# Domestic carnivore interactions with wildlife in the Cape Horn Biosphere Reserve, Chile: husbandry and perceptions of impacts from a community perspective

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**Background.** Hundreds of millions of domestic carnivores worldwide have diverse positive affiliations with humans, but can provoke serious socio-ecological impacts when free-roaming. Unconfined dogs (*Canis familiaris*) and cats (*Felis catus*) interact with wildlife as predators, competitors, and disease-transmitters; their access to wildlife depends on husbandry, perceptions, attitudes, and behaviors of pet owners and non-owners.

**Methods.** To better understand husbandry and perceptions of impacts by unconfined, domestic carnivores, we administered questionnaires (n=244) to pet owners and non-owners living in one of the last wilderness areas of the world, the Cape Horn Biosphere Reserve, located in southern Chile. We used descriptive statistics to provide demographic pet and husbandry information, quantify free-roaming dogs and cats, map their sightings in nature, and report experiences and perceptions of the impact of free-roaming dogs and cats on wildlife. We corroborated our results with an analysis of prey remains in dog feces (n=53). With generalized linear models, we examined which factors (i.e., food provisioning, reproductive state, rural/village households, sex, and size) predicted that owned dogs and cats bring wildlife prey home.

**Results.** Thirty-one percent of village dogs (n=121) and 60% of dogs in rural areas (n=47) roamed freely day and/or night. We found free-roaming dog packs frequently observed (64% of participants) in the wild, including a feral dog population on Navarino Island. Dogs (31 of 168) brought invasive muskrats (*Ondatra zibethicus*) and avian prey home, and over half of all cats (27 of 51) mainly brought birds. Birds were also the most harassed group by one third of all dogs and cats. Despite these facts, dog-wildlife conflicts were hardly perceived (<9% of observed conflicts and suspected problems) and only 34% of the participants thought that cats might impact birds. Diet analysis revealed that dogs consumed livestock (64% of 59 prey occurrences), beavers (*Castor canadensis*, 14%), and birds (10%). The probability that dogs brought prey to owners' homes was higher in rural and larger dogs. There was also evidence that cats from rural households and with an inadequate food supply brought more prey home than village cats.

**Discussion.** Despite that muskrat, beavers, and birds were brought home, harassed, or found in dog feces, free-roaming dogs and, to a lesser extent, cats are perceived predominantly in an anthropogenic context (i.e., as pets) and not as carnivores interacting with wildlife. Therefore, technical and legal

measures should be applied to encourage neutering, increase confinement, particularly in rural areas, and stimulate social change via environmental education that draws attention to the possibility and consequences of unconfined pet interaction with wildlife in the southernmost protected area of the globe.

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2    **husbandry and perceptions of impacts from a community perspective**

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19   **Abstract**

20   **Background.** Hundreds of millions of domestic carnivores worldwide have diverse positive

21   affiliations with humans, but can provoke serious socio-ecological impacts when free-roaming.

22   Unconfined dogs (*Canis familiaris*) and cats (*Felis catus*) interact with wildlife as predators,

23   competitors, and disease-transmitters; their access to wildlife depends on husbandry, perceptions,

24   attitudes, and behaviors of pet owners and non-owners.

25   **Methods.** To better understand husbandry and perceptions of impacts by unconfined, domestic

26   carnivores, we administered questionnaires (n=244) to pet owners and non-owners living in one

27   of the last wilderness areas of the world, the Cape Horn Biosphere Reserve, located in southern

28   Chile. We used descriptive statistics to provide demographic pet and husbandry information,

29   quantify free-roaming dogs and cats, map their sightings in nature, and report experiences and

30   perceptions of the impact of free-roaming dogs and cats on wildlife. We corroborated our results

31   with an analysis of prey remains in dog feces (n=53). With generalized linear models, we examined

32   which factors (i.e., food provisioning, reproductive state, rural/village households, sex, and size)

33   predicted that owned dogs and cats bring wildlife prey home.

34   **Results.** Thirty-one percent of village dogs (n=121) and 60% of dogs in rural areas (n=47) roamed

35   freely day and/or night. We found free-roaming dog packs frequently observed (64% of

36   participants) in the wild, including a feral dog population on Navarino Island. Dogs (31 of 168)

37   brought invasive muskrats (*Ondatra zibethicus*) and avian prey home, and over half of all cats (27

38   of 51) mainly brought birds. Birds were also the most harassed group by one third of all dogs and

39   cats. Despite these facts, dog-wildlife conflicts were hardly perceived (<9% of observed conflicts

40   and suspected problems) and only 34% of the participants thought that cats might impact birds.

41   Diet analysis revealed that dogs consumed livestock (64% of 59 prey occurrences), beavers

42   (*Castor canadensis*, 14%), and birds (10%). The probability that dogs brought prey to owners'

43   homes was higher in rural and larger dogs. There was also evidence that cats from rural households

44   and with an inadequate food supply brought more prey home than village cats.

45   **Discussion.** Despite that muskrat, beavers, and birds were brought home, harassed, or found in

46   dog feces, free-roaming dogs and, to a lesser extent, cats are perceived predominantly in an

47   anthropogenic context (i.e., as pets) and not as carnivores interacting with wildlife. Therefore,

48   technical and legal measures should be applied to encourage neutering, increase confinement,

49   particularly in rural areas, and stimulate social change via environmental education that draws

50  attention to the possibility and consequences of unconfined pet interaction with wildlife in the
51  southernmost protected area of the globe.

52

53  **Introduction**

54       In parallel to human population growth, the number of companion animals is constantly
55  increasing as well. Pet and feral dogs (*Canis familiaris*) have reached population estimates of 900
56  million and cats (*Felis catus*) of 600 million (O'Brien & Johnson, 2007; Gompper, 2014a), existing
57  on all continents except Antarctica (Hughes et al., 2015). Since their domestication thousands of
58  years ago, domestic dogs have had profound roles in human lives. These include companionship,
59  livestock guarding, rescue, hunting, tourism, service animals, and wildlife management (Hart &
60  Yamamoto, 2017). As dogs are part of a diversity of human cultures, their various roles, husbandry,
61  and people's attitudes towards them have different implications for human-dog-wildlife
62  interactions (Miller, Ritchie & Weston, 2014).

63       The possibility to interact with wildlife depends on dogs' and cats' husbandry, particularly
64  on their confinement. This ranges from complete mobility restriction, for leashed and/or indoor
65  dogs and cats, to feral domestic carnivores that survive independently of supplemental
66  provisioning from humans (Kays & DeWan, 2004; Vanak & Gompper, 2009). In between these
67  extremes, there exists a range of free-roaming animals that are owned or unowned and are, to some
68  extent, subsidized by humans. As subsidized predators, domestic carnivores can reach higher
69  population densities than wild carnivore populations (Gompper, 2014b), leading to complex socio-
70  ecological consequences.

71       The impacts of free-roaming subsidized and feral domestic dogs include loss of livestock
72  (Baker et al., 2008; Echegaray & Vilà, 2010), aggression towards humans (Schalamon et al., 2006),
73  disease transmission (Matter & Daniels, 2010), and wildlife interference (reviewed in Young et
74  al., 2011; Hughes & Macdonald, 2013). Dogs prey upon (Butler, du Toit & Bingham, 2004; Manor
75  & Saltz, 2004), compete with (Mitchell & Banks, 2005; Vanak, Thaker & Gompper, 2009), infect
76  (Acosta-Jamett, 2009), and disturb (Silva-Rodríguez, Ortega-Solís & Jiménez, 2010; Silva-
77  Rodríguez & Sieving, 2012) wild animals. Suburban cats are successful small vertebrate predators
78  (Woods, McDonald & Harris, 2003; Loyd et al., 2013). On islands, Medina et al. (2011)
79  demonstrated that feral cats were responsible for at least 14% of global avian, mammalian, and

80    reptilian extinctions (see also Nogales et al., 2013). Finally, both dogs and cats may hybridize with

81    their wild relatives (Randi, 2008).

82         While the biology of domestic carnivore-wildlife interactions is often the focus of research,

83    studies on social dimensions are still in their infancy (Miller, Ritchie & Weston, 2014).

84    Understanding the perceptions of free-roaming pet carnivores is indispensable to inform

85    conservation action, as causes and solutions to this problem directly depend upon humans'

86    relationships with them (Gramza et al., 2016). Conflicts between dogs/cats and wildlife could thus

87    be minimized by a better understanding of how husbandry, attitudes, and behaviors of pet owners

88    influence dogs and cats in their access to and interaction with wild prey or carnivores, particularly

89    when close to protected areas. For example, dog owners felt more obliged to leash their dogs when

90    they thought their dog would harm beach-nesting birds or people (Williams et al., 2009). Recent

91    studies have shown that a more adequate diet (i.e., commercial or prepared food instead of e.g.,

92    household scraps) for dogs and cats decreases the probability of preying upon wild animals (Silva-

93    Rodríguez & Sieving 2012, Sepúlveda et al., 2014). Additionally, in the absence of biological data

94    or for logistical and cost reasons, a community-based assessment may provide suitable information

95    on species' impacts on other species (White et al., 2005).

96         Here, we focus on understanding the interactions with wildlife by a population of free-

97    roaming dogs and cats in a sensitive conservation area of southern Chile, the Cape Horn Biosphere

98    Reserve, from a community perspective. To date, the only substantial human impacts in the

99    biosphere reserve are biological invasions, particularly of wild and domestic exotic mammals that

100   outnumber their native counterparts (Anderson et al., 2006). Additionally, native terrestrial

101   predators are absent on many of the islands of the reserve, including Navarino Island, where the

102   only village of the reserve is located (Anderson et al., 2006). This indicates that impacts on native

103   and often naïve prey generated by introduced predators may cause extensive population reductions

104   (discussed in Sih et al., 2010). Although free-roaming and feral dogs are commonly observed by

105   locals on Navarino Island, few observations of their impacts exist. Dogs have been reported to

106   prey upon the southernmost population of guanacos (*Lama guanicoe*), which is virtually unstudied

107   and considered in danger of local extinction (Cunazza, 1991; Gónzalez, 2005). Evidence also

108   exists of dogs preying upon nests of solitary nesting waterfowl, such as the Flightless Steamer

109   Duck (*Tachyeres pteneres*), a species endemic to Patagonia, and nesting colonies of the South

110 American Tern (*Sterna hirundinacea*, Schüttler et al., 2009). There are no published accounts of

111 local cat impacts.

112      We administered questionnaires  to pet owners and non-owners to address the following

113 objectives: (1) provide demographic and husbandry information relevant for future dog and cat

114 management in one of the last wilderness areas of the globe, (2) quantify free-roaming dogs and

115 cats and map their locations in nature, (3) examine experiences and perceptions of the impact of

116 free-roaming dogs and cats on wildlife and corroborate those with an analysis of prey remains of

117 dog feces, and (4) predict which factors best explain when owned dogs and cats bring wildlife prey

118 home. With regard to the paucity of ecological data on domestic carnivore-wildlife interactions in

119 this sub-Antarctic wilderness area, this study allows a first insight into this conservation problem.

120

121 **Materials & Methods**

122

123 **Ethics statement**

124      We obtained prior informed consent from each participant by reading a printed statement

125 explaining the project aims, the lack of risks in participating, the possibility to omit questions,

126 information about use of and access to the results, and that the interview was anonymous and

127 voluntary. The participants agreed to participate by signing a copy of the informed consent; they

128 were also given a copy. Paper and digital questionnaires were stored anonymously. The Scientific

129 Ethical Committee of the University of Magallanes, Chile, certified ethical approval of the

130 instrument.

131

132 **Study area**

133      We carried out this study in the Cape Horn Biosphere Reserve (CHBR) (19,172 km$^2$

134 terrestrial surface), Chile, located at the extreme southern tip of South America (Fig. 1). The

135 biosphere reserve exists within the Magellanic Sub-Antarctic forest ecoregion, one of the

136 remaining 24 wilderness areas of the world (Mittermeier et al., 2003). The dominant habitats

137 within this ecoregion are unfragmented evergreen and deciduous southern beech (*Nothofagus* spp.)

138 and Winter's bark (*Drimys winteri*) forests, Magellanic peat bogs (predominantly *Sphagnum* spp.),

139 high-Andean habitats, and glaciers (Pisano, 1977). The human population in the CHBR is of mixed

140 cultural and ethnic origin (i.e., Yaghan indigenous people, Chilean Navy, fishermen, and Chilean

141 and foreign short- and long-term settlers) and is concentrated in the only town within the reserve,

142 Puerto Williams (2,800 inhabitants) on Navarino Island. A small fishing village, Puerto Toro,

143 exists on the eastern coast of Navarino as well as eight rural farm settlements. In the remainder of

144 the biosphere reserve, there are only 11 Chilean Navy posts operated by a new family each year,

145 and one farm on Hoste Island (Fig. 1). The principal economic activities on Navarino Island

146 include fishing, tourism, and small-scale livestock farming. The infrastructure is limited to a dirt

147 road along the northern coast of Navarino; public maritime transport within the reserve does not

148 exist.

149

150 [please insert Figure 1 here]

151

152 **Survey**

153 From May 2015 to April 2016, we interviewed 215 households in Puerto Williams, seven

154 farm owners on Navarino Island, and 22 Chilean Navy families living for one year on the 11 Navy

155 posts on different islands in the CHBR (n=244 total interviews). To test the questionnaire design

156 and adapt the questions, we conducted a pilot study with four trial informants who were later

157 excluded from the dataset.

158 We calculated a representative 95% probability sample of 215 interviewees in Puerto

159 Williams based on a census of households applied by ES in May 2015 (490 houses). We used a

160 confidence interval of 5% and applied the finite population correction for smaller populations

161 (Bernard, 2006: 183). We randomly chose 280 households from a map of numbered houses in

162 town (adding 30% to the sample size of 215 to correct for non-responses). When an adult was not

163 present, we left a written message explaining the motivation for our visit and our contact

164 information. We visited each household up to three times before it was replaced. The

165 questionnaires were administered at different times in a face-to-face interview approach at the

166 participant's home and took 10-30 min. Two interviewers conducted the interviews in Spanish

167 (n=92 by ES and n=152 by LS).

168 To meet objective 1, we collected information on dog and cat demographics (i.e., number,

169 age, sex, origin, purpose of pets, number of pups/kittens in previous year, elimination, and

170 temporary and definite pet loss) as well as on pet care/husbandry (i.e., veterinary treatments, food

171 type, in how many households pets eat, and whether owned or unowned street dogs are fed). We

172    asked participants whether they restricted the movements of their dogs (i.e., day and/or night and

173    if free-ranging, why), whether they saw unaccompanied dogs and cats (adults, pups/kittens)

174    outside of town and from where they thought the animals came (objective 2). We asked participants

175    about their observations of problematic dog situations in and out of town, perceptions of possible

176    impacts of free-roaming dogs and cats, and their personal experiences regarding the pet's

177    interaction(s) with other animals (objective 3). To better understand predictors (i.e., food

178    provisioning, reproductive state, rural/village households, sex, size) of dog and cat interactions

179    with wildlife, we asked owners whether their pets brought wildlife prey home (objective 4). We

180    finished the questionnaire by asking for suggestions for reducing the number of free-roaming dogs,

181    personal data (i.e., age, sex, education, residence time), and the owner´s permission to take a photo

182    of their pet. From this photo, we then classified dog sizes (i.e., small, medium, large) and calculated

183    the mean of two independent estimations by ES and LSA. For farm owners, we added questions

184    on their experience in losing domestic animals such as cattle (*Bos taurus*) or sheep (*Ovis aries*) to

185    dog attacks. For participants without pets, non-relevant questions were not asked. Some questions

186    were focused only on dogs because dogs produce visible socio-ecological conflicts in the study

187    area. The complete questionnaire is provided as Supplementary Material S1.

188

189    **Dog diet**

190    Dog feces of owned and feral dogs (n=70) were opportunistically collected within one km

191    of the 11 Navy posts and during trekking events on Navarino Island (June 2015 to April 2016).

192    Each sample was dried, rehydrated, and degreased with detergent, and then grouped into hair,

193    bones, feathers, and rubbish. Using a microscope, we examined the medullary and cuticular

194    patterns of guard hairs to identify up to species level using gelatin as the printing medium (similar

195    to González-Esteban, Villate & Irizar,1996). As reference collections, we used those provided by

196    the Instituto de la Patagonia, Universidad de Magallanes, complemented by our own additions,

197    and local keys (Chehébar & Martín, 1989).

198

199    **Statistics**

200    We first calculated descriptive statistics to analyze basic demographic and husbandry

201    information from the interviews to (i) quantify free-roaming dogs and cats, (ii) report experienced

202    problems associated with dogs, (iii) perceptions of the potential impact of free-roaming dogs and

203  cats on wildlife, (iv) report percentages of prey and harassed animals by dogs and cats, and (v)

204  percentages of prey groups in dog feces. We then used generalized linear models (GLMs) to

205  examine predictors of interactions with wildlife of owned dogs and cats (Table 1). Our response

206  variable for the dog and the cat model was whether pets brought wildlife home, defined here as

207  any exotic or native wild mammal or bird (PREY). As covariates, we considered diet (dinner

208  leftovers and/or commercial pet food) provided by the animal's owner (FOOD), sex (SEX),

209  sterility (STERILIZED), owners' household location (LOCATION, rural or village), and pet size

210  (SIZE, only for dogs). We focused on those covariates as they might identify pet characteristics or

211  levels of care which can then inform recommendations for pet management for the benefit of

212  wildlife. The location was included because rural households are imbedded in wilderness settings

213  and access to wildlife is immediate. Response and predictor variables are explained in detail in

214  Table 2.

215      As the response variable of the two models was binomial, we fitted generalized linear

216  models (GLMs) with binomial error structure and logit link. The models were parameterized with

217  all possible covariate combinations. Prior to analysis, we explored these data following Zuur et al.

218  (2010). Collinearity between ordinal covariates was assessed with Spearman correlation

219  coefficients (no coefficients were >|0.4|). We tested the independence of categorical variables

220  using contingency tables (Chi-square and Fisher's exact tests, p <0.05). We removed SEX and

221  STERILIZED from the dog model for being significantly associated with LOCATION; similarly,

222  we removed STERILIZED from the cat model for being significantly associated with LOCATION

223  and SEX. FOOD was maintained here, despite its collinearity with LOCATION, to test the same

224  variables in the dog and cat models (the conclusions for models tested with and without FOOD

225  were identical, see Mundry, 2014, for treating collinearity). For model selection, we used Akaike's

226  Information Criterion corrected for small sample size (AIC$_c$). We tested for an interviewer effect

227  by including interviewer as a random effect in the models (generalized linear mixed models,

228  GLMMs), but did not detect any (AIC GLMMs >AIC GLMs of the global models, respectively).

229  We accounted for model selection uncertainty (model weights $\omega_i$ were <0.9) using full-model

230  averaging (Symonds & Moussalli, 2011). To rank predictor variables in terms of importance, we

231  summed Akaike weights for each model in which the variable under consideration appeared

232  (Burnham & Anderson, 2002). We explored the direction of predictor impacts on the response

233 variable by calculating log odds ratios of the averaged estimates with 95% confidence intervals.

234 Statistical modelling was conducted in R (R Core Team, 2016).

235

236 [Please insert Table 1 here]

237 [Please insert Table 2 here]

238

239 **Results**

240       We conducted 215 interviews in Puerto Williams, seven in rural households, and 22 with

241 Navy post families. Only five people in Puerto Williams refused to participate. Of the 244

242 participants, 61.5% were female, mean participant's age was 39.5 years (SD 11.6, range 18-76

243 years), and mean residence time in the biosphere reserve was 11.6 years (SD 14.2, range one

244 month-66 years).

245       The Puerto Williams participants owned 121 dogs and 36 cats, predominantly for

246 companionship. The seven farm households owned 30 dogs and 15 cats, mainly kept as working

247 dogs and for rodent control, respectively. The 22 Navy families owned 17 dogs primarily for

248 companionship and two cats for rodent control. Two dogs and two cats stayed at the Navy post

249 when families were exchanged after one year ("inherited animals"), the others left with their

250 families. Reproductive control was moderate to high in Puerto Williams (41.7% of dogs and 19.4%

251 of cats not sterilized), but almost absent in rural areas (83.3% dogs, 93.3% cats) and Navy posts

252 (86.7% dogs, 100% cats, but 9 of 17 dogs were ≤1-year, Table 3). Additionally, four participants

253 had eliminated unwanted dog pups.

254       In Puerto Williams, over half of the dogs and around one third of the cats were vaccinated

255 against rabies (55.4% and 33.3%, respectively) and treated for parasites (60.3% and 36.1%,

256 respectively). Pet owners in rural households did not vaccinate against rabies, but treated them for

257 parasites (100% dogs, 40.0% cats). At Navy posts, only dogs were vaccinated and dewormed

258 (64.7%). Pets in Puerto Williams, rural dogs, and dogs at Navy posts were provided mainly with

259 commercial food and/or meat (>77.7%). However, 35 village dogs (28.9%) were fed in more than

260 one household, and 74 interviewees in town (34.4%) reported feeding street dogs on a regular basis

261 (71.8% at least once a week), mostly with leftovers (73.5% of 83 mentioned food items).

262       Sixty-five of 168 dogs (38.7%) roamed freely day or night and 39 dogs (23.2%) were

263 always unrestricted. Using an extrapolated number of dogs for the 490 households in Puerto

264  Williams (n=275.8 with 1.4 dogs/household), we estimate that 84 dogs (30.6%) roam freely in

265  town during day or night. The most common method of dog restriction (69.4% in town, 53.3%

266  rural, 17.6% Navy posts) was keeping dogs in the house (63.6% of 121 responses), fewer were

267  kept free in the yard (18.2%) or leashed (18.2%). Reasons mentioned for allowing unrestricted

268  movement of dogs in town and rural environments were (i) the owner claimed animal freedom,

269  (ii) leashing may increase aggressiveness, (iii) acclimation to free-roaming and releasing energy,

270  (iv) the dog is not dangerous, and (v) unsuitable facilities (together 77.2% of 70 explanations).

271  Also, 44.0% of 91 non-pet owners thought that street dogs enjoyed their freedom, and most dog

272  owners (87.2% of 86) thought that street dogs roamed into the forest. Finally, 22 of 168 dogs

273  (13.1%) went missing between 12-24 hours during the last year (2014/15), among which 13 dogs

274  had disappeared up to one week before returning home. Cats disappeared more frequently (n=18,

275  34.0%); 14 cats for 2-7 days. Over the last 10 years, 35 pets (23 dogs, 12 cats) never returned.

276

277  [Please insert Table 3 here]

278

279     Free-roaming dogs not accompanied by people outside of town were frequently observed

280  on Navarino Island (63.9% of 244 participants), whereas cat sightings in the wild were almost

281  absent (6.1%, Fig. 2). The greatest distance of sighted dogs and cats was 19.4 km and 5.2 km from

282  the northern settled coast, respectively. Neither dogs nor cats were seen roaming around Navy

283  posts, except near the two posts on Navarino Island. Dogs were mostly observed in packs, with a

284  median pack size of four dogs (mean 6.6, SD 7.5, range 2-60, n=172 sightings), while only 9.2%

285  of the sightings were single dogs. Dog pups (abandoned or feral) outside Puerto Williams were

286  sighted by 52 participants (21.3%) with a mean litter size of 4.0 (SD 2.3, range 1-12). Four

287  participants observed pups and kittens (n=17) abandoned in cardboard boxes outside town.

288  Apparently, the landfill, at an approximately 500 m from Puerto Williams, was a point of attraction

289  for dogs, as 12 participants observed dog packs with a median size of eight (mean 10.75, SD 8.0,

290  range 1-25, Fig. 2) in this area.

291

292  [Please insert Figure 2 here]

293

294    Over half of the participants (55.9%, n=222) on Navarino Island had experienced problems

295    with dogs in Puerto Williams during 2009-2015 (83.9% had occurred during the last year,

296    2014/15), whereas 41 participants (18.5%) reported problems outside the town (61.4% during

297    2014/2015). Predominant experienced dog problems in town were conflicts with people (biting,

298    attacking, frightening, disease transmitting, accidents, and stealing; 40.6% of 143 problems, 24.1%

299    concerned children) and free-ranging domestic animals (cows, horses, and their offspring) in town,

300    mostly foals (37.1%, Fig. 3). Outside of town, people experienced conflicts between dogs and

301    domestic animals, particularly involving cattle (77.3% of 44 problems), whereas only two people

302    saw dogs feeding on wildfowl eggs (4.5%).

303    Beyond personal experiences, most participants thought that free-roaming dogs caused

304    problems both in and outside of town (91.9% and 89.2%, respectively). In town, suspected dog

305    problems mainly involved people (68.8% of 221 problems), whereas outside of town concerns

306    involved domestic animals and people (Fig. 3). Dog-wildlife conflicts (e.g., involving guanacos)

307    were only mentioned 19 times (9.4% of 202 problems). However, when asked directly whether

308    feral dogs could have negative impacts on wildlife and what kind of, most participants said yes

309    (80.8%, n=239) regarding birds (67.3% of 349 problems). Guanacos were only mentioned 16 times

310    among the affected wildlife (4.6%).

311    Regarding suspected cat problems, only one third of participants (33.8% of 240) associated

312    problems with them outside of town, particularly with cats harassing and eating wild birds and

313    their eggs (67.5% of 77 problems, Fig. 3).

314    Five of seven farm owners reported losing domestic animals due to unrestricted dogs of

315    Puerto Williams or feral dogs during 2014/15. The estimated total loss during these events were

316    62 calves, 25 cows, and 30 sheep, while 30 sheep and 2 calves were found injured. The losses

317    corresponded to 3.3%, 11.5%, 16.7%, 18.8%, 35.0% (cows), and 75.0% (sheep) of owned

318    livestock.

319

320    [Please insert Figure 3 here]

321

322    Thirty-one village and rural dogs (18.5%) brought prey home, mainly invasive muskrats

323    (32.5%) and birds (27.5%, Fig. 4). Among avian prey were songbirds (Austral Blackbird *Curaeus*

324    *curaeus*, Austral Thrush *Turdus falcklandii*, Rufous-collared Sparrow *Zonotrichia capensis*),

325    shorebirds (terns, Upland Goose *Chloephaga picta*), and raptors (Chimango Caracara *Milvago*

326    *chimango*). Over one third of all dogs (n=64) were observed harassing (but not killing) other

327    animals, particularly birds (38.0% of 79 items mentioned: Chimango Caracara, Patagonian Sierra-

328    Finch *Phrygilus patagonicus*, Upland Goose, and ducks such as Flightless Steamer Ducks), other

329    dogs (16.5%), and horses (15.2%); three dogs harassed native mammals (i.e., foxes and seals).

330    Over half of all village and rural cats (n=27) brought prey home (birds were 57.6% of 33 prey

331    items): among songbirds, the Austral Thrush, Fired-eyed Diucon *Xolmis pyrope,* House Sparrow

332    *Passer domesticus*, Patagonian Sierra-Finch, and among shorebirds, ducks and terns. Birds were

333    also the most commonly-harassed prey group (72.0%) by 18 cats (only one species referred to

334    here: Patagonian Sierra-Finch). The 244 participants mentioned diverse food items they thought

335    feral dogs would eat (Fig. 4). Domestic livestock was the most important group mentioned

336    (39.9%), whereas native birds and guanacos were less perceived (15.2% and 2.2%, respectively).

337

338    [Please insert Figure 4 here]

339

340         We could not identify prey remains of seven feces of owned and feral dogs (n=70) in rural

341    zones of the CHBR and 10 feces were excluded for only containing dog hair. The subsequent diet

342    analysis revealed that the main food item (64.4% of 59 prey occurrences) found in 53 feces was

343    ungulates (i.e., horses and cows, which could not be distinguished here), followed by beavers

344    (13.6%), birds (10.2%), mice (5.1%), rubbish (5.1%), and Fuegian red fox (*Pseudalopex culpaeus,*

345    1.7%).

346

347         Three models best explained whether dogs would bring prey home (Table 4). The most

348    important variable with the highest summed Akaike weights ($\omega$, upper limit=1.0) was LOCATION

349    ($\omega$=0.99); FOOD ($\omega$=0.54) and SEX ($\omega$=0.30) had less importance. The averaged estimates

350    indicated that dogs in rural areas were more likely to bring prey home (Fig. 5A), whereas an

351    adequate diet and the dog's sex had little influence (their confidence intervals overlapped the odds

352    ratio at one). LOCATION ($\omega$=0.99) and FOOD ($\omega$=0.99) were the most important variables in the

353    cat model, whereas sex played a minor role ($\omega$=0.24, Table 4). Based on the averaged model

354    estimates (Fig. 5B), there is evidence that rural cats that received more leftovers brought more prey

355    home than village cats, whereas the cat´s sex was a poor predictor. From the collinear variables

356  removed before modelling, only SIZE had a significant association with LOCATION and PREY,

357  respectively (Fisher's exact tests, p <0.001), indicating that not only rural, but also larger dogs

358  were more prone to preying upon wildlife.

359

360  [Please insert Table 4 here]

361

362  [Please insert Figure 5 here]

363

364      Importantly, participants suggested several measures to diminish the number of street dogs,

365  including reproductive control (18.9%, n=534 suggestions), registration (14.6%), responsible pet

366  husbandry (11.2%), establishing an animal shelter (10.5%), education and adoption campaigns

367  (9.2%), controls and penalties (8.4%), movement restriction (8.1%), animal health (7.3%), limiting

368  the number of dogs per family or not abandoning dogs (7.1%), and euthanasia (4.7%).

369

370  **Discussion**

371      In the absence of biological studies, this survey provides a first understanding of the

372  interactions of domestic carnivores with wildlife in a sub-Antarctic wilderness setting. A

373  representative sample of the local population in the Cape Horn Biosphere Reserve gave insight

374  into pet husbandry and perceptions of impacts of free-roaming dogs and cats. We found that free-

375  roaming dog packs were frequently observed (64% of participants) in natural areas on Navarino

376  Island. Many of these individuals may be owned, as many participants indicated their dogs were

377  not confined (65 of 168 dogs roamed freely day or night, and 22 dogs had even disappeared for

378  24 h or more). Further, travel distances of free-roaming owned rural dogs vary, with reports of 4

379  km (Sepúlveda et al., 2015) or up to 8-30 km (Meek, 1999). However, such large foray distances

380  are an exception. Finding a village dog at a distance >1 km from its home had a 10% chance in a

381  study of dogs scavenging sea-turtle nests (Ruiz-Izaguirre et al., 2014) and most rural dogs even

382  stayed 95% of their time within <200 m from their households (Sepúlveda et al., 2015).

383      Our findings indicate that there is evidence of a feral dog population on Navarino Island.

384  The participants reported sightings of unaccompanied dog packs in remote parts of the island (up

385  to 19.4 km from the northern settled coast, Fig. 2), and sightings of dog pups (feral or abandoned)

386  outside town (52 participants). They declared 52% of the 172 sightings as feral dogs. This may be

387 an over-estimate, but given that free-roaming village dogs are easily recognized in the small town

388 of Puerto Williams, it is likely that participants could distinguish between owned and feral dogs.

389 However, it is not clear whether this presumably feral population has achieved long-term human

390 independence, as for example the dogs eradicated from Isabela Island, Galápagos (Reponen et al.,

391 2014). The reported population of abandoned dog pups and missing dogs may have been recruited

392 into feral dog packs (e.g., Boitani et al., 2017). The importance of the local landfill (12 sightings

393 of dog packs of 8-11 animals on average) as a food subsidy warrants further investigation, as these

394 novel ecosystems can produce a variety of positive and negative impacts on vertebrate species

395 exploiting them (Boitani et al., 2017; Plaza & Lambertucci, 2017). For cats, the few sightings (5%

396 of participants) in natural areas were along the northern-settled coast, except for one cat sighted

397 5.2 km south of the coast. Further phenotypical, genetic, and ecological research is needed to better

398 understand the feral dog and possible feral cat population and their impacts on Navarino Island.

399 Although there were 227 dog sightings during 2014/2015, dog-wildlife conflicts of free-

400 roaming dogs were hardly perceived (4.5% of 44 observed problems, Fig. 3). The direct

401 observation of dog-wildlife interactions is probably a rare situation, particularly with mammals, as

402 the mammalian community on Navarino Island is limited (Anderson et al., 2006). Only five

403 terrestrial native species exist: two species each of bats and mice, and the vulnerable guanaco.

404 Among exotic mammals, there are three elusive wild species (North American beaver, American

405 mink *Neovison vison*, and muskrat) and free-ranging domestic mammals such as cows, horses,

406 sheep, and pigs. Dog interactions with exotic mammals may not have been considered as true

407 wildlife-conflict by the participants as the population reduction of exotic mammals such as mink

408 and beavers was a general consensus in a community survey (Schüttler et al., 2011).

409 Guanacos have not been sighted along the northern coast for many years (González, Zapata

410 & Marín, 2002) and their densities were as low as 0.14 individuals/km$^2$ for the northeastern coast

411 of Navarino Island during 2002-2005 (González, 2005). Thus, it is almost impossible to see

412 depredation or harassment of guanacos by dogs (one piece of photographic evidence was taken by

413 Denis Chevallay in 2002). However, individual dog attacks on rare species may impact their

414 persistence substantially (e.g., pudus, Silva-Rodríguez & Sieving, 2012; mountain gazelles

415 *Gazella gazella*, Manor & Saltz, 2004). Therefore, future studies on dog impacts on the

416 southernmost isolated population of guanacos are an urgent need.

417    The likelihood of interactions among dogs and avian species should be much higher, as
418    birds, among them many seabirds, are the most diverse and abundant group among vertebrates in
419    the CHBR (Rozzi et al., 2006). Indeed, eleven dogs brought bird prey home and 30 dogs were
420    observed by their owners to harass birds (songbirds, shorebirds, and raptors, Fig. 4). However,
421    these experiences were not translated into the context of a possible "dog-wildlife" conflict: only
422    9% of 202 suspected dog problems outside town were dog-wildlife problems (Fig. 3); most were
423    dog-domestic animal (54%) or dog-people conflicts (35%). On the one hand, this may be due to a
424    lack of knowledge of the local fauna by short-term residents; further, Cape Horn biocultural
425    identity is missing in the classrooms. Rozzi et al. (2008) reported an absence of native fauna in the
426    minds of local short-term residents who primarily mentioned cosmopolitan roses and apple trees
427    as local plant species. On the other hand, the absence of dog-wildlife interactions in the
428    participants' minds might indicate that dogs are mainly perceived as domestic animals that act in
429    a human-dominated context and not as carnivores in a natural ecosystem. Personal safety was also
430    the most common public concern regarding free-roaming dogs and cats in central Italy (Slater et
431    al., 2008). This perception may be attributed to the historical attachment bonding between the dog-
432    human dyad believed to be similar to a child-parent relationship (review in Payne, Bennett &
433    McGreevy, 2015).

434    For cats, awareness of possible cat-wildlife problems, particularly with birds, was higher
435    (68% of 77 problems, Fig. 3). On the one hand, these problems might be more visible, at least for
436    cat owners, whose cats brought birds home (37% of cats in this study, Fig. 4). This number,
437    however, probably clearly underestimates true capture rates, as Loyd et al. (2013) demonstrated
438    with animal-borne video cameras worn by urban cats in the United States (see also Kays & DeWan,
439    2004). On the other hand, Arahori et al. (2017) showed that owners' views of their cats and dogs
440    differed; for example, cat owners had a weaker tendency to regard their pets as family members
441    than dog owners. This perception may also influence their view on how cats behave outside their
442    homes (i.e., as carnivorous species).

443    Besides prey brought home by dogs and cats, our diet analysis of dog feces showed that
444    dogs indeed preyed upon domestic animals such as cows and horses (64%); but beavers (14%) and
445    birds (10%) were present in feces as well. This finding is consistent with cow losses reported by
446    Navarino's farm owners. However, more biological methods, such as analyzing cat diet or

447    observations of what free-roaming dogs and cats actually do, are needed to further validate and
448    complement the self-reported observations on wildlife-interactions in this survey.

449        Finally, with GLMs, we showed that rural provenience, large dog size, and an adequately
450    food supply for cats played a significant role as predictors for bringing wildlife prey home. When
451    rural households are imbedded in wilderness settings and spatial and behavioral barriers between
452    domestic and wild animals lack, the apparent consequence are higher depredation rates of (larger)
453    dogs and cats on wildlife. Increasing the confinement of those pets should thus be part of
454    management strategies. Unlike other studies, an inadequate food supply (i.e., higher percentage of
455    leftovers) was not associated with dogs preying upon wildlife. This may be due to methodological
456    differences. Silva-Rodríguez & Sieving (2011) and Ruiz-Izaguirre et al. (2014) considered body
457    condition score and metabolic energy intake, whereas we only relied on the participants'
458    statements. To some extent, the social desirability bias (where the participants wish to appear
459    socially or morally worthy, Maccoby & Maccoby, 1954) might underlie these differences by
460    biasing results that dogs are fed a commercial food diet. While restricting boundaries for farm dogs
461    and cats is probably a difficult task due to their roles as working dogs or for rodent control, the
462    necessity of improving nutrition could be more assumable by owners, not only for lowering
463    wildlife depredation, but also for pet welfare.

464

**Conclusions**

466        Unconfined dogs and cats in the Cape Horn Biosphere Reserve interact with wildlife,
467    although this passes almost unperceived by the local community, particularly with dogs. To
468    guarantee the future intactness of this wilderness area, it is essential to put the possible impacts of
469    free-roaming pet carnivores on wildlife into perspective. This should be done using an integrative
470    approach that respects the many dimensions of pet carnivores in their beneficial and problematic
471    interactions with their human, conspecific, and natural environment: (1) Although over half of pets
472    in Puerto Williams were sterilized, encouraging neutering, particularly in rural areas, could reduce
473    pet density and avoid elimination or abandonment of unwanted pups/kittens. Moreover, sterilized
474    dogs were described to show lower rates of escaping from home and less roaming behavior
475    (Neilson, Eckstein & Hart, 1997; Spain, Scarlett & Houpt, 2004, but see Garde et al., 2015), which
476    might lower their access to wildlife. (2) Despite its probable unpopularity (e.g., Grayson, Calver
477    & Styles, 2002), we recommend that dog and cat ownership should be completely banned in

478   families living in Navy posts, as they are located within wild insular environments (some in

479   National Parks) where pet interactions with wildlife can be particularly severe (Medina et al., 2011)

480   and pets can become feral. (3) The evidence of a feral population of dogs on Navarino Island

481   (where native predators lack) urgently needs biological methods of confirmation such as GPS

482   monitoring (Young et al., 2011) and an assessment of its impacts. Feral dogs are still poorly

483   investigated (Boitani et al., 2017) and management implications for feral dogs are challenging (i.e.,

484   they may include the removal of dogs) due to their avoidance of human contact (Boitani & Ciucci,

485   1995) and restriction to natural habitats. (4) Increasing dog and cat confinement is beneficial to

486   prevent not only pet-wildlife interactions, but also many socio-economic problems. In-house/yard

487   confinement largely depends upon cultural settings (Hsu, Severinghaus & Serpell, 2003; Jackman

488   & Rowan, 2007) and is low in many countries in Africa, Asia, and South America (Reece, 2005),

489   including Chile, which has high percentages of free-roaming dogs in rural settings (67%, Acosta-

490   Jamett et al., 2010; 84-91% Silva-Rodríguez & Sieving, 2012; 92% Sepúlveda et al., 2014). A new

491   Chilean law promoting responsible pet ownership was recently enacted (Ley 21.020, 2017) and

492   could be a first step towards regulating confinement by national legislation which was considered

493   far from sufficient in 2014 by Bonacic & Abarca (2014). Meanwhile, bells or electronic alarms are

494   an option for free-roaming cats to reduce depredation rates on wildlife (Gordon, Matthaei & Van

495   Heezik, 2010; Calver & Thomas, 2011). (5) Finally, an instrument such as this survey can reveal

496   what experienced problems with free-roaming pets exist; thus, giving insight into impacts in the

497   absence of biological studies or complementary to them (e.g., dogs interacting with rare and

498   endemic mammals were only detected through interviews in Silva-Rodríguez & Sieving, 2011).

499   Owners' and non-owners' suggestions can also contribute to creating acceptable measures towards

500   responsible pet ownership (Calver et al., 2011). For the CHBR, in addition to the above mentioned

501   technical and legal solutions, social change to improve pet management for wildlife benefits could

502   be stimulated through education about the vulnerability of native fauna to dogs and cats, attractive

503   education material such as puppet videos, documentaries, or animal-borne films for school pupils,

504   and action days such as walking with leashed dogs or breakfasts with dog owners (further examples

505   in Miller, Ritchie & Weston, 2014).

506

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517

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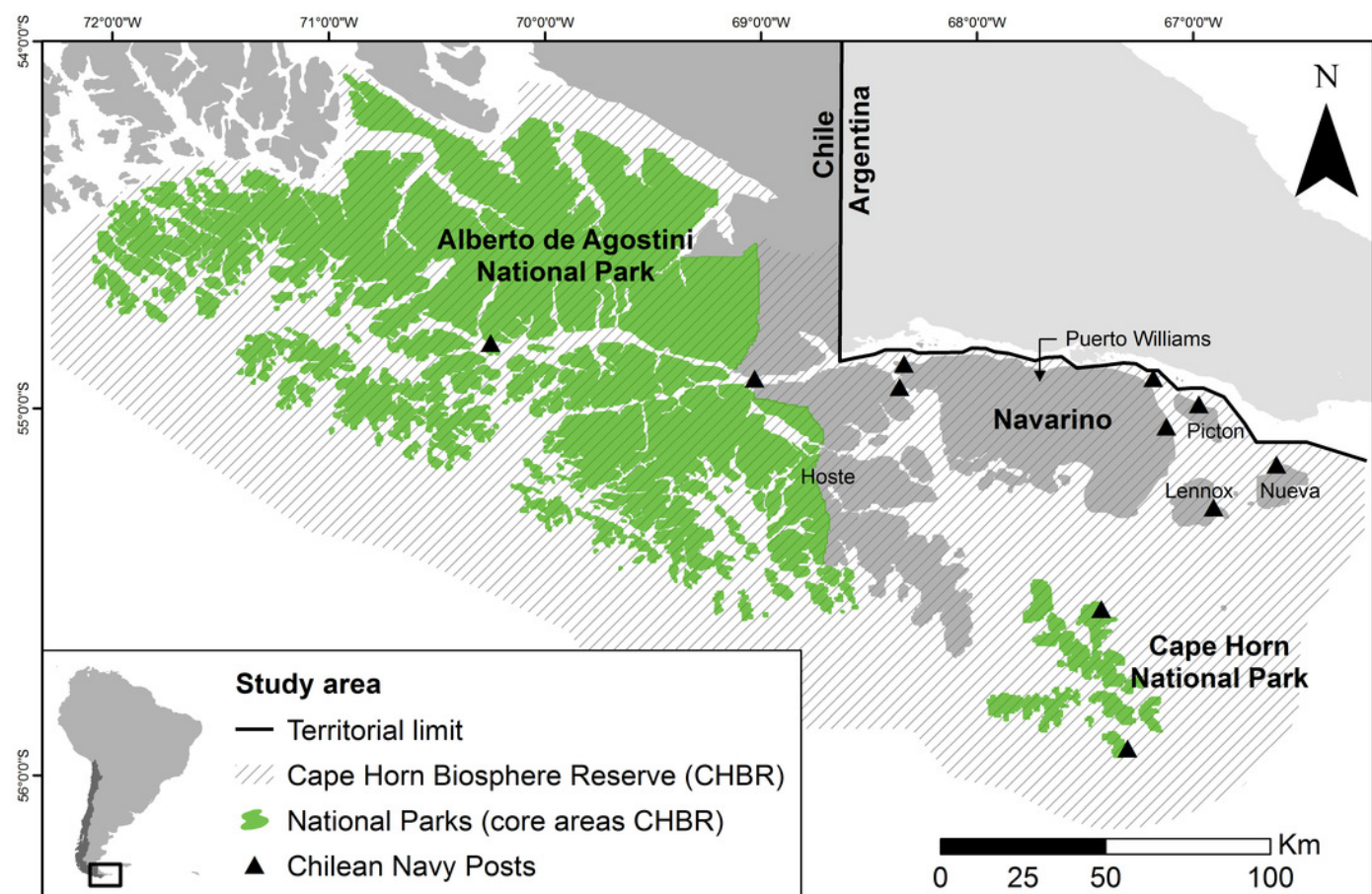
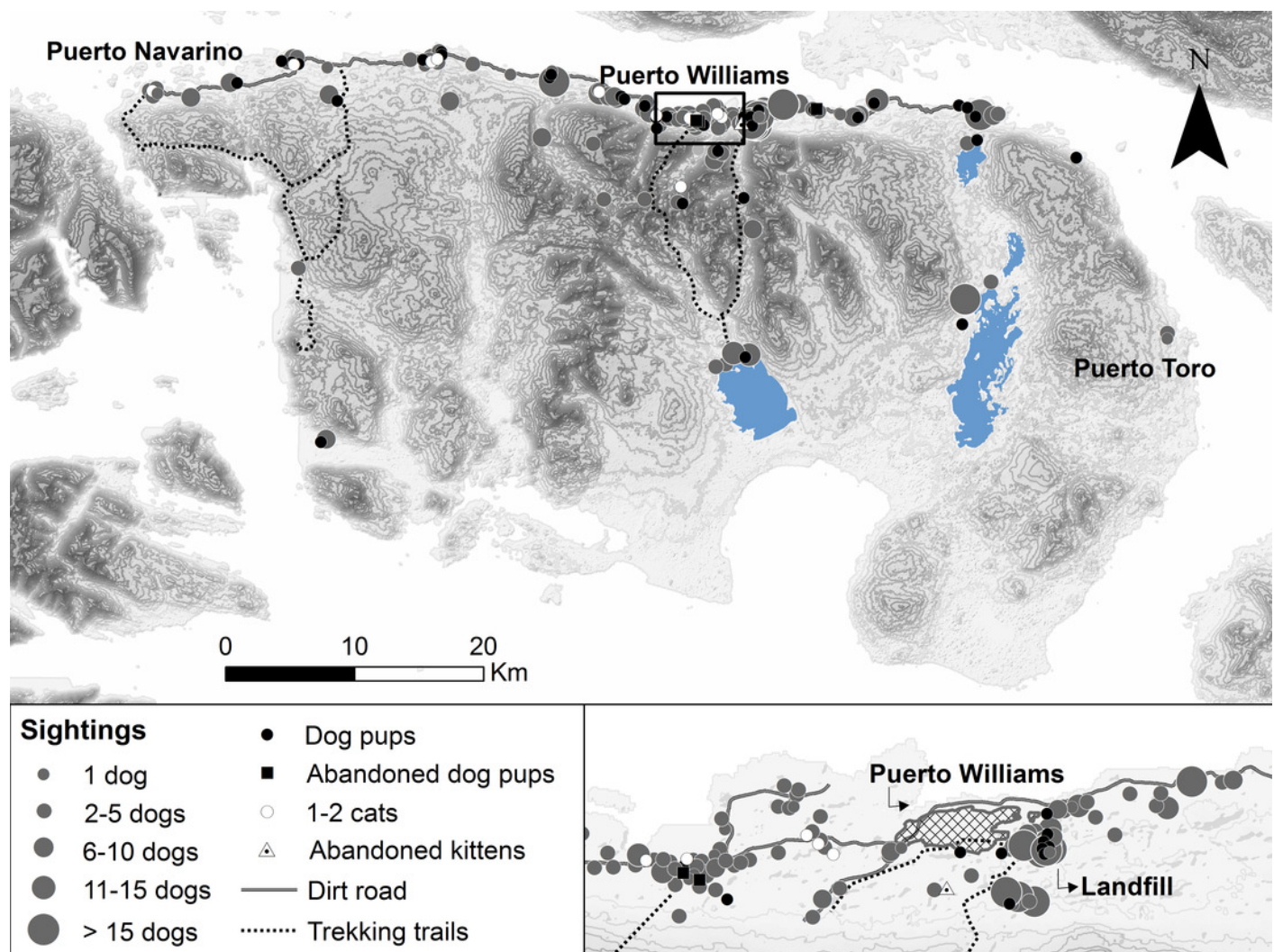
705

# Figure 1

Map of the Cape Horn Biosphere Reserve, southern Chile.

The Alberto de Agostini and Cape Horn National Parks are core areas of the CHBR and Yendegaia is a recently-created national park. The only large settlement (2,800 inhabitants) is Puerto Williams, on Navarino Island. Eleven Chilean Navy posts are located throughout the reserve on Tierra del Fuego Island (n=2), Navarino Island (n=2), and uninhabited islands (n=7); all are only accessible via maritime transport, except the western Navy post on Navarino Island.

# Figure 2

Free-roaming dog and cat sightings on Navarino Island, southern Chile.

Approximate sighting locations of unaccompanied adult dogs and cats, dog pups (abandoned or feral), and kittens (abandoned) from n=227 sightings by 143 participants during 2014/15. Dog sightings are shown in different classes of pack size.

# Figure 3

Experienced and suspected problems with dogs and cats in southern Chile.

Problematic experiences with dogs during 2009-2015 A) inside (n=143) and B) outside (n=44) of Puerto Williams, suspected dog problems (first problem mentioned) C) inside (n=221) and D) outside of town (n=202), and suspected cat problems (first problem mentioned) E) outside of town (n=77). Conflicts with people included biting, attacking, frightening, disease transmitting, accidents, and stealing. Dog-domestic animal problems referred to killing, attacking, or feeding on free-ranging domestic animals such as cows, horses (*Equus caballus*), sheep, pigs (*Sus scrofa*), and cats, whereas cat-domestic animal problems referred to preying upon chickens (*Gallus gallus domesticus*). Conflicts with wildlife included killing wild animals such as birds and their eggs, North American beavers (*Castor canadensis*), and guanacos, or harming ecosystems. Conflicts with conspecifics were fights among dog packs or between cats, and disease transmission. Dog feces and waste dispersing were considered as hygienic problems. "Other" includes dog and cat overpopulation, bad image for tourists, and barking. Images of animals represent predominant animals involved in dog/cat problems.

**_Experienced dog problems_** (%)

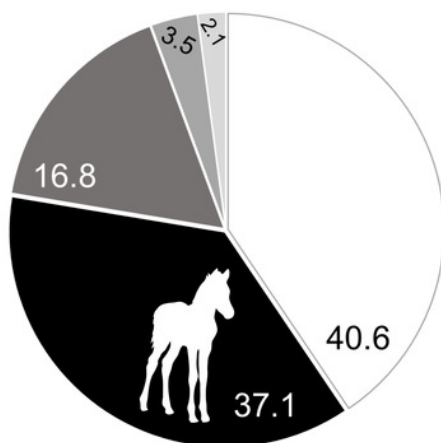
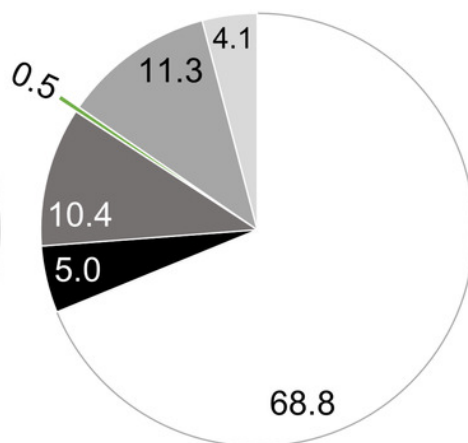
**_Suspected dog problems_** (%)

**_Suspected cat problems_** (%)

A Inside town

3.5  2.1
16.8
40.6
37.1

C Inside town

0.5
4.1
11.3
10.4
5.0
68.8

**Problems with:**

☐ People

■ Domestic animals

■ Conspecifics

■ Wildlife

■ Hygiene

☐ Other

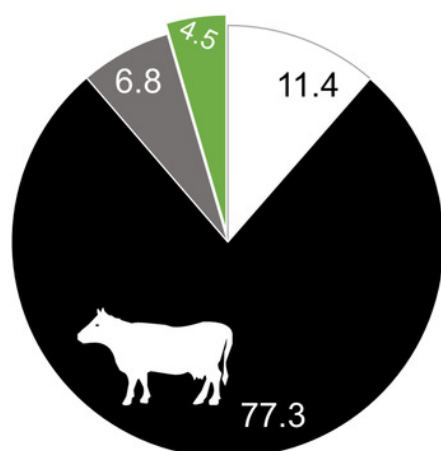
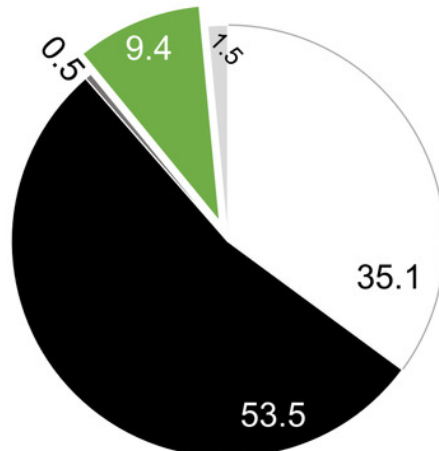
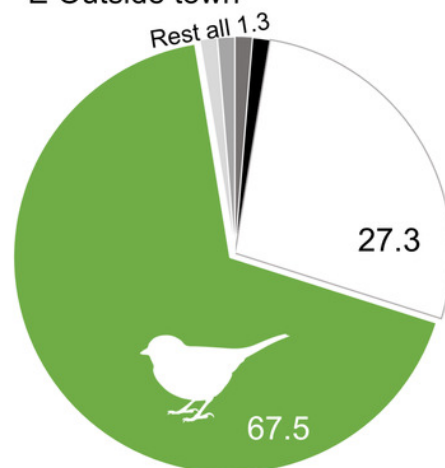
B Outside town

4.5
6.8
11.4
77.3

D Outside town

0.5
9.4
1.5
35.1
53.5

E Outside town

Rest all 1.3
27.3
67.5

# Figure 4

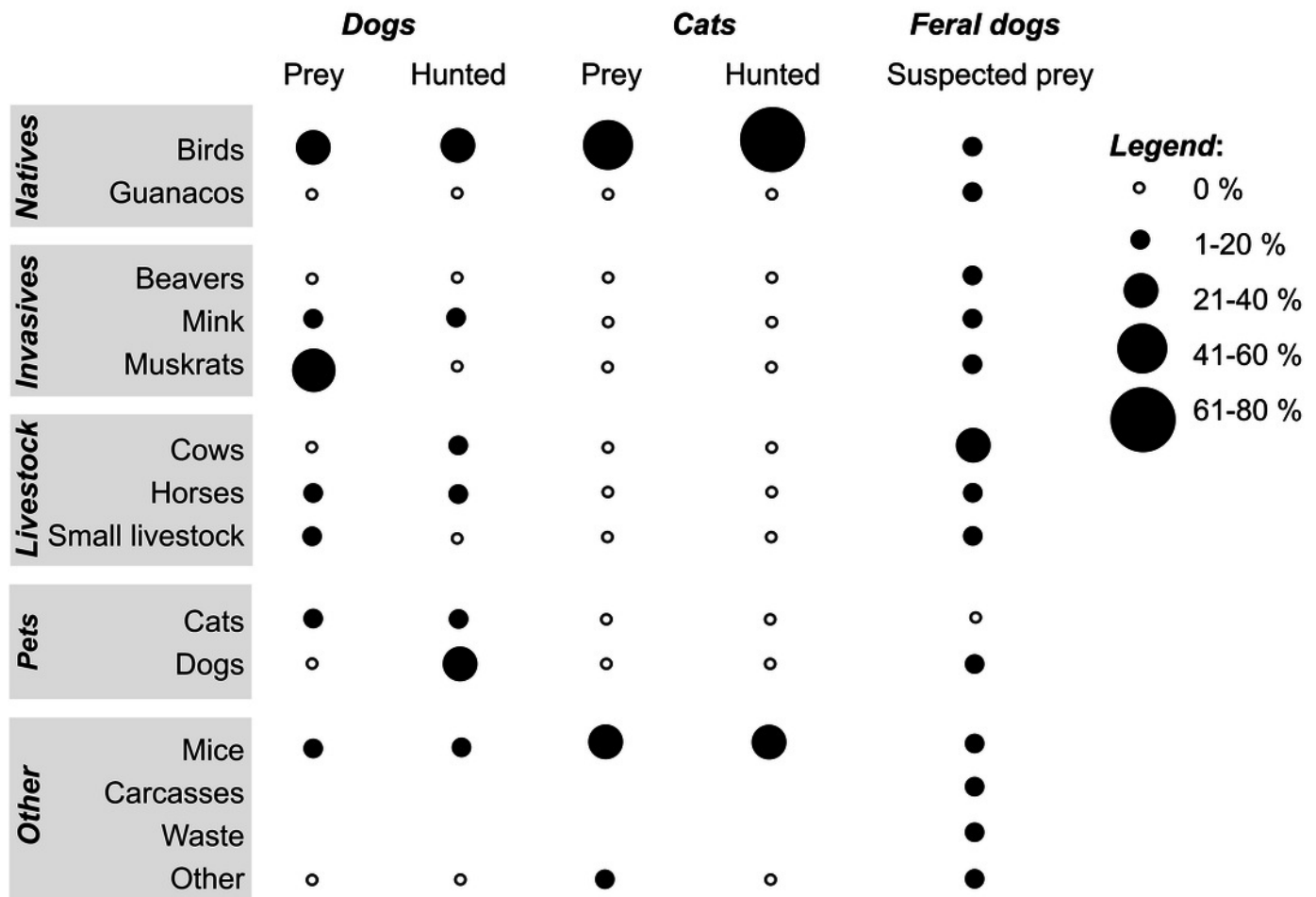
Preyed and harassed animals by dogs and cats, and suspected feral dog prey in southern Chile.

Prey brought to owners by 31 of 168 dogs (n=40 mentioned items), animals observed to be harassed by 64 dogs (n=79 items), prey brought to owners by 27 of 52 cats (n=33 items), animals observed to be harassed by 19 cats (n=25 items), and suspected prey of feral dogs (n=494 items) by 244 participants. "Other" includes fish (dog prey); fish, foxes, and seals, (harassed by dogs); bats (cat prey); and bird and horse feces, fish bait, foxes, seals, and vegetable material (suspected feral dog prey). "Small livestock" refer to chickens, pigs, and sheep. All bird species mentioned were native, except for the house sparrow, species mentioned among the cat prey.

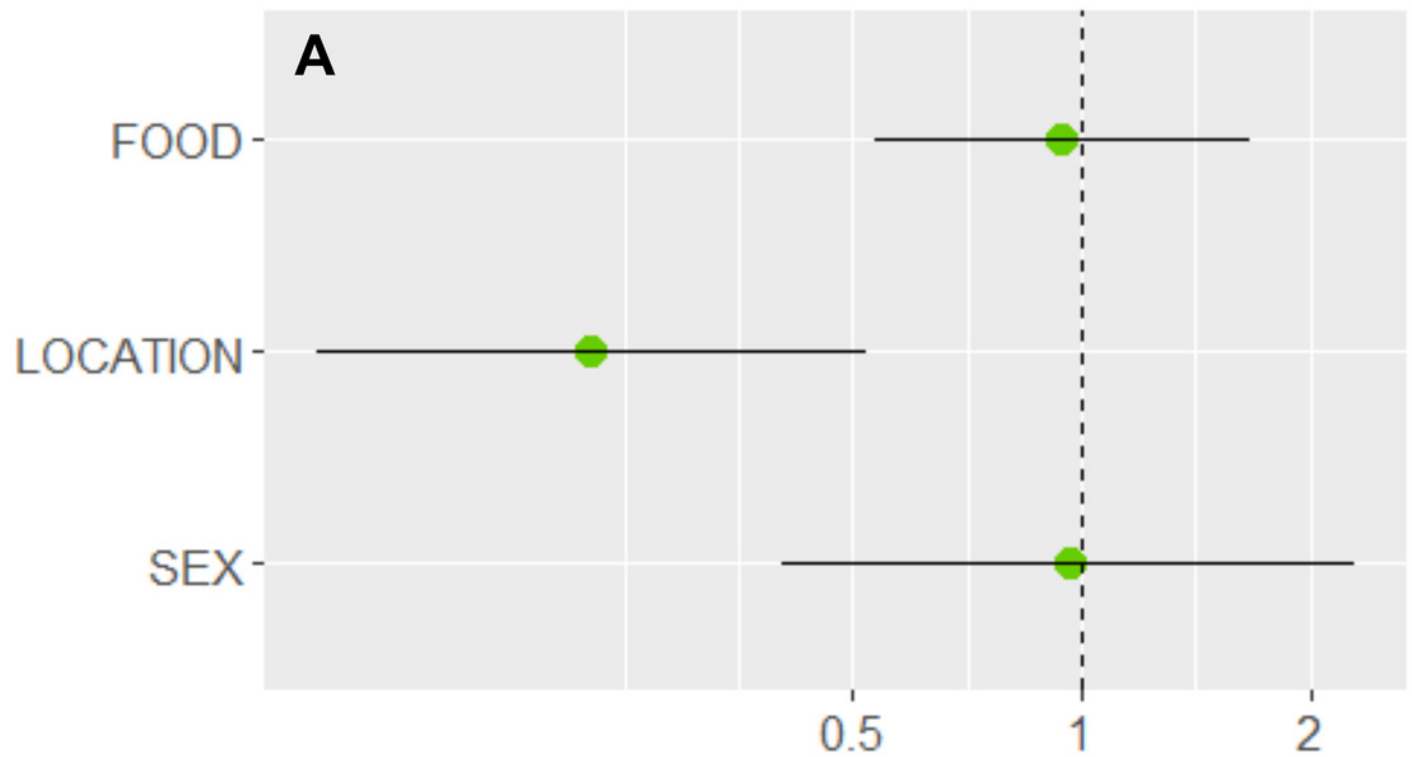
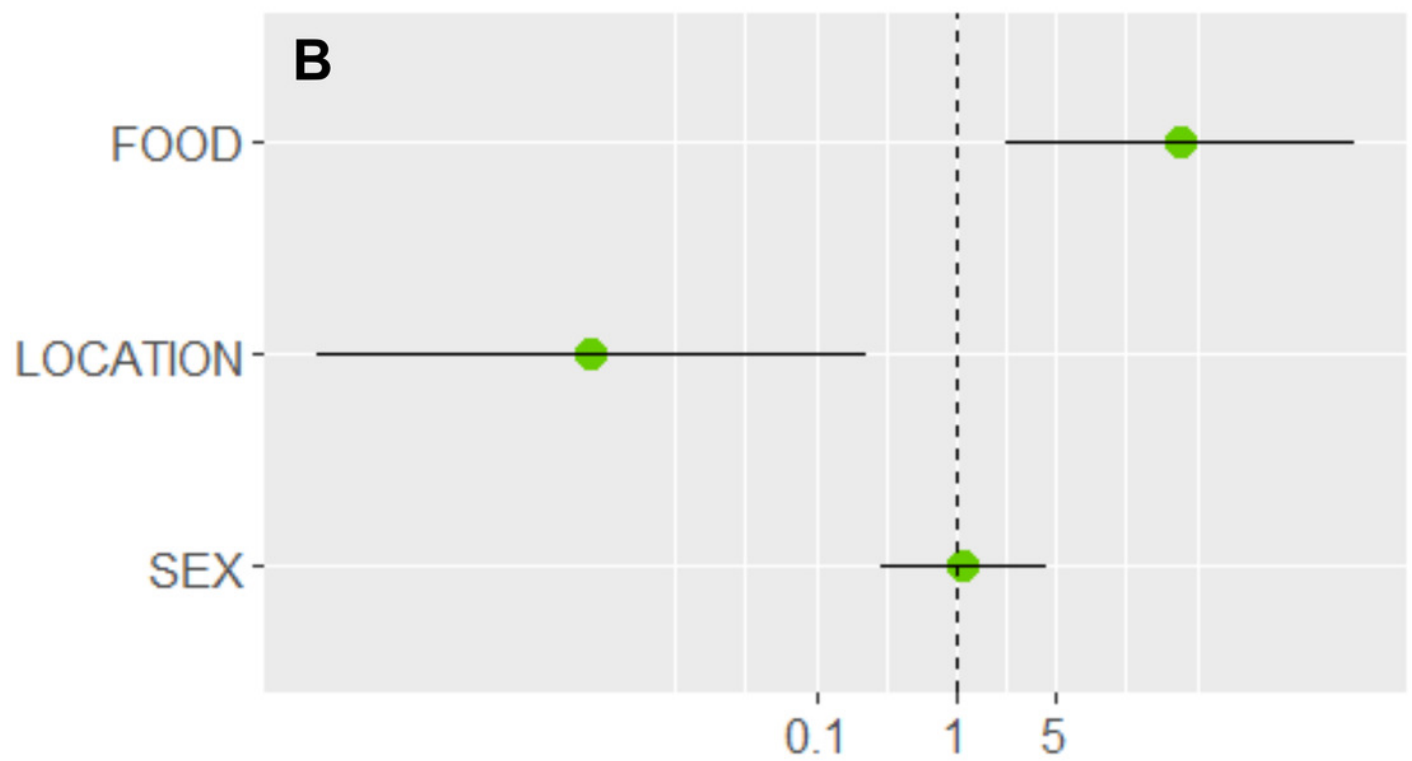
*Note: Auto Gamma Correction was used for the image. This only affects the reviewing manuscript. See original source image if needed for review.*

|  |  | **Dogs** | | **Cats** | | **Feral dogs** | |
|---|---|---|---|---|---|---|---|
|  |  | Prey | Hunted | Prey | Hunted | Suspected prey | |
| **Natives** | Birds | ⬤ | ⬤ | ⬤ | ⬤ | ● | |
|  | Guanacos | ○ | ○ | ○ | ○ | ● | |
| **Invasives** | Beavers | ○ | ○ | ○ | ○ | ● | |
|  | Mink | ● | ● | ○ | ○ | ● | |
|  | Muskrats | ⬤ | ○ | ○ | ○ | ● | |
| **Livestock** | Cows | ○ | ● | ○ | ○ | ⬤ | |
|  | Horses | ● | ● | ○ | ○ | ● | |
|  | Small livestock | ● | ○ | ○ | ○ | ● | |
| **Pets** | Cats | ● | ● | ○ | ○ | ○ | |
|  | Dogs | ○ | ⬤ | ○ | ○ | ● | |
| **Other** | Mice | ● | ● | ⬤ | ⬤ | ● | |
|  | Carcasses |  |  |  |  | ● | |
|  | Waste |  |  |  |  | ● | |
|  | Other | ○ | ○ | ● | ○ | ● | |

**Legend:**

| | |
|---|---|
| ○ | 0 % |
| ● | 1-20 % |
| ⬤ | 21-40 % |
| ⬤ | 41-60 % |
| ⬤ | 61-80 % |

# Figure 5

Model averaged odds ratios for models predicting dog and cat wildlife interactions in southern Chile.

Plots show the model averaged parameter estimates as odds ratios on a log scale with 95% confidence intervals (CI) for A) dog model and B) cat model, where LOCATION (dogs and cats) and FOOD (only cats) best predicted whether pets brought wildlife prey home. The other variables had confidence intervals that clearly overlapped the dashed line at 1, which implies that there is no direction of the parameter estimate. Estimates with odds ratios <1 indicate a negative association with the response variable, whereas those >1 indicate a positive association.

Odds ratio (log scale) and 95% CI

Odds ratio (log scale) and 95% CI

Candidate models for predicting dog and cat wildlife interactions in southern Chile.

A detailed description of the response and predictor variables is provided in Table 2.

| *Candidate model sets* | *Response variable* | *Quantitative value of response variable* | *Predictor variables* | *n\*\** |
|---|---|---|---|---|
| **Dog model** | PREY | 19.0% of dogs brought prey home | FOOD+LOCATION+SEX SIZE* STERILIZED* | 163 |
| **Cat model** | PREY | 51.9% of cats brought prey home | FOOD+LOCATION+SEX STERILIZED* | 52 |

1  * Predictor variables not included in final model set due to collinearity

2  ** We deleted 5 NAs from the dog model (3.0%) and 1 NA from the cat model (1.9%)

Variable description of candidate models for predicting dog and cat wildlife interactions in southern Chile.

The variable description refers to the questionnaire (see Supplementary Material S1).

| Variable | Variable type | Variable description and question number | Categories |
|---|---|---|---|
| PREY | Response | Dog/cat brought wildlife prey home (Q25) | Yes/no |
| FOOD | Predictor | Feeding of participant's dog/cat with leftovers, commercial food/meat, or both (Q15) | 0=leftovers<br>1=leftovers and commercial food/meat<br>2=commercial food/meat |
| LOCATION | Predictor | Dog/cat lives in rural environment (farm /Navy post) or in Puerto Williams | Rural/village |
| SEX | Predictor | Dog's/cat's sex (Q2) | F=Female, M=Male |
| SIZE* | Predictor | Dog's size (mean of two independent estimations by ES and LSA, Q42) | 1=small, 1.5=small to medium-sized, 2=medium-sized, 2.5=medium-sized to large, 3=large |
| STERILIZED | Predictor | Dog/cat is sterilized (Q11) | 0=not sterilized<br>1=pet's age<1 year<br>2=sterilized |

1  * Variable only used in the dog model, not in the cat model

Demographic dog and cat data, and husbandry results from southern Chile.

We obtained data on owned dog and cat populations via questionnaires from households in Puerto Williams (n=215), accessible farm households on Navarino Island (n=7), and Navy families (n=22, data from two years) living on the 11 Navy posts on different islands within the CHBR.

| | Town households (n=215) | | Farm households (n=7) | | Navy posts (n=22) | |
|---|---|---|---|---|---|---|
| | *Dogs* | *Cats* | *Dogs* | *Cats* | *Dogs* | *Cats* |
| **Demographic data** | | | | | | |
| Households with pet ownership (%) | 85 (39.5) | 30 (14.0) | 6 (85.7) | 6 (85.7) | 19 (86.4) | 4 (18.2) |
| Mean pet number per household (SD) | 1.4 (0.9) | 1.2 (0.6) | 5 (3.3) | 2.5 (2.5) | 1.3 (0.5) | 1.0 (0.0) |
| Total pet number | 121 | 36 | 30 | 15 | 17 | 2 |
| Male:female ratio | 1.3:1 | 0.7:1 | 2:1 | 0.3:1 | 0.7:1 | 0:1 |
| Mean pet age (SD) | 3.7 (3.8) | 4.8 (4.1) | 3.8 (4.6) | 3.0 (3.0) | 3.0 (3.7) | 3.3 (1.1) |
| Number of offspring in previous year | 16 | 0 | 21 | 7 | 9 | 0 |
| Local origin (CHBR, %) | 66.1 | 66.7 | 100 | 100 | 29.4 | 100 |
| **Reproductive control** | | | | | | |
| Females spayed; males neutered (%) | 66.7; 52.2 | 71.4; 93.3 | 10.0; 20.0 | 8.3; 0.0 | 11.1; 16.7 | 0.0; 0.0 |
| **Health** | | | | | | |
| Vaccinated against rabies (%) | 55.4 | 33.3 | 0.0 | 0.0 | 64.7 | 0.0 |
| Treated for parasites (%) | 60.3 | 36.1 | 100.0 | 40.0 | 64.7 | 50.0 |
| **Food provisioning** | | | | | | |
| Commercial food and/or meat (%) | 77.7 | 94.4 | 86.7 | 20.0 | 82.3 | 50.0 |
| Leftovers (%) | 12.4 | 0.0 | 13.3 | 33.3 | 5.9 | 0.0 |
| Mix of above (%) | 9.9 | 5.6 | 0.0 | 46.7 | 11.8 | 50.0 |
| **Dog confinement** | | | | | | |
| Free-roaming during day or night (%) | 30.6 | - | 46.7 | - | 82.4 | - |
| 24-h free-roaming (%) | 19.0 | - | 30.0 | - | 41.2 | - |

Best-ranked generalized linear models for predicting dog and cat wildlife interactions in southern Chile.

Summary of model selection for models with $\Delta AIC_c$ <2. K indicates number of parameters per model, $\Delta AIC_c$ distance from lowest $AIC_c$, and $\omega_i$ model weight.

| Model set | Competing models | $k$ | $AIC_c$ | $\Delta AIC_c$ | $\omega_i$ |
|---|---|---|---|---|---|
| **Dog model** | FOOD+LOCATION | 3 | 150.72 | 0.00 | 0.37 |
| | LOCATION | 2 | 151.03 | 0.32 | 0.32 |
| | FOOD+LOCATION+SEX | 4 | 152.32 | 1.60 | 0.17 |
| **Cat model** | FOOD+LOCATION | 3 | 62.19 | 0.00 | 0.75 |