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## Activity patterns of *Tayra Eira barbara* populations from Costa Rica and Colombia: evidence of seasonal effects

### Patrones de actividad de poblaciones de la *Tayra Eira barbara* en Costa Rica y Colombia: evidencia de efectos estacionales

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#### Abstract

**Objective:** The objective of this study was to evaluate the activity patterns of *Tayra Eira barbara* and the effect of seasonality in two different landscapes, one in Colombia (Canal del Dique Watershed) and another in Costa Rica (Talamanca). **Methodology:** Between 2005 and 2009 camera trapping samplings were conducted to determine activity patterns of the species. We estimated capture frequencies, activity patterns, and made comparisons between sites and seasons, classifying data in 24-hours and in time-periods: Diurnal, Nocturnal and Crepuscular. Comparisons were made using Kuiper tests for homogeneity, Chi-square for differences in patterns and Chao-Jaccard tests for testing overlapping activities. **Results:** Differences between activity periods ( $X^2=124.26$ ,  $p<0.0001$ ) and hours ( $X^2=46.38$ ,  $p=0.0001$ ) were found, with three activity peaks during the day, being this period in which the species is more active in general ( $X^2=124.26$ ,  $p<0.0001$ ). Seasonality seems to be the most important factor influencing activity patterns ( $X^2=14.15$ ,  $p=0.0002$ ), especially influencing the hours of higher activity ( $X^2=12.42$ ,  $p=0.0033$ ). **Conclusions:** Activity patterns in Tayras seem to slightly vary both in space and time, with seasonality been the most evident driver. Our results coincide with previous studies in similar habitats, but differ with other locations with different ecosystems, highlighting variation within the species and potentially related with different subspecies. The evaluation and identification of basic aspects of natural history of *E. barbara* are necessary for a better understanding of the species ecology, life history, habitat requirements and their role in ecosystems.

**Keywords:** Canal del Dique, Capture frequency, Carnivores, Circadian Rythms, Talamanca.

#### Resumen

**Objetivo:** El objetivos del presente estudio fue evaluar los patrones de actividad de la *Tayra Eira barbara* y el efecto de la estacionalidad en dos paisajes diferentes, uno en Colombia (Canal del Dique) y uno en Costa Rica (Talamanca). **Metodología:** Entre el 2005 y el 2009 se realizaron muestreos con cámaras-trampa para determinar las horas de actividad de la especie. Estimamos frecuencias de captura y patrones de actividad y estos fueron comparados entre sitios y estaciones, clasificando los datos en las 24 horas y según periodos: Diurno, Nocturno y Crepuscular. Las comparaciones se realizaron mediante pruebas de Kuiper de homogeneidad, Chi-cuadrado para las diferencias en los patrones y pruebas Chao-Jaccard para evaluar la sobreposición. **Resultados:** Se encontraron diferencias entre los períodos de actividad ( $X^2=124.26$ ,  $p<0.0001$ ) y las horas ( $X^2=46.38$ ,  $p=0.0001$ ), mostrando tres picos de actividad durante el día, siendo este periodo durante el cual la especie está más activa en general ( $X^2=124.26$ ,  $p<0.0001$ ). La estacionalidad parece ser el factor más importante afectando los patrones de actividad de la especie ( $X^2=14.15$ ,  $p=0.0002$ ), especialmente influenciando las horas de mayor actividad ( $X^2=12.42$ ,  $p=0.0033$ ). **Conclusiones:** Los patrones de actividad en Tayras parecen variar levemente tanto en el espacio como el tiempo, con la estacionalidad sido el conductor más evidente. Nuestros resultados coinciden con estudios previos en hábitats similares, pero difieren en otras localidades con diferentes ecosistemas, destacando la variación dentro de las especie y potencialmente relacionados con diferentes subspecies. Evaluar

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e identificar los aspectos básicos de la historia natural de *E. barbara* son necesarios para entender la ecología, historia de vida, los requerimientos de hábitat y el papel que cumple la especie dentro de los ecosistemas.

**Palabras clave:** Canal del Dique, Carnívoros, Frecuencias de Captura, Ritmo circadiano, Talamanca.

## Introduction

Activity patterns are important characteristics of the natural history of a species, and represent an important input for understanding species ecology and their role in ecosystems (González-Maya *et al.* 2009, Vela-Vargas and Pérez-Torres 2012). Tayra (*Eira barbara*) is a small carnivore species distributed from central Mexico to southern Brazil and northern Argentina, and includes seven sub-species (Presley 2000), with *E. b. sinuensis* distributed from Costa Rica to Colombia (Presley 2000). The species is considered as Least Concern with decreasing populations by the IUCN Red List of Threatened Species across its distribution (Cuarón *et al.* 2008).

Tayra has been historically understudied in general, with scarce field studies in few locations within its distribution, and most of the existing information has been obtained as “by-catch” from samplings aimed at more charismatic species (González-Maya *et al.* 2011). In general, there is a lack of information regarding several aspects of the species ecology and natural history (González-Maya *et al.* 2009, Presley 2000), being difficult to assess with certainty the conservation status of the species, and understand its biology and ecology (Cuarón *et al.* 2008, Tewksbury *et al.* 2014, Valenzuela 1998).

This scarcity of ecological information has complicated understanding the species role in conserved and disturbed ecosystems or their response to human intervention. Previous studies have suggested Tayras to tolerate certain degrees of human intervention (Cuarón *et al.* 2008) and thus, it could potentially play a role on meso-carnivore release processes (González-Maya *et al.* 2011); thereof, Tayras could play a key role in ecosystems where there is no presence of larger predators, controlling populations of small and medium mammals (Camargo and Ferrari 2007, Lindenmayer 1999), however, the trophic dynamics under these scenarios are still mostly unknown.

Here we present the first comparative study on

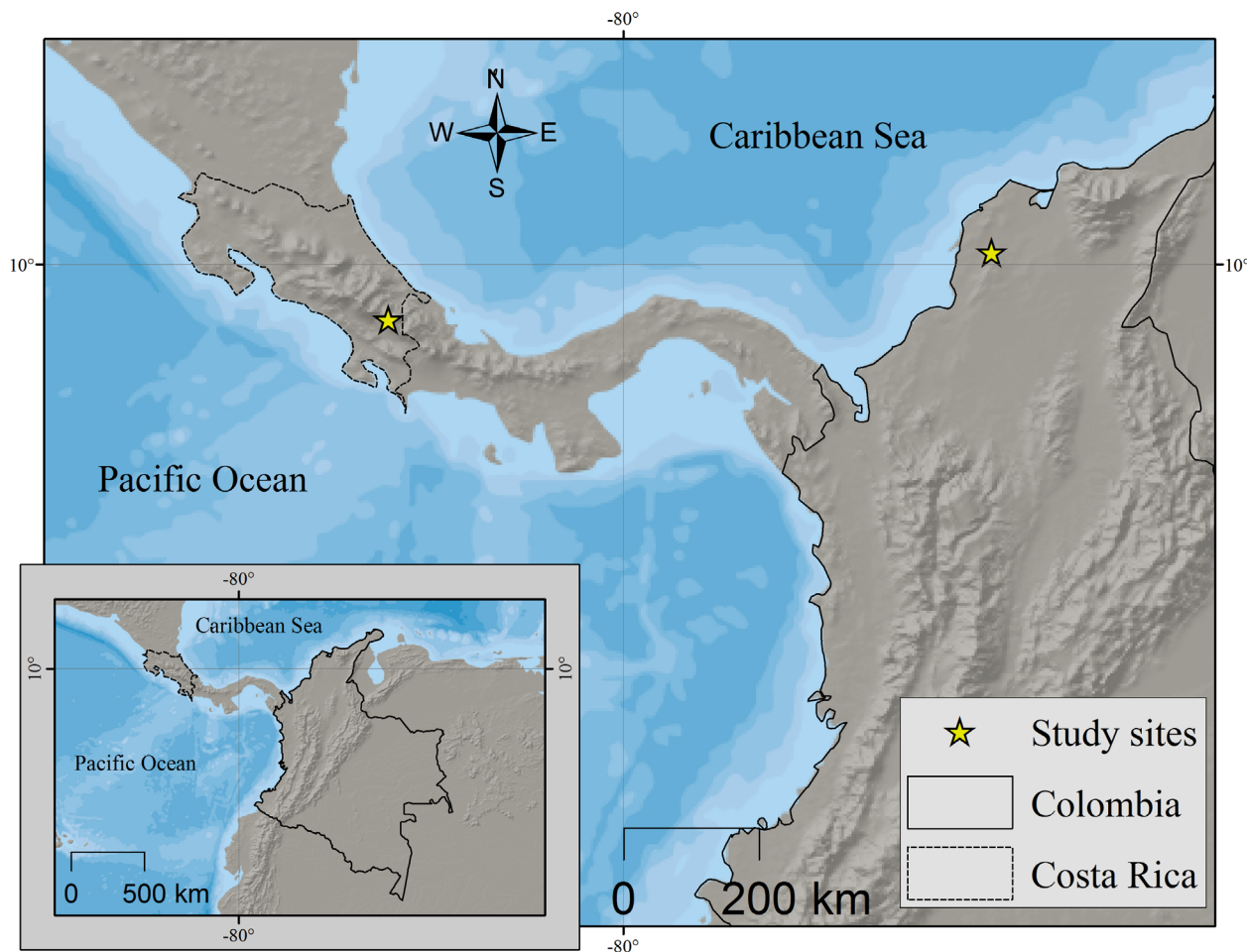
activity patterns for Tayra in Costa Rica and Colombia, specifically addressing geographic variation and the effect of seasonality over these patterns.

## Methodology

**Study area.** The present study was conducted in two areas, one in Colombia and another in Costa Rica (Figure 1), both with different landscapes configuration and characteristics, but sharing the same Tayra sub-species.

Talamanca region is located in southern Costa Rica and is shared with Panama. It represents the most representative forest patch, and includes the largest protected area (La Amistad National Park) in the country. The region is traditionally divided in two slopes of the Cordillera de Talamanca, Caribbean (0-3600m asl) and Pacific (1,000-3600m asl) slopes, and is located from 8°37' - 9°38' N and 82°24' - 83°25' W. Precipitation ranges from 2000 to 5000 mm annually with a mean rainfall of 3500 mm; a bi-seasonal weather occurs in the area with a dry season from November/December to March/April and a rainy season from April/May through October/November for the Pacific (González-Maya *et al.* 2013a), and almost permanent rainy season on the Caribbean with small dry seasons in March-April and September-October (Schipper 2010). The mean temperature is 27°C and a relative humidity between 70% and 90%, during most of the year (United Nations Environmental Programme/World Conservation Monitoring 2011).

The Canal del Dique basin is located in northern Colombia, on the Caribbean coast near Cartagena city. This region has been historically used for cattle and cropping and the remnant natural vegetation is scarce and fragmented and embedded in a matrix of intensive agricultural use (Conservación Internacional Colombia and Fundación Herencia Ambiental Caribe 2010); it ranges between 0 and 700 m asl and includes two protected areas and a matrix of pastures, crops and forest remnants (Conservación Internacional Colombia and Fundación Herencia Ambiental Caribe 2010). The mean annual precipitation is around 1236 mm with a rainy season from May through November and a dry season between December and April. The mean annual temperature ranges from 27.2°C to 28.3°C and the relative humidity from 79% to 84%, with the maximum in 90% and the minimum



**Figure 1.** Location of study sites in Colombia and Costa Rica for the estimation of activity patterns of *Eira barbara*.

in 68% (Conservación Internacional Colombia and Fundación Herencia Ambiental Caribe 2010).

**Methods.** We evaluated the activity patterns derived from camera-trapping samplings in both areas through 12 sampling events and 324 camera stations. The sampling included 11 samplings for Talamanca from 2005 through 2009 and one for Colombia in 2009. Most of the effort was concentrated in Finca Las Alturas located in Las Tablas Protected Zone on the Pacific slopes (González-Maya and Mata-Lorenzen 2008), and in the Corredor Biológico Talamanca-Caribe in the Caribbean slopes of Talamanca (Schipper 2010). The surveys were established with different purposes, in Costa Rica as part of ProCAT International continuous work in the region to evaluate conservation status and assessment of species for conservation planning. In Colombia as part of the projects of the Plan de Conservación de Felinos para

el Caribe Colombiano (Colombian Caribbean Felids Conservation Plan) a joint initiative from several national institutions to preserve felid species and prey in the Caribbean region of the country (Castaño-Uribe et al. 2013).

Cameras were settled across the landscapes to be active in the field for a minimum of one month and a maximum of three months, using a standard delay of one minute. Some stations included two cameras to acquire images of both sides of the animal, however, such events were considered as one capture (González-Maya et al. 2009). All the stations were established in order to maximize capture probabilities; each area was surveyed to define the best probable sites for camera trapping, sometimes using human and animal trails, and also with the support from local communities' knowledge (Chávez et al. 2013). Each camera was set 30 to 60 cm above ground

on standing trees looking towards the selected sites, taking special caution to protect cameras from direct sunlight, flooding and even delinquency.

**Data analysis.** Every Tayra capture was considered an independent event and was summed for the total count; consecutive captures in 1h-periods were considered as one capture. We estimated capture frequencies by dividing the number of photos per sampling efforts and were organized in 1-hour discrete periods, and the capture histories were organized in periods following van Schaik and Grigffiths (1996) and González-Maya *et al.* (2009) in nocturnal (18h00-05h00), diurnal (06h00-17h00) and crepuscular (17h00-18h00 and 05h00-06h00h) activity periods. Capture frequencies, as proportions, were plotted across a complete day cycle (24h) to explore the activity patterns, and capture frequencies to determine the highest capture rates for each sampling. Kuiper tests (*K*) were used to assess if distribution of captures was homogenous across the 24-hour day periods for the overall dataset for each country and season (Vela-Vargas and Pérez-Torres 2012). Chi-square tests and contingency tables were used to test for significant differences among countries, periods, seasons and hours and we used Chao-Jaccard index to determine time overlap (Chao *et al.* 2004), as previously used for these type of analyses (González-Maya *et al.* 2009). All analyses were performed in language R (R Team Development Core 2008).

## Results

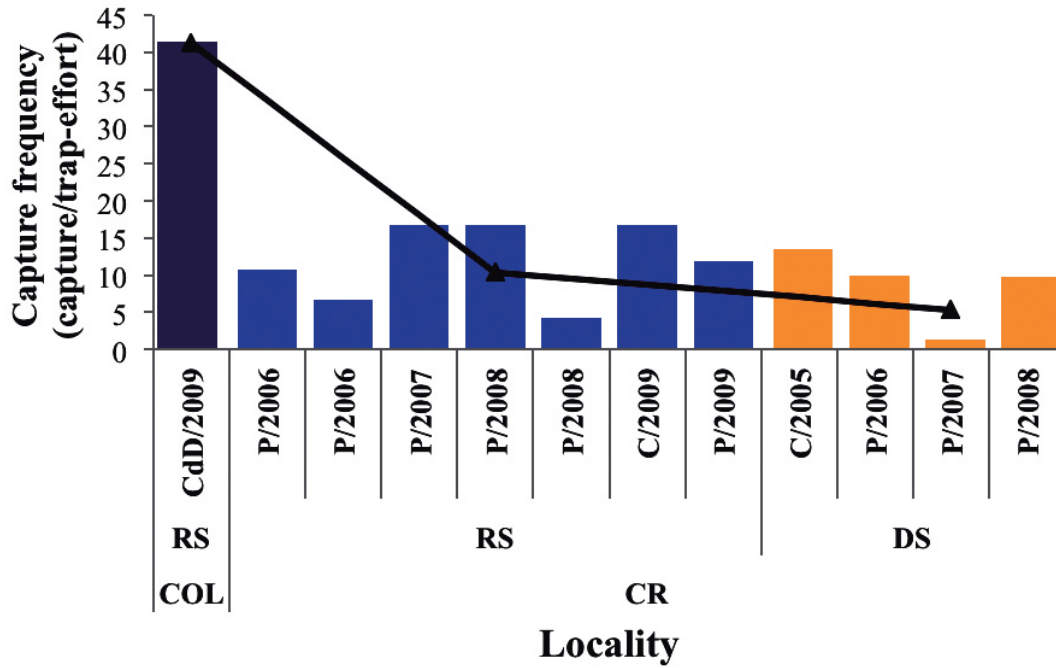
A total of 324 camera stations were used in 12 samplings for a total of 8602 trap-days sampling effort (Table1). For Costa Rica, 289 camera stations were used, with a mean ( $\pm$ SD) of 26.2 $\pm$ 35.2 cameras per sampling, and 35 stations were used for Colombia (Table1).

A total of 94 Tayra captures were obtained with 77 for Costa Rica and 17 for Colombia. Tayras were captured in 35 locations in Talamanca and in 6 locations in Canal del Dique, being the Talamanca Caribbean sampling the one with the highest number of captures, but Colombia the one with the highest frequency of the entire study (Figure 2). For Talamanca, three samplings showed the highest capture frequencies, two in the Pacific and one in the Caribbean, all of them in the rainy season and in three different years, and the lowest was the dry season sampling of the Pacific during 2007. When comparing the seasonality, the total capture frequencies for the entire study and for the Costa Rica portion showed a higher capture frequency for the rainy season ( $p=0.0025$  and  $0.001$ , respectively).

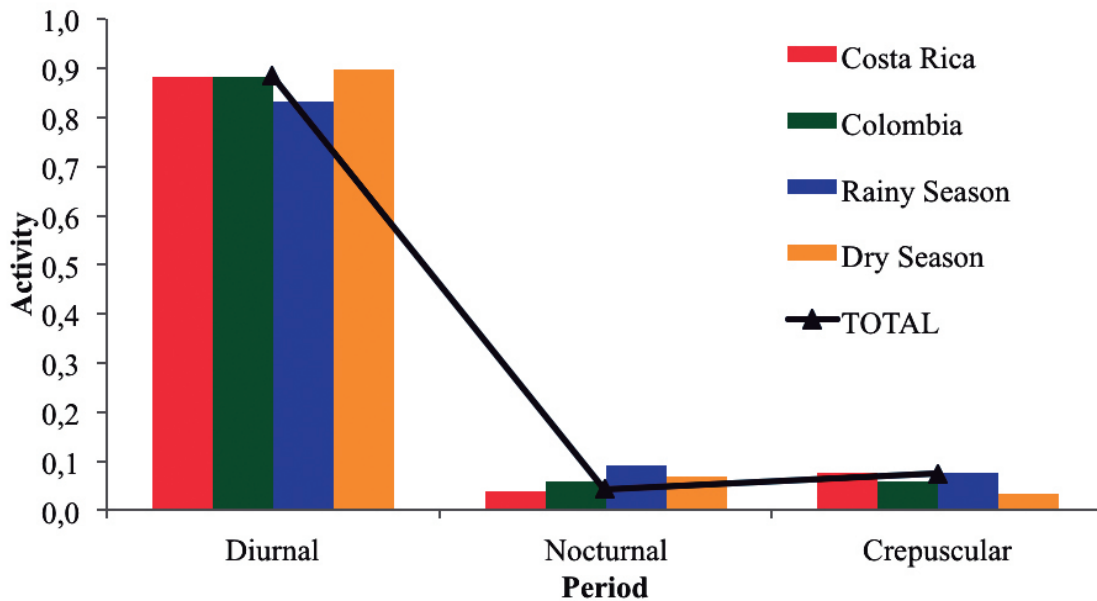
Activity patterns showed a heterogeneous distribution along the 24-hour day periods for the

**Table 1.** Sampling locations for *Eira barbara* detections classified by country, season, location and year in Colombia and Costa Rica

Country	Season	Location	Year	Total N° of stations	Trapping effort	N° stations w/Tayra	Total captures
Colombia	Rainy	Canal del Dique	2009	35	411	6	17
		Pacific	2006	10	600	2	6
	Dry	Pacific	2007	32	1440	2	2
		Pacific	2008	24	720	2	7
		Caribbean	2005	130	1696	18	23
Costa Rica	Rainy	Pacific	2006	10	600	1	4
		Pacific	2006	14	840	3	9
		Pacific	2007	10	300	1	5
		Pacific	2008	24	720	1	3
		Caribbean	2009	10	300	1	5
		Pacific	2009	15	675	2	8
<b>Total</b>				<b>324</b>	<b>8602</b>	<b>41</b>	<b>94</b>



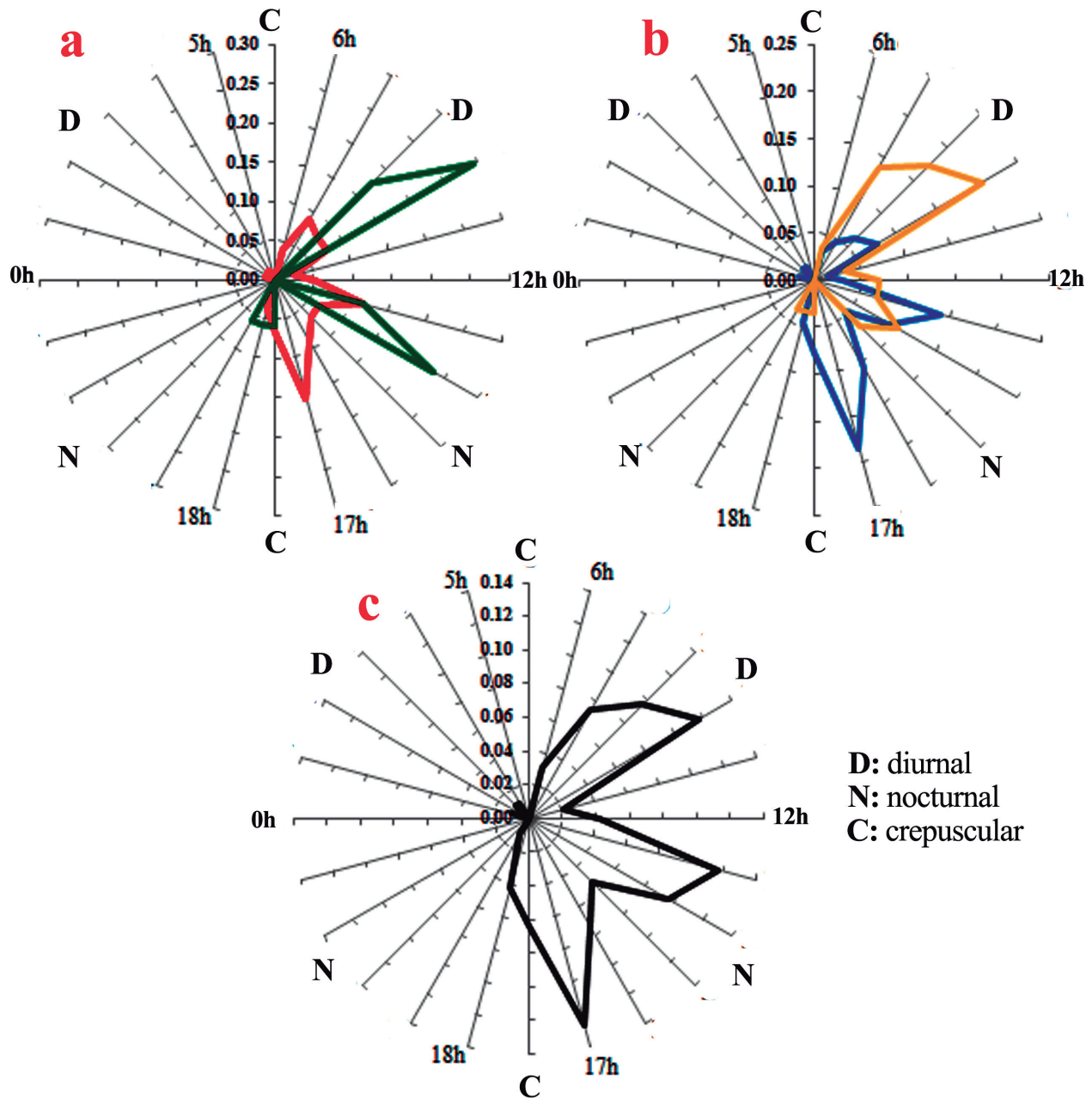
**Figure 2.** *Eira barbara* capture frequencies classified per country (COL: Colombia, CR: Costa Rica), Season (RS: Rainy Season, DS: Dry Season), locality (CdD: Canal del Dique, C: Caribbean slope, P: Pacific Slope) and year.



**Figure 3.** Activity patterns (frequency of captures) for *Eira barbara* according to time-period in Costa Rica and Colombia and by season; the black line indicates totals for each time-period.

entire study ( $K=99.02$ ,  $p<0.001$ ), for Colombia and Costa Rica ( $K=70.47$ ,  $p<0.001$  and  $K=74.55$ ,  $p<0.001$ , respectively) and for both rainy and dry seasons ( $K=69.96$ ,  $p<0.001$  and  $K=62.30$ ,  $p<0.001$ , respectively). *Tayras* showed a predominant diurnal activity with respect to nocturnal

and crepuscular activities for the entire dataset ( $X^2=124.26$ ,  $p<0.0001$ ; Figure 3). In the two countries the species showed a highly similar pattern with diurnal activities being predominant both in observations (88%), and significantly in frequency (Colombia:  $X^2= 22.27$ ,  $p<0.0001$ ;



**Figure 4.** Activity patterns of *Eira barbara* in study sites from (a) Colombia (green) and Costa Rica (red), (b) during Rainy (blue) and Dry (yellow) seasons and (c) for the entire study (black).

Costa Rica:  $X^2= 102.19$ ,  $p<0.0001$ ).

For the Canal del Dique area, morning hours (8h00-9h00) represented the highest peak of activity of the species, followed by noon (12h00-13h00), while for Talamanca, mid-afternoon hours (15h00-16h00) was the main peak followed

by before-noon hours (11h00-12h00). For all sites, three peaks of activity were notorious: 8h00 to 9h00, 11h00 to 12h00 and 15h00 to 16h00, following the same pattern of the independent country sites (Figure 4). Significant differences were found among the activities per hour for both

countries ( $X^2=46.38$ ,  $p=0.0001$ ) and for Colombia ( $X^2=30.04$ ,  $p=0.0118$ ) but not for Costa Rica ( $X^2=6.38$ ,  $p=0.3819$ ). The Chao-Jaccard index estimated an overlapping between activities patterns of 0.685 (68.5%) between countries, and a mean ( $\pm$ SD) of  $75.6\% \pm 11.6\%$  along sites, with overall higher similarity between sites in Costa Rica ( $87.6\% \pm 7.6\%$ ) than in Colombia ( $77.35\% \pm 8.6\%$ ).

Comparing activity patterns among seasons, we found significant differences for all periods in all sites ( $X^2=14.15$ ,  $p=0.0002$ ), and for both seasons along day-hours ( $X^2=28.42$ ,  $p=0.0281$ ) with overall higher significant mid-day and afternoon (17h00) activity during rainy seasons ( $X^2=34.30$ ,  $p=0.0031$ ) and mid-morning (10h00) during the dry seasons ( $X^2=12.42$ ,  $p=0.0033$ ; Figure 4).

## Discussion

Tayras are among the most widespread and yet least known carnivore species in the tropics (Cuarón *et al.* 2008, Emmons and Feer 1999), with very scarce information regarding the most basic aspects of its ecology and natural history. Despite Tayras are commonly recorded in camera-traps in most tropical countries, and it is in general considered common (Cuarón *et al.* 2008), for our study sites is not as frequently recorded, with a relatively low number of detections despite a large trapping-effort. From the few details that can be derived from our study in terms of capture frequency, it seems Tayras are more commonly detected during rainy season but in few stations, which could indicate is not as common or widespread across habitats, or just supports the idea of Tayra as an elusive species or avoiding certain areas. However, even with a large sampling effort, camera specific locations can exert an important influence on the detection of the species.

According to frequency of captures, Tayras in both landscapes (i.e., Costa Rica and Colombia) showed similar patterns across sites with slight differences despite the heterogeneous landscapes analyzed. For Talamanca, Tayra represents a small carnivore under the dominance of big predators such as jaguar and puma, overlapping only on 45% of

the time with jaguars (González-Maya *et al.* 2012), probably for predatory evasion, while in Canal del Dique, Tayra is one of the predominant predator species due to the low abundance and potential absence of top large predators (González-Maya *et al.* 2011, González-Maya *et al.* 2013b, González-Maya *et al.* 2013c); it is possible that for Canal del Dique there is some “plasticity” for the selection of activity-hours derived from the absence of dominant predators and suggested by the relatively higher concentrated detections found in Talamanca. The activity hours found can also be related with the availability of food or by seasonality, as found, and therefore by the consequent climatic constraints and variation.

Previous studies have suggested the species as crepuscular in unrelated ecosystems of Belize (Konecny 1989), in other areas of Colombia (Delgado-V *et al.* 2011) and nearby human settlements (Calderón-Capote *et al.* 2015), and mostly diurnal in similar ecosystems in Costa Rica (González-Maya *et al.* 2009), which in our study seems to coincide, with low activity during crepuscular hours and mostly active during the day. However, the specific hours during the day significantly vary according to season. The intraspecific variation in activity periods for the species across its distribution seem to highlight the effect of ecosystem types, human intervention and presence of top predators, and could potentially reflect variation at subspecific levels, such as *E. b. senex* in Belize. Diurnal activities are more frequent for Tayra probably because the easiness of foraging during day hours since the species is considered mainly omnivorous (Cuarón *et al.* 2008). However, Delgado-V *et al.* (2011) found an important peak of activity of Tayra in crepuscular periods in a fragmented forest in Colombia, suggesting that other factors may be influencing their activity patterns; further research should be done to understand these differences.

The strong effect of seasonality over Tayra activity patterns is an interesting finding, and is probably related with forest phenology and the consequent availability of food resources across habitats. Also, water sources can become scarce during dry seasons, therefore affecting space use, thus, ecosystems with more dramatic seasonality would likely reflect also considerable variation in these patterns. Activity patterns assessments in more localities and with larger seasonality variations would allow to draw better



inferences regarding Tayra activities according to ecosystem, season and potentially more direct ecological drivers such as food availability and interspecific competition.

Activity periods for the species has been pointed as one of the main reasons for low inter-specific competition with other carnivores (Sunquist *et al.* 1989), so the results herein included can be a useful input for carnivore guild analyses in tropical ecosystems, and as a base to understand sympatry and interactions of small carnivore communities in the tropics (González-Maya *et al.* 2009). Furthermore, our results helps to understand better daily activities patterns of Tayras providing basic data for expanding our knowledge on the natural history of the species (Delgado-V *et al.* 2011) and potentially as the basis for further research into the role of small carnivores in tropical ecosystems, and their potential effect as a mesocarnivore, among other related questions both in ecology and conservation.

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### Literature cited

- Calderón-Capote MC, Rojas-Rojas AV, Cárdenas González C, Pardo-Martínez A. 2015. Familia Mustelidae. pp. 110-35. In: Suárez-Castro AF, Ramírez-Chaves HE (eds.). *Los carnívoros terrestres y semiacuáticos continentales de Colombia. Guía de Campo*. Bogotá: Universidad Nacional de Colombia.
- Camargo CC, Ferrari SF. 2007. Interactions between tayras (*Eira barbara*) and red-handed howlers (*Alouatta belzebul*) in eastern Amazonia. *Primates*. 48: 147-50.
- Castaño-Uribe C, González-Maya JF, Zárrate-Charry DA, Ange-Jaramillo C, Vela-Vargas IM. 2013. *Plan de Conservación de Felinos del Caribe Colombiano: Los felinos y su papel en la planificación regional integral basada en especies clave*. Santa Marta: Fundación Herencia Ambiental Caribe, ProCAT Colombia, The Sierra to Sea Institute. 232 pp.
- Conservación Internacional Colombia and Fundación Herencia Ambiental Caribe. 2010. *Estrategia regional de conservación de bosque seco y manglar; hábitat del jaguar y el puma en la cuenca del Canal del Dique y el Caribe*. Cartagena: Conservación Internacional Colombia, Fundación Herencia Ambiental Caribe. 185 pp.
- Cuarón AD, Reid F, Helgen KM. *Eira barbara*. (Online) 2008 (Accessed June 15). *The IUCN Red List of Threatened Species*. International Union for Conservation of Nature and Natural Resources. URL <http://www.iucnredlist.org>
- Chao A, Chazdon RL, Colwell RK, Shen T-J. 2004. A new statistical approach for assessing similarity of species composition with incidence and abundance data. *Ecol. Lett.* 8: 148-59.
- Chávez C, De la Torre A, Bárcenas H, Medellín RA, Zarza H, Ceballos G. 2013. *Manual de fototrampeo para estudio de fauna silvestre. El jaguar en México como estudio de caso*. México DF: Alianza WWF-Telcel, Universidad Nacional Autónoma de México. 108 pp.
- Delgado-V CA, Arias Alzate A, Botero S, Sánchez-Londoño JD. 2011. Behaviour of the Tayra *Eira barbara* near Medellín, Colombia: preliminary data from a video-capturing survey. *Small Carniv Conservat.* 44: 19-21.
- Emmons LH, Feer F. 1999. *Neotropical Rainforest Mammals: A Field Guide*. Chicago: The University of Chicago Press. 320 pp.
- González-Maya J, Schipper J, Hoepker A. 2013a. Talamancan montane forests. pp. 1203-5. In: Howarth R (ed.). *Biomes and ecosystems: an encyclopedia*. Ipswich: Salem Press.
- González-Maya JF, Cepeda AA, Belant JL, Zárrate-Charry DA, Balaguera-Reina SA, Rodríguez-Bolaños A. 2011. Research priorities for the small carnivores of Colombia. *Small Carniv Conservat.* 44: 7-13.
- González-Maya JF, Mata-Lorenzen J. 2008. Dung-beetles (Coleoptera: Scarabaeidae) from the Zona Protectora Las Tablas, Costa Rica. *Checklist*. 4: 458-63.
- González-Maya JF, Romero-Rendón JF, Zárrate-Charry DA, Castaño-Uribe C, González M, Viquez-R LR, *et al.* 2013b. Evaluación geográfica y prioridades de conservación de hábitat para felinos en el Caribe colombiano. pp. 77-87. In: Castaño-Uribe C, González-Maya JF, Zárrate-Charry DA, Ange-Jaramillo C, Vela-Vargas IM (eds.). *Plan de Conservación de Felinos del Caribe Colombiano: Los felinos y su papel en la planificación regional integral basada en especies clave*. Santa Marta: Fundación Herencia Ambiental Caribe, ProCAT Colombia, The Sierra to Sea Institute .
- González-Maya JF, Schipper J, Benítez A. 2009. Activity patterns and community ecology of small carnivores in the Talamancan region, Costa Rica. *Small Carniv Conservat.* 41: 9-14.
- González-Maya JF, Schipper J, Finegan B. 2012. *Ecología y conservación del Jaguar en Talamancan, Costa Rica: he-*

- rramientas de planificación a escala regional*. Saarbrücken: Editorial Académica Española.
- González-Maya JF, Zárrate-Charry DA, Cepeda AA, Pineda-Guerrero A, Vela-Vargas IM, González M, et al. 2013c. Ecología y conservación de felinos y presas en el Caribe colombiano. pp. 95-104. In: Castaño-Uribe C, González-Maya JF, Zárrate-Charry DA, Ange-Jaramillo C, Vela-Vargas IM (eds.). *Plan de Conservación de Felinos del Caribe Colombiano: Los felinos y su papel en la planificación regional integral basada en especies clave*. Santa Marta: Fundación Herencia Ambiental Caribe, ProCAT Colombia, The Sierra to Sea Institute .
- Konecny MJ. 1989. Movement patterns and food habits of four sympatric carnivore species in Belize, Central America. pp. 243-64. In: Redford KH, Eisenberg JF (eds.). *Advances in neotropical mammalogy*. Gainesville: Sandhill Crane Press.
- Lindenmayer DB. 1999. Future directions for biodiversity conservation in managed forests: indicator species, impact studies and monitoring programs. *Forest Ecol Manag.* 115: 227-87.
- Presley SJ. 2000. *Eira barbara*. *Mammalian Spec.* 636: 1-6.
- R Team Development Core. 2008. *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.
- Schipper J. 2010. *Mammal diversity, threats and knowledge across spatial scales*. PhD thesis. Moscow: University of Idaho-CATIE. 202 pp.
- Sunquist ME, Sunquist F, Daneke DE. 1989. Ecological separation in a Venezuelan llanos carnivore community. pp. 197-232. In: Redford KH, Eisenberg JF (eds.). *Advances in neotropical mammalogy*. Gainesville: Sandhill Crane Press.
- Tewksbury JJ, Anderson JGT, Bakker JD, Billo TJ, Dunwiddie PW, Groom MJ, et al. 2014. Natural History's Place in Science and Society. *BioScience.* 64: 300-10.
- United Nations Environmental Programme/World Conservation Monitoring, C. 2011. Talamanca Range-La Amistad Reserves / La Amistad National Park, Costa Rica and Panama. Ciudad?: United Nations Environmental Programme. 9 pp.
- Valenzuela D. 1998. Natural history of the White-Nosed Coati, *Nasua narica*, in a Tropical Dry Forest of western Mexico. *Rev Mex Mastozool.* 3: 26-44.
- van Schaik CP, Grigffiths M. 1996. Activity periods of Indonesian Rain Forest mammals. *Biotropica.* 28: 105-12.
- Vela-Vargas IM, Pérez-Torres J. 2012. Murciélagos asociados a remanentes de bosque seco tropical en un sistema de ganadería extensiva (Colombia). *Chiroptera Neotrop.* 18: 1089-100.