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EVALUATION OF A FECAL-PELLET INDEX OF ABUNDANCE FOR MOUNTAIN VIZCACHAS (*Lagidium viscacia*) IN PATAGONIA

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ABSTRACT: We present an index of abundance based on fecal-pellet counts for mountain vizcachas (*Lagidium viscacia*) in the Patagonian steppe. We use regression to calibrate the index to size of populations of mountain vizcachas estimated by captures and intensive observations at seven sites. By obtaining index values on two different occasions and comparing the regressions for these two occasions, we determine that this is a valid constant-proportion index under the conditions of our study. The use of this index should be limited to populations of mountain vizcachas inhabiting low, vertical cliffs. Its use outside the study area requires the assumption that local conditions do not affect the relationship between the number of piles of pellets and the number of mountain vizcachas which we found in our study area. We advise that a validation study be done locally wherever the index is to be used. If this is not possible, the index should be used to compare relative rather than absolute abundance, and results should be interpreted with caution.

RESUMEN: Evaluación de un índice de abundancia para el chinchillón en la Patagonia. Presentamos un índice de abundancia para chinchillones (*Lagidium viscacia*) en la estepa patagónica basado en conteos de pilas de fecas. Usamos regresión para calibrar el índice con los tamaños de poblaciones de chinchillones estimados con capturas y observaciones intensivas en siete sitios. Al obtener valores del índice en dos ocasiones distintas y comparar las regresiones para esas dos ocasiones, determinamos que el índice es válido como un índice de proporciones constantes en las condiciones de nuestro estudio. El uso de este índice debería limitarse a poblaciones de chinchillones que habiten acantilados bajos y verticales. Su uso fuera del área de estudio requiere suponer que las condiciones locales no afectan la relación entre el número de pilas de fecas y el número de chinchillones que encontramos en nuestra área de estudio. Aconsejamos que se haga una validación local siempre que se vaya a usar este índice. Si esto no es posible, el índice debería usarse para comparar densidades relativas en vez de absolutas y debería tenerse precaución al analizar los resultados.

Key words: index, calibration, abundance, mountain vizcacha, *Lagidium,* Patagonia

Palabras clave: índice, calibración, abundancia, chinchillón, *Lagidium*, Patagonia

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INTRODUCTION

Indices of animal abundance based on signs are widely used, but there are relatively few reports in the literature describing evaluation of these methods (Vincent et al., 1991; Southwell, 1994; Mallick et al., 1997; Hubbs et al., 2000), and existing evaluations are often incomplete. To be valid as a measure of relative abundance, an index should be related to true abundance as in the equation $E(n)=pN$, with E(n) the expected value of the index, N the true population size, and *p* the constant proportion of the population size which is represented by the index (Lancia et al., 1994). The index must be calibrated to the true population size in order to estimate *p* (Eberhardt and Simmons, 1987). This may be done by obtaining unbiased estimates of population size and values of the index for several time periods or locations, and doing a regression of population estimates on index values. In a true constant-proportion index, there is a linear relationship between population size and index values, a zero intercept, and the slope of the regression provides an estimate of *p* (Lancia et al., 1994).

Mountain vizcachas (*Lagidium* spp.) are large caviomorph rodents of the Andean region and the Patagonian steppe of South America, with a distribution from central Peru to southwestern Argentina (Redford and Eisenberg, 1992). Although there are studies of other species of the genus (Pearson, 1948), there is little information available on the ecology and behavior of *Lagidium viscacia* (Molina, 1782), the species of the southern Andes and the northern Patagonian steppe (Galende et al., 1998; Puig et al., 1998). Its status throughout its range is unknown, but preliminary work indicates that its densities are declining in northwestern Patagonia (Walker et al., unpubl.). Therefore, it is important to determine current population sizes and monitor changes.

Mountain vizcachas live in deep crevices in large rocks (Pearson, 1948). In our study area rocks used by mountain vizcachas are mostly in the form of linear cliffs with vertical faces. Mountain vizcachas may pass many hours a day sunning on rocks near their dens, usually near the tops of the cliffs. They are coprophagic, and defecate in their sunning spots (pers. obs.). Thus the nature of their habitat in our area, combined with their behavior, results in piles of feces laid out near the tops of the cliffs.

Mountain vizcachas tend to use the same sunning spots day after day, and with observation, it is often possible to learn how many are inhabiting a site (pers. obs.). On occasion, the number of individuals at a given site may be counted in a single visit. More often, it takes many days or even weeks of observation, depending on weather conditions, history of hunting by humans, and other factors which affect their visibility. Therefore, an indirect method is more suitable as a quick method for estimating population sizes at numerous sites.

The objective of this study is to evaluate the use of fecal-pellet counts as an index of abundance for mountain vizcachas in the Patagonian steppe. Because this method is quick and inexpensive, it could make it feasible to monitor populations over large areas in little time.

METHODS

The study was carried out in the vicinity of Pilolil (39º 35' S, 70º 80' W), Province of Neuquén, Argentina, in a habitat of grass/shrub steppe (León et al., 1998). In summer (February-March) of 1996, we estimated the number of mountain vizcachas at six cliffs by capture and marking of animals and by direct observations. Each cliff averaged from 10 to 15 m high and had an almost vertical face. Cliffs ranged in length from 260 to 1090 m.

Mountain vizcachas were captured by local assistants who chased them into holes or crevices and grabbed them by hand. We kept captured animals in covered cages and before handling, sedated them with 20 mg/kg of ketamine hydrochloride injected intramuscularly. We attached a colored plastic disc approximately 2.5 cm in diameter in each ear with metal rabbit ear-tags. Each individual could be identified from a distance by the unique combinations of colored discs in their ears. Animals were held overnight and released at the point of capture the next day.

At each cliff, observations were carried out repeatedly over several days, at different times of day. At sites where we had resightings of marked animals we used the unbiased Lincoln-Peterson estimator (Lancia et al., 1994) to estimate the population size. We estimated sighting probability as the ratio of the number of mountain vizcachas sighted at one time to the Lincoln-Peterson estimate of population size, and averaged these over various occasions and sites. To estimate population size at sites where we had no marked animals, but many hours of observations, we divided the maximum number of individuals seen by the average sighting probability.

The index we used was the number of fresh piles of fecal pellets encountered in a transect walked along the upper edge of the cliff. We counted each group of feces which was still in the form of a pile, assuming that these were recently deposited, as the incessant Patagonian winds quickly disperse the fecal pellets when they dry in the sun. Transects were done in the morning hours, and not on rainy days or days with high winds. By counting only intact piles of feces under these conditions, we avoided the necessity for estimating rate of decay of feces, as is done in many fecal-based indices for other species (Taylor, 1956; Neff, 1968).

We did a least-squares regression of estimated population size on the number of fresh piles per cliff. To determine the 95% confidence intervals for the slope and the intercept, we bootstrapped the regression 1000 times, using the program Resampling Stats (Bruce et al., 1995). Count data are not expected to be normally distributed, and our sample size was small. By bootstrapping, we determined the probability that the intercept and the slope were different from zero without making assumptions about fit of the data to any theoretical distribution function (Sokal and Rohlf, 1995).

To evaluate whether the number of piles of fecal pellets is a constant-proportion index, we repeated the transects in May (fall) 1996. We assumed that the number of individuals inhabiting the cliffs was the same because of the short time (approximately two months) between the transects. We were unable to repeat the transect at cliff #20 because of weather conditions, but we were able to add a cliff (#32) for which we did not have an estimate in the summer. To determine whether the relationship between the number of piles of pellets and the number of individuals differed between seasons, we did *T*-tests of differences between the slopes and intercepts (Zar, 1996) for the regressions with the fall and summer counts. For our final estimate of the proportion represented by *p*, we repeated the regressions for the two sets of counts, but this time using an intercept of 0. We then calculated a weighted regression coefficient to incorporate both sets of estimates into a single estimate of *p* (Zar, 1996) with 95% confidence intervals calculated with resampling as described above.

RESULTS AND DISCUSSION

Population sizes at cliffs were small (3 - 19 individuals) (**Table 1**). We used the Lincoln-Peterson estimator at sites # 4, 15, 19, 20, and 32. At sites 19, 20, and 32, either all marked animals were observed or all observed animals were marked. This results in a variance of zero for the Lincoln-Peterson estimates of population size at these sites, due to zeros in the numerators of the variance equations. The

Table 1. Numbers of mountain vizcachas based on captures and sightings (No. Ind.) and number of fresh piles of pellets encountered in summer and fall at cliffs of different lengths (in meters) in southern Neuquén Province, Argentina, 1996. 95% CI = lower and upper limits of 95% confidence intervals for the estimation of number of individuals. NA = not available.

				# Piles of Pellets	
Cliff	**Length**	**No. Ind.**	**95% CI**	**Summer**	**Fall**
2	280	3	NA	38	15
3	270	5	NA	83	42
4	1090	19	14-23	235	161
15	640	8	7-13	68	97
19	590	5	NA	59	65
20	420	3	NA	49	—
32	280	3	NA	—	20

Table 2. Intercepts and slopes estimated with least-squares regression of numbers of mountain vizcachas on fresh piles of fecal pellets in summer and fall, 1996, in southern Neuquén Province, Argentina. Ninety-five percent confidence intervals in parentheses following estimates are based on bootstrapped regressions.

	Intercept	Slope	Slope without Intercept
Summer	4.6 (-15.5 - 44.8)	11.7 (3.6 - 13.9)	12.1 (10 - 14.1)
Fall	4.3 (-40.2 - 20.7)	8.7 (7.6 - 18.7)	9.08 (8.4 - 11.7)
Combined		10.6 (8.9 - 12.3)	

95% confidence intervals at the two cliffs where we were able to estimate a non-zero variance (cliff #4 and cliff #15) were small and non-overlapping (**Table 1**), supporting the rank order of the population sizes. The average sighting probability was 0.61 (SE = 0.08). The population-size estimates at #2 and #3 were calculated with the sighting probability. At sites #2, #3, and #20 our estimates of population size were corroborated by people living nearby, who had observed the cliffs over longer time periods.

Our results indicate that transects to count fresh piles of fecal pellets are valid as an index of abundance of mountain vizcachas under the conditions of our study. There was a significant linear relationship (**Table 2**) between the number of piles of fresh pellets and the estimated number of mountain vizcachas in both the summer ($p = 0.006$) and the fall ($p < 0.001$). There was no difference between the least-squares estimates of the intercepts for the summer and fall regressions ($T = 0.31$, df = 9, $p = 0.76$), and both 95% confidence intervals for the intercepts encompassed zero. Therefore we have no evidence that the intercepts are different from zero. Finally, the slopes for the two seasons were not different ($T = 1.57$, df = 8, $p = 0.16$), which suggests that this is a constant-proportion index. The weighted slope estimate was 10.6 (95% confidence interval: 8.9 - 12.3) (**Fig. 1**).

The application of this index to estimate absolute numbers should be restricted to the conditions under which it was calibrated (Eberhardt and Simmons, 1987). We tested the index only in summer and fall, and studies evaluating counts of deer pellets as indices of abundance have found seasonal differences in the numbers of pellets produced (Dzieciolowski, 1976). We believe that seasonal variation in numbers of pellets produced should not greatly affect our index, because we are counting piles of pellets, rather than quantities of individual pellets. However, the index has not been tested for winter and spring, and behavioral differences of mountain vizcachas in the production and depositing of feces may vary among seasons.

The index should be used for mountain vizcachas only in areas where the habitat is in the form of low (<15-20 m high) linear cliffs with a vertical face, resulting in feces being concentrated near the edge of the cliff. There were two other cliffs in our area with vertical faces, but which have sections that are very high (>25 m), providing many sunning spots that are not visible from the top of the cliff. At those sites the index provided an estimate much lower than the number of mountain vizcachas known to inhabit those sites. Also, the method could not be used at some sites in our study area where the top edge of the cliff was not distinct, and we could not determine where to walk the transect. In other areas, mountain vizcachas may live in talus slopes and other rock formations with crevices, and the method cannot be used in those types of habitat either. However, the index is potentially valid for a large proportion of mountain vizcacha habitat in Patagonia, as vertical cliffs on the edge of plateaus are widespread throughout the Patagonian steppe.

If the index is used outside of the study area, it should be used as an index of relative abundance rather than to estimate absolute numbers (Mallick et al., 1997). Its use outside the study area implicitly involves the assumption

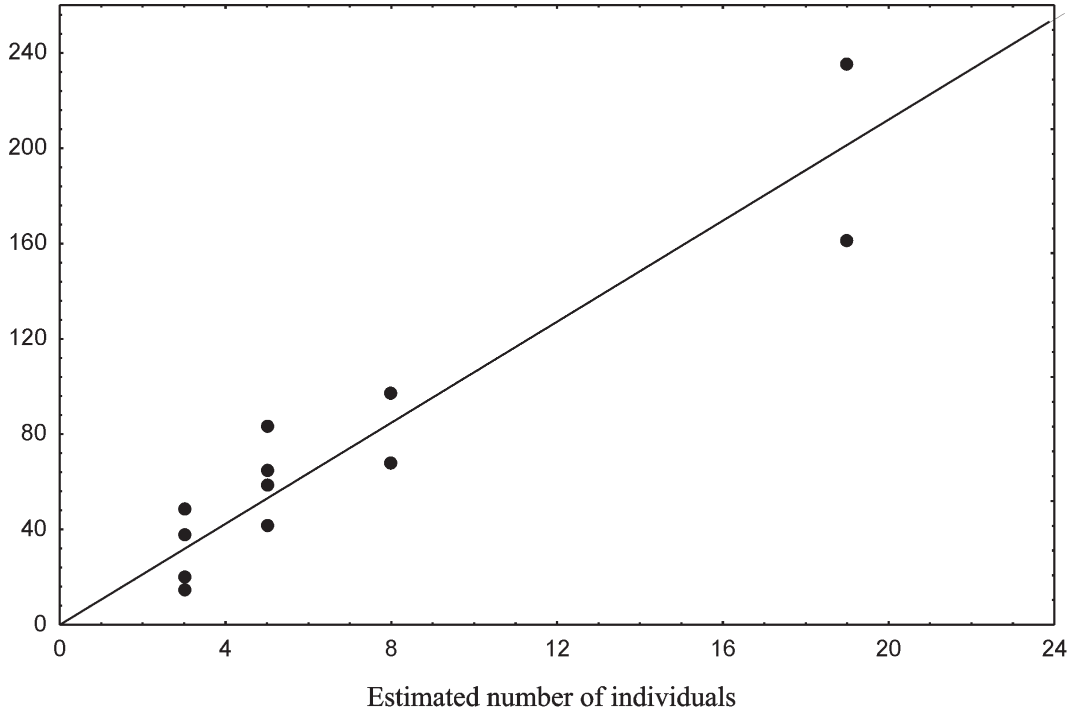

Fig. 1. Regression line for summer and fall pellet counts combined, with intercept through zero. Weighted slope estimate is 10.6 (95% confidence limits 8.9-12.3).

that local conditions do not affect the relationship between number of fresh fecal piles and number of mountain vizcachas that we found in this study. Behavioral differences among populations of mountain vizcachas could have a strong impact on the functioning of the index, though, so whenever possible, calibration should be attempted within the area where the index is to be used. Without a validation study done locally, this assumption is untested, and results must be interpreted with caution.

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