a more general test of our hypothesis, but would lack the specificity to reveal
367 clearly which component of PE was responsible for any observed mismatch because different
368 biophysical, socio-political, and intervention designs would cloud the interpretation of results.
369 Regardless, either type of study would help to advance research on preventing HWCC. We
370 expect coexistence would be promoted as a result.

371 **12.3 Guidelines to Measure Perceived Effectiveness of Interventions**

372 For this purpose, we present guidelines and steps in designing and conducting research
373 regarding our PE criteria. We will focus on the intent of coexistence interventions, and how they
374 affect PE, and each of its components. For example, we need to: (1) use the integrative

375 framework to target and focus on components that have not been addressed in former studies
376 conducted in the same locations (e.g. define research questions), (2) select robust designs to
377 reduce all sorts of biases (e.g. design of studies), (3) develop methods to target research
378 questions (e.g. questionnaires, appropriate framing and design of questionnaires) (see Marchini
379 & Macdonald 2012; St. John et al. 2014), and (4) consider temporality within study design (e.g.
380 before, during, after and follow-up measurements) (see McManus et al. 2015) (see summary in
381 Table 12.1).

382 **12.3.1 Study Design for PE**

383 We propose to randomly apply questionnaires to farmers within a study area, a common
384 method in social sciences, to measure our proposed components (Newing et al. 2011). The focus
385 of questionnaires may depend on the amount and type of existing information that is related to
386 our framework and available at the site. However, for our purposes we will target all components
387 described earlier (Figure 12.1 and 12.3). We recommend that questionnaires follow the time-
388 scale presented in our PE framework; with questions that target information before, during,
389 immediately and long after implementation of interventions. At the same time, we suggest
390 following the construct of our proposed integrative framework to design questions that measure
391 each component. For example, questions can be in the form of statements for each variable
392 within components, using Likert scale answers (from strongly agree to strongly disagree)
393 (Newing et al. 2011). This is a commonly used method to measure latent constructs such as
394 attitudes and behaviours. Here are some examples of statements for each component: (1) *I am*
395 *confident about continuing using the intervention* (ability to implement), (2) *I feel social*
396 *pressure to use a specific intervention* (side-effects and outside group influences), (3) *The*
397 *intervention has been very effective in reducing attacks on livestock* (uncertainty of

398 effectiveness) (see Marchini & Macdonald 2012; St. John et al. 2014). To test, we can use a
 399 general linear model (GLM) between integrative framework variables as predictors (e.g. ability
 400 to implement, uncertainty of effectiveness, social norms) and the binary result of the intention or
 401 not (0 or 1) to implement the proposed intervention as response variable.

402

403 **Table 12.1** Guidelines to measure perceived effectiveness of interventions.

Timing relative to implementation	Response Variable	Predictors		
		Uncertainty of effectiveness	Social Norms (measured within participants and outside interest groups)	Ability to implement
Before	Intention to implement?	Measure the participant's appraisal of future effectiveness	<ul style="list-style-type: none"> - Measure the likely gain or loss of social status if they implement (based on perceptions relative to others) - Measure side-effects from outside interest groups as perceived by participant and associates 	Measure anticipated feasibility (cost, skill, time, side-effects other than social ones)
During	Maintain implementation?	Measure the participant's appraisal of ongoing effectiveness	Measure the actual gain or loss of social status as perceived by participant, associates, and outside interest groups (based on perceptions relative to others)	Measure ongoing actualized feasibility (cost, skill, time, side-effects other than social ones)

Shortly after	Appraisal of outcomes?	Measure the participant's conclusion about effectiveness	Measure the actual gain or loss of social status as perceived by participant, associates, and outside interest groups (based on perceptions relative to others)	Measure final, actualized feasibility (cost, skill, time, side-effects other than social ones) and the benefits – costs of outcomes
Long after	Adopt and promote with others?	Measure the participant's willingness to continue use or communicate outcomes to others	Measure the actual gain or loss of social status as perceived by participant, associates, and outside interest groups (based on perceptions relative to others)	Measure long-term side-effects and the costs and the benefits – costs of outcomes

404

405 **12.4 Conclusions: Tying Back to Coexistence**

406 Interventions aim at reducing negative interactions between wildlife and humans,
407 promoting coexistence. Under our integrative framework, we hypothesize that the successful
408 adoption of proven effective interventions are more likely if functional and perceived
409 effectiveness align ($PE \geq FE$ and FE is high), which in the long term should promote and foster
410 coexistence. Similarly, Heberlein (2012) argued that to approach environmental problems
411 successfully, more than one of his proposed fixes (e.g. technical, cognitive and structural) need
412 to be addressed. Analogously, our framework is proposing to address both technical (i.e.
413 technical solution to reduce livestock losses - functional effectiveness) and structural-cognitive
414 fixes (indirect solution that attempts to address peoples attitudes and behaviours towards wildlife
415 - perceived effectiveness, also see Treves et al. 2006, 2009) to improve coexistence. We

416 recommend interdisciplinary measurement of both human cognition and behaviour as well as
417 experimental tests of functional effectiveness. By promoting PE and FE alignment, we fall to the
418 right side of the conflict-to-coexistence continuum, aimed at improving positive
419 attitudes/behaviours towards wildlife (Frank 2016).

420 Our framework (Figure 12.2) predicts that political conflicts will arise in two different
421 ways when $FE \neq PE$. When $PE > FE$ and FE is low, technical experts will object to the
422 implementation of an ineffective intervention, and the political conflicts and disputes that ensue
423 will focus on trust in science, as well as legitimacy of unscientific decisions, among others. If
424 opposing interest groups are involved, the interest group that either ideologically prefers the
425 intervention or prefers science-based decision-making will take sides. When $PE < FE$ and FE is
426 high (case study 3), we predict technical experts will find themselves trying to persuade lay
427 people to implement something they are resistant to try. If technical experts fail, then the likely
428 outcome would be the case where a lower FE method is implemented ($PE > FE$, FE is low).

429 Without evidence for high FE, PE tends to sway decisions and will determine which
430 intervention is implemented. Confirming that FE is high before implementing an intervention is
431 especially important if decision-makers perceive that nonhuman animals do not deserve moral
432 consideration. If an intervention has low FE and is implemented nonetheless, nonhuman animals
433 - wild and domestic - are likely to suffer. Moreover, our inability to deliberate fairly with
434 nonhumans and the power asymmetry between parties will tend to undermine coexistence
435 between humans and nonhumans (Favre 1979; Hutchins & Wemmer 1986). Within this social
436 and structural context, the implementation of interventions with $PE > FE$ that can be harmful or
437 lethal to nonhuman animals (e.g. lethal methods, translocation) should be viewed most
438 sceptically by youth and future generations and by current adults concerned with ethics,

439 legitimacy, and precautionary principles. Here, emerging fields such as compassionate
440 conservation and practices such as predator-friendly farming can help in providing principles and
441 guidance on the implementation of socially acceptable interventions that promote animal well-
442 being (Ramp & Bekoff 2015; Wallach et al. 2015; Johnson & Wallach 2016). By emphasizing
443 coexistence with individual nonhumans (not just species), these fields promote the moral
444 standing of nonhumans and attempt to equitably consider individual nonhuman interests when
445 deciding if and when to intervene in their lives (Santiago-Ávila et al. 2018b).

446

447 **12.5 Recommendations and Future Directions**

- 448 • Strengthen the rigor of science for understanding adoption and maintenance of
449 interventions for coexistence.
- 450 • Collect both ecological (FE) and social-psychological (PE) variables when evaluating an
451 intervention aimed to reduce conflict. This would enable a more balanced
452 interdisciplinary understanding of social–ecological systems, such as human-wildlife
453 interactions.
- 454 • Test hypotheses of particular interventions in a rigorously designed study. This would
455 help in better design and implementation of interventions to reduce conflicts (see
456 guidelines in Table 12.1).
- 457 • Address current gaps in the use of gold-standard designs to evaluate both FE and PE of
458 methods and their implications for carnivore and wildlife conservation in general.
- 459 • Address current gaps in knowledge on possible unexpected effects of non-lethal
460 interventions on predators and other wildlife (e.g. disruption of behaviour and social
461 organization).

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