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Assessing mammal community composition in the Huinay Biological Reserve (Chile) through questionnaire surveys: biases associated with respondents

Evaluación de la composición de la comunidad de mamíferos de la Reserva Biológica de Huinay (Chile) a través de cuestionarios: sesgos asociados con los participantes

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Abstract

The study of people's knowledge through interviews and questionnaires can provide a good picture of the composition of mammal communities. However, there is considerable potential for error and bias in these surveys, including some associated with the familiarity of respondents with wildlife. Our main goals were: 1) to assess mammal community composition of the Huinay Biological Reserve, a remote Valdivian rainforest area in southern Chile, and 2) to evaluate the relationship between the degree of respondents' contact with native mammals and their knowledge about the mammal community. A questionnaire was designed to gather data about the mammal species recorded by people who lived in, or had visited, the area between 2010 and 2013. A total of 13 mammal species were mentioned by 43 participants in the survey. Overall, all the mammal species that inhabit the study area according to general mammal distribution maps were identified in our survey. Both the total number of species mentioned (observed or not) and the number of species seen by the respondents were positively associated with the time they stayed in the area. Our findings suggest that questionnaire surveys may provide useful information about the composition of mammal communities in remote areas of southern Chile, but selecting knowledgeable respondents is challenging.
Keywords: Freelisting method, Remote areas, Species richness, Valdivian rainforest, Wildlife inventory.

Resumen

El estudio del conocimiento de la gente mediante cuestionarios puede proporcionar una buena idea de la composición de las comunidades de mamíferos. Sin embargo, existen sesgos y errores potenciales en estos estudios, como los asociados a la familiaridad de los encuestados con la fauna. Nuestros objetivos principales fueron: 1) evaluar la composición de la comunidad de mamíferos de la Reserva Biológica de Huinay, un área remota de bosque Valdiviano en el sur de Chile, y 2) analizar la relación entre el grado de contacto de los encuestados con los mamíferos nativos y su conocimiento sobre la comunidad de mamíferos. Designamos un cuestionario para obtener información sobre el número de especies de mamíferos registradas por la gente que vivió en, o visitó, el área entre 2010 y 2013. Los 43 participantes en este trabajo registraron un total de 13 especies de mamíferos. Todas las especies que habitan en la zona según los atlas generales de distribución fueron citadas por los participantes. Tanto el número de especies citadas como las observadas estuvieron correlacionadas positivamente con el tiempo que los participantes habían permanecido en el área. Nuestros resultados sugieren que los estudios basados en cuestionarios pueden proporcionar una buena visión general de la composición de las comunidades de mamíferos de áreas remotas del sur de Chile, pero también indican el reto que supone seleccionar participantes bien informados en estas áreas.
Palabras claves: Áreas remotas, Bosque Valdiviano, Inventario de fauna, Método de listado, Riqueza específica.

Introduction

Remote areas host some of the most intact ecosystems and richest biodiversity of the world (McCauley *et al.* 2013). However, information about biodiversity distribution in these areas is usually scarce (Ficetola *et al.* 2013), and therefore quantifying the amount of this unknown biodiversity is a conservation priority (Mora *et al.* 2011). A good example of this comes from the Valdivian rainforest of southern Chile, which is included as one of the world biodiversity hotspots (Conservation International 2014) and where knowledge regarding the composition of wildlife and plant communities is generally scarce. Surveying people's ecological knowledge through questionnaires and interviews may be an effective method to assess the composition of wildlife communities in the region. These methods have been increasingly used to study the distribution of species that are elusive, nocturnal and/or occur at low densities, such as some mammals (e.g. Michalski & Peres 2005, Ziembicky *et al.* 2013, Kotschwar Lowan *et al.* 2015). These surveys are relatively fast and inexpensive in comparison to other, more time consuming (direct observation) or costly methods (e.g. camera-trapping; Gerber *et al.* 2010), and may provide a good picture of the composition of mammal communities across wide geographic areas (Ziembicky *et al.* 2013).

Some studies have indicated that ecological knowledge collected through questionnaires and interviews may be limited or partially inaccurate (Can & Togan 2009). This may be due to potential bias in the collection, interpretation and quantification of ecological knowledge. Some biases are related to the characteristics of the species considered, as some are more easily identifiable than others, such as large-bodied vertebrates, charismatic species or those of socioeconomic importance (Mallory *et al.* 2003, Karst & Turner 2011). Other biases are associated with survey participants (hereafter participants or respondents). For example, respondents' familiarity with wildlife, their age or their environmental awareness may affect their knowledge of the occurring species (Turvey *et al.* 2010, 2014). Biases associated with the respondents are especially problematic in remote areas, such as those in southern Chile, where recruiting sufficient participants for this type of survey is usually very difficult.

In this study, our main aims were: 1) to assess mammal community composition in the Huinay Biological Reserve (HBR), a pristine Valdivian rainforest area in southern Chile (Soto-Benavides & Flores-Toro 2011), and 2) to evaluate the relationship between the amount of information provided by each respondent and his/her degree of contact with native mammals. For this purpose, we used the time respondents had spent in the study area, whether they had walked in the forest, and whether they had some relationship with wildlife, as proxies of their degree of contact with native mammals.

Material and Methods

Study area

The HBR is located in the Comau fjord in Los Lagos Region of southern Chile (42º22' S, 72º24' W). It covers nearly 34,000 ha dominated by Valdivian temperate rainforests (more details including a figure with the location of the study area can be found in Delibes-Mateos *et al.* 2014a, b). The climate is temperate and humid, with an annual average temperature of 10.5ºC and an average annual rainfall greater than 6,000 mm (Huinay scientific research foundation; http://www.huinay.cl/site/sp/index.html). The reserve is only accessible by boat from the fjord, and the closest significant mainland town is Puerto Montt, 200 km to the north. There is a small village in the HBR called San Ignacio del Huinay; currently only a few families are living in the village. This small population owns some livestock (mainly cows), and/or are fishermen in the fjord. Most of them have lived in the HBR for a long time. A few other households are scattered along the fjord, outside the reserve. In December 2001, the Huinay scientific station was inaugurated, with the main goal of facilitating and promoting research in a variety of fields within the HBR. This station employs a small staff, including a scientific director, an administrator, two research assistants and some locals for station maintenance and a boat skipper. The station receives researchers every year who spend short stays (usually less than one month) in the reserve to do field work. Most research projects focus on marine biology and a few on botany and ornithology (http://www.huinay.cl/site/sp/). Other people, including relatives and friends of the residents in the reserve and those inhabiting neighbouring areas, occasionally visit the HBR. In 2013, the total number of residents in the HBR was less than 35, and from 2009 to

2014 around 400 people visited the reserve (Katie McConnell, personal communication).

Survey implementation

A questionnaire was specifically designed to gather information about the composition of the mammal community in the HBR. First, we asked the respondents about what mammal species they had seen in the area. Given that the number of species seen was generally low, we also asked the respondents to freely list other species they knew to occur in the area. Using this information, we calculated the total number of species mentioned by each respondent (either observed or not). A person may know the presence of a species in a particular area because, for example, he/she may have consulted information about wildlife on the Internet or in the literature or because other people may have talked to him/her about it. A respondent's list length is a measure of that person's depth of knowledge or familiarity within the target domain (e.g. Furlow 2003), i.e. the mammal community in our study.

This method, called freelisting, is well-established in ethnography (Bernard 2006), and is based on three assumptions: people tend to list terms in order of familiarity, individuals who know a lot about a subject list more terms than people who know less, and terms that most respondents mention usually indicate locally prominent items (Quinland 2005). The freelisting method presents several important advantages over other methods that are based on interviews or questionnaires. For example, freelists are rapid and easy, allowing for much larger samples in less time (Quinland 2005). In addition, freelists allow the capture of participants' perceptions regardless of researchers' expectations. This differs from other methods like questionnaires, and sorting and ranking interviews, for example, that have predetermined responses based on researcher knowledge (Bernard 2006). Finally, freelists are quantifiable unlike data obtained through other qualitative methods (Quinland 2005).

There are some potential shortcomings associated with freelisting. For example, inventories generated through freelisting may not be as exhaustive as inventories gained through other methods, like long interviews with key informants (Quinland 2005). Another factor potentially limiting freelists is that they reflect only terms (i.e. names of species in our study) in a respondent's active vocabulary. This means that it is sometimes difficult to assign some terms unequivocally to particular wildlife species. For this reason, in our study, a few non-assignable names like 'otter' or 'wildcat' were discarded (see results). In addition, it is likely that this method does not provide reliable results in the case of small mammals, as these species are often unidentifiable by participants in local knowledge surveys (Ziembicky *et al.* 2013). This is why we focused on medium-sized and large mammals in this study. Nevertheless, we included the native marsupial *Dromiciops gliroides* Thomas, 1894, because it is a very charismatic, unique and well known mammal in the area (Iriarte 2008, Celis-Diez *et al.* 2012).

In addition to freelisting mammal species, we asked the participants about the total time they had spent in the HBR. We expected this to vary notably between occasional visitors and residents, likely influencing their observation of and familiarity with wildlife. For analyses, we transformed all the responses to days, counting a month as 30 days. We also asked the participants whether they had walked in the forest during their stay in the reserve, as this could also vary substantially. Huinay is a marine protected area that is very rich in biodiversity (Häussermann & Fösterra 2010), and therefore many of the researchers visiting the scientific station are marine biologists who usually spend nearly all of their time in the fjord. Along the same lines, we suspected that some people (e.g. cooks or people in charge of facilities maintenance) visited the forest very rarely, in contrast with the habits of other participants in the survey (i.e. botanists, research assistants, livestock breeders, etc). Our expectation was that walking in the forest could increase the probability of observing wildlife as well as respondents' familiarity with the species present in the study area. Finally, we asked the participants whether they had some type of relationship with wildlife as another proxy of their familiarity with wildlife. Most of the people who had a relationship with wildlife were biologists working on wildlife research projects. Nevertheless, a few people who responded affirmatively were not involved in wildlife projects, but they declared themselves to be passionate wildlife watchers. Participants without a relationship to wildlife included researchers specializing in other topics (e.g. mycologists) and some of the residents in the reserve (e.g. people in charge of the facilities).

Almost half of the respondents were personally interviewed during the authors' visit to the study area (September-October 2013). In addition, after our visit, we also sent the questionnaire by e-mail to other people who had visited or lived in the HBR (mainly researchers). The contact details of these people were obtained from the scientific station staff or from other respondents. Forty-three people who had visited or lived (29 and 14, respectively) in the HBR between 2010 and 2013 responded to the questionnaire. People who lived there included employees of the scientific station (n=10) and residents of the village (n=4). Visiting respondents were mainly researchers (n=27); the other two visitors were an occasional worker (computer technician) and a researcher companion.

Data analysis

We used General Linear Models with a Poisson distribution and a log link function to assess both the total number of mammal species mentioned (either observed or not) and the number of species observed by respondents as a function of: the time spent in the HBR, whether respondents had walked in the forest (categorical variable), and whether they had any relationship to wildlife (categorical variable). The time spent in the HBR was log-transformed to reduce the influence of a few large values (Zar 1999). The interactions between both categorical variables and the time spent in the HBR were also included in the models. We assessed whether the models were affected by overdispersion, accepting dispersion parameter levels between 0.5 and 1.5 (Zuur *et al.* 2009). We also checked for potential collinearity and redundancy of the explanatory variables by analyzing the variable inflation factor (VIF) with the vif function (car Package; Fox & Weisberg 2011), accepting VIF values <3 (Zuur *et al.* 2013). The deviance (or pseudo R^2; difference between the null and residual deviances divided by the null deviance, values between 0 and 1) was used as a measure of the explicative power of the model (Zuur *et al.* 2009). Models were fitted with the glm function (Stats Package; R development Core Team 2013).

Results

A total of 13 mammal species (average ± SD: 3.4 ± 2.7; Table 1) were identified. All of these, except *Hippocamelus bisulcus* Molina, 1782 and *Lycalopex griseus* Gray, 1837, were observed in the study area by the respondents (Table 1). On only a few occasions, participants provided common names that could not be assigned to any particular species (4.5%; nº of total responses=153).

The time spent by respondents in the HBR

Table 1. Species mentioned during our survey. 'N observed': number of participants who observed each species; 'N not observed': number of participants who knew of the occurrence of each species without having observed it; 'N total mentioned': total number of participants who mentioned each species (either observed or not); Total number of participants= 43.

Species	N observed	N not observed	N total mentioned
Dromiciops gliroides	4*	18	22
Galictis cuja	4	0	4
Hippocamelus bisulcus	0	3	3
Lagidium sp.	5	10	15
Leopardus colocolo	2	2	4
Leopardus guigna	7	8	15
Lontra felina	1	4	5
Lontra provocax	2	0	2
Lycalopex griseus	0	4	4
Myocastor coypus	2	1	3
Neovison vison	10	3	13
Pudu puda	19	15	34
Puma concolor	5	21	26

*All of them observed an animal that was found dead in the reserve.

ranged from 2 to 17,520 days (average ± SD: 1,514 ± 3,792; n= 41; two persons did not respond to this question). Most respondents walked in the forest during their stay in the reserve (69.7%; n= 43), and most had some relationship with wildlife (56%; n= 41; two persons did not respond to the second question). Our models including all the covariates and their interactions were not affected by overdispersion, and they accounted for 51% and 49% of the deviance for species mentioned and species observed, respectively. The three predictor variables had VIF < 1.15, so were considered not redundant. Both the total number of species mentioned and the number of species observed were significantly and positively associated with the time spent in the HBR by the respondent (Table 2); i.e. the longer respondents had stayed in the area, the higher number of species they mentioned (Fig. 1a) and observed (Fig. 1b). Walking in the forest or a relationship with wildlife were not significantly related to the total number of species mentioned or observed by the respondents; only the relationship between the forest variable and the total number of species mentioned was marginally significant (Table 2). The interactions between these categorical variables and the time spent by respondents in the HBR were not significant in the models (Table 2).

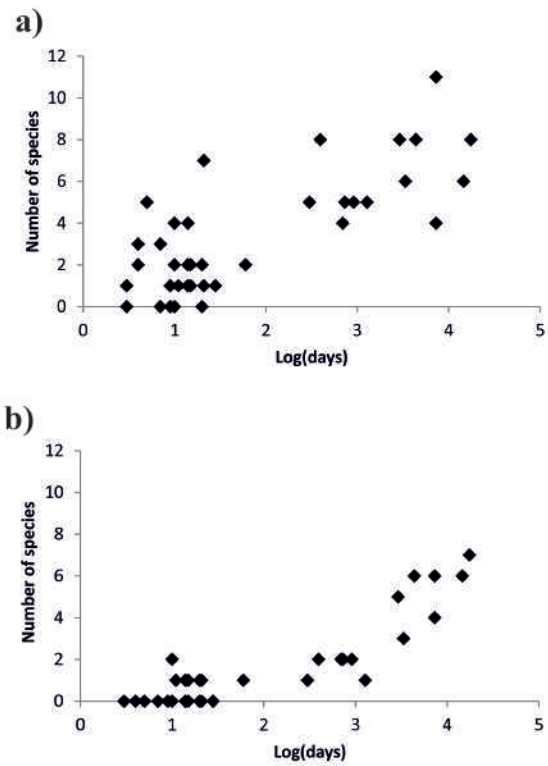

Figure 1. Relationship between the time (days, log-transformed) spent in the study area by each participant and (a) the total number of species mentioned (either observed or not), and (b) the number of species exclusively observed.

Table 2. Parameter estimates and standard errors (SE) for the explanatory variables used in the models explaining the total number of species mentioned (either observed or not) and the number of species observed by each respondent. TIME refers to the time respondents had spent in the study area. FOREST indicates whether respondents had walked in the forest, and WILDLIFE whether they had some relationship with wildlife. The levels 'not' of FOREST and WILDLFE are included in the intercept.

		Estimate	SE	Z value	*P*
Total number of species mentioned	Intercept	-0.528	0.425	-1.241	0.214
	Time HBR	0.616	0.139	4.423	<0.001
	FOREST:yes	0.826	0.431	1.916	0.055
	WILDLIFE: yes	0.339	0.402	0.844	0.398
	FOREST:yes* TIME	-0.206	0.156	-1.317	0.187
	WILDLIFE:yes* TIME	-0.034	0.152	-0.227	0.820
Number of species observed	Intercept	-3.942	1.269	-3.106	0.001
	Time HBR	1.382	0.326	4.238	<0.001
	FOREST:yes	0.976	1.116	0.874	0.382
	WILDLIFE: yes	1.364	1.080	1.262	0.206
	FOREST:yes* TIME	-0.197	0.313	-0.630	0.528
	WILDLIFE:yes* TIME	-0.312	0.319	-0.979	0.327

The pseudo R^2 for the model of the number of species mentioned is 0.51 and residual deviance is 42.08 on 33 df; the pseudo R^2 for the model of the number of species observed is 0.49 and residual deviance is 43.53 on 33 df.

Discussion

All the mammal species that inhabit the study area according to general mammal distribution maps (Redford & Eisenberg 1992, Iriarte 2008) were recorded in our survey, and most of them (85 %) were also observed by the respondents. In addition, they mentioned three species that were not cited in these maps, including the viscacha (*Lagidum* sp.), the southern huemul (*H. bisulcus*), and the Pampas cat *Leopardus colocolo* (Molina 1782), although the latter is present in the area according to a recent review on the biodiversity and conservation of Chilean wild cats (Iriarte *et al.* 2013). Moreover, we could confirm the presence of viscachas (sighting their pellets) during the transects we carried out in the HBR (Delibes-Mateos *et al.* 2014a), and signs of the southern huemul have been recorded in neighbouring areas (Aldridge 2010).

The presence of some mammal species is nearly undetectable when they exist at very low densities using traditional ecological surveys, which typically have a limited budget. A recent survey, which included both camera-trapping and transects on foot to record signs of mammal presence (e.g. scats and tracks) in the same area, was only able to detect 6 mammal species (Delibes-Mateos *et al.* 2014a), less than half of those identified in the present study. Although the abundance of mammal species may be successfully assessed through questionnaire or interview surveys on some occasions (e.g. Pérez-Peña *et al.* 2012), biases associated not only with respondents (see below), but also with species can make this assessment unreliable (Msoffe *et al.* 2007). In fact, the number of times a species was mentioned in our study did not seem to be a good estimate of abundance (Delibes-Mateos *et al.* 2014a); e.g. *Puma concolor* (Molina 1782), which is usually found at low densities, was mentioned frequently by the participants (Table 1). Furthermore, we did not find any direct relationship between the most cited species and their detectability. Species that are relatively more easily detectable at the HBR like *Pudu puda* were not cited by respondents more frequently than others with lower probability of detection like *Puma concolor* or *Dromiciops gliroides*. Overall, our results suggest that surveys based on questionnaires may provide a reasonably precise picture of the composition of mammal communities in remote areas of southern Chile, where conducting empirical studies using conventional ecological surveys at a large scale can be logistically and financially unfeasible. Nevertheless, the latter are essential when fine-scale information on mammal abundance and distribution is required.

A potential drawback of the freelisting method is that there may be differences in the species naming, especially among local and non-expert informants (Fleck *et al.* 2002). However, in our study, only very few responses could not be assigned to any particular species (see results). For example, 3 participants mentioned "wildcats" and 2 knew the occurrence of "foxes", but we were not able to identify the species to which they were referring. This very low level of lexical variation may be explained by the fact that a great proportion of the participants (67%) were biologists or researchers in related disciplines, and because employees at the scientific station were in close contact with researchers and, therefore, were likely accustomed to scientific language. An alternative to overcome this potential source of error could have been showing the participants pictures of the species that we expected to occur in the area (e.g. Van Holt *et al.* 2010). However, there was no previous reliable information about the mammal community composition in the HBR and this approach could have skewed participants' responses towards some species, likely underestimating the presence of unexpected species.

Our study identified variations among respondents in their ability to enumerate mammals found in the HBR. This suggests that it is essential to correctly select the participants who are knowledgeable to increase the efficiency, effectiveness and validity of questionnaire and interview surveys in remote areas of southern Chile. Knowledge about wildlife can differ considerably among individuals based on their age, experiences, and numerous other socio-economic factors (Berkes *et al.* 2000). Information reported by respondents about species that had not been seen, just known to occur, may be in some cases unreliable, as people may provide a mix of reality and fantasy or myths. However, in our study the number of species observed was also positively associated with the time respondents had spent in the study area. Therefore, our results suggest the likelihood of having seen or being aware of the presence of native mammal species may increase with the time spent in an area, which agrees with previous studies (Nyhus *et al.* 2003). Our results also show that the total number of species mentioned (and observed) by respondents who had lived in the study area for several months was generally considerably higher than that reported by occasional visitors (Fig. 1). This suggests that the information provided by the latter was not meaningful to assess the composition of the mammal community in this remote area. The relatively low knowledge of the animals present in the reserve among occasional visitors may also reflect the secretive nature of many mammals, the difficulty of observing wildlife in dense forests, and the likely relatively low abundance of some of these animals in the HBR (Delibes-Mateos *et al.* 2014a,b; but see also Nyhus *et al.* 2003).

The time spent in the forest can be a good predictor of whether respondents have seen or heard of native mammal species (Turvey *et al.* 2014). In our study, the effect of going into the forest was only marginally significant in the model for the total number of species mentioned, likely because we only allowed a yes/no response that prevented us to quantify the total time respondents had spent in the forest. This means that the same category was assigned to, for example, respondents who walked into the forest occasionally and to those who had been going into the forest repeatedly or for a long time. In addition, there were no differences in the total number of species mentioned and seen by respondents who had some relationship with wildlife and those who had no relationship. This could be explained by the fact that we obtained responses about very different types of relationships to wildlife, some of which were not necessarily related to Chilean terrestrial mammals.

In conclusion, our findings suggest that selecting a few long-term residents as key informants and interviewing them in depth, rather than exploring the views of a higher number of short-term residents or occasional visitors, may be a more effective method. Future research should evaluate whether other variables can affect the amount of information provided by respondents in remote areas in southern Chile, as reported in other regions (e.g. Nyhus *et al.* 2003). Given that selecting knowledgeable participants is not always possible in remote, sparsely populated areas, we recommend gathering information about the participants that allows controlling species richness estimates for potentially influencing factors, thus obtaining unbiased results.

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