Supplementary material

File S1. Complementary description of data manipulation for interaction model generation

Activity and foraging strata

Activity period and foraging strata data are from EltonTraits database [1], and are generated from previously published data where the foraging strata is obtained through the standardization of descriptions about the use of the different strata by the species to then define in percentage terms the foraging category of which they make the most use, while for the activity period a classification of the activity is made into diurnal, nocturnal, and crepuscular and, according to the literature, it is established in a binary way if the species is active (1) or not (0) in a certain time period. In the case of the activity period, species data were presence-absence variables separated as diurnal, crepuscular and nocturnal in the original database [1]. Therefore, to use these variables as a single filter reflecting the period of temporal coincidence of the species, we decided to recategorize these variables to a single factor of six levels depending on the time period (categories) used by each species. Species active all the daytime were classified as "All", those active during the day but not at night or at twilight as "diurnal", those active at night but not during the day or twilight as "nocturnal", those active during twilight but not during the day or night as "crepuscular", those active during the day and twilight but not at night as "DC" and those active at night and twilight but not during the day as "NC "

Food web niche model

Food webs are hierarchical systems where larger species generally consume smaller ones [2-3]. The niche model of food webs considers this hierarchical property to predict the structure of food webs (e.g., generality, vulnerability) by using a single trait interval, namely body size, in which a species usually eats whatever species that is to the left of its position along the interval (i.e., smaller species) and is eaten by the species to the right of its position along the interval (i.e., larger species); in this way the smallest species has no prey and the largest one has no predators. For the above, we used body mass as a proxy of body size to represent the interval where predators and prey will be placed. We used body size as the niche interval mainly for three main reasons: i) felid species have hypercarnivory [4], where 80% or more of their diets is composed by meat mostly derived from mammals (e.g., [5]), ii) in terrestrial mammals the body size of predators is positively correlated with that of their prey, as well as with its trophic level [6-7], and iii) it has been observed that prey size influences the frequency of consumption of certain sizes of prey by some terrestrial predators such as the jaguar, which consumes most frequently medium and large sized preys than small ones (e.g., [8]).

Here, we apply the niche model interval to predict the structure of predator-prey interactions at the level of the felid species rather than at the community level as commonly done in food-web ecology (e.g., [9]). To do so, we defined the body size interval for each predator species by considering the body sizes of all prey species reported in the literature review for that predator species (i.e. observed interaction field). Then, with prey breadth and taking the minimum and maximum values of the observed prey of the focal species we defined the "Niche Model Interval" in a similar way as has been proposed in previous studies where a species can interact with each species that falls into their "Eltonian niche" [10].

Restricted niche model

Above, we defined the limits of the niche model (NM) interval assuming that the maximum and minimum prey sizes observed in the literature are the limits of the prey size interval for the predator. However, these values may be biased due to sampling errors and thus it is difficult to confirm if they represent (or not) the real prey size limits of a predator species

[11]. Moreover, the observed prey size interval consumed by a particular felid species can be misleading due to the opportunistic behavior of felid species (e.g., [12-13]). Therefore, we defined an additional prey size interval for a restricted niche model (RNM) in which we only considered the preferred prey size categories (prey-kinds) of each felid species. To do so, we first obtained a single standardized interval that reflected the entire morpho-space that could be divided into equal parts, without being biased by the global distribution of mammal body sizes [14]. We standardized the species' body size values with respect to the observed minimum and maximum body sizes in the regional set of potential prey (RSPP) defined previously. From these regional minimum and maximum body sizes, as well as the body size of each mammal species, we applied a min-max normalization to obtain the standardized body size value for each mammal species using the following equation [15]:

$$A_i = \frac{x_i - X_{min}}{X_{max} - X_{min}}$$

where A_i is the standardized body size value of the ith species, x_i is the body size value of the ith species, X_{min} and X_{max} represent, respectively, the body size of the largest and the smallest species of the RSP. This standardization allowed us to generate a single dimension, ranging from 0 to 1, that contained all mammal species that co-occur with at least one of our focal felid species. Each species is located according to its body size with respect to the largest and the smallest species of the RSP. Therefore, by re-scaling the values of each species based on the minimum and maximum observed in the RSP, we are able to generate a standardized interval that maintains the original variation and where all felid species are comparable to each other [15].

In addition, we defined the preferred prey for each felid species by classifying their prey species into different prey-kinds. For this, we used a statistical definition that allowed us to deal with problems associated with taxonomic classifications and thus objectively separating prey into different kinds [16]. First, we divided the RSPP body size interval into ten classes of the same amplitude (10%). That is, considering the standardized RSP size interval created above, the first prey-kind corresponds to those mammal species whose position is between 0 and 0.1, the second prey-kind corresponds to those between >0.1 and 0.2 and so on. The above generates ten prey-kinds of the same amplitude but composed of different number of species due to the distribution of mammal body sizes [14]. We defined the set of mammals that can be a potential prey for each felid species from the distribution maps and the interaction diversity field of each species; then, these species were classified according to their body size within one of the different prey-kind categories described above. Once these species were classified, a count was made to define the availability of each prey-kind within the distribution of each felid species. Furthermore, all the prey species reported in the literature that fall within? the entire distribution of each felid species were also classified according to their body size into the different prey-kinds, in this way we can define the use of each prey-kind for each felid species. From both values (i.e., availability and use), we calculated the standardized residuals of a chi-square test.

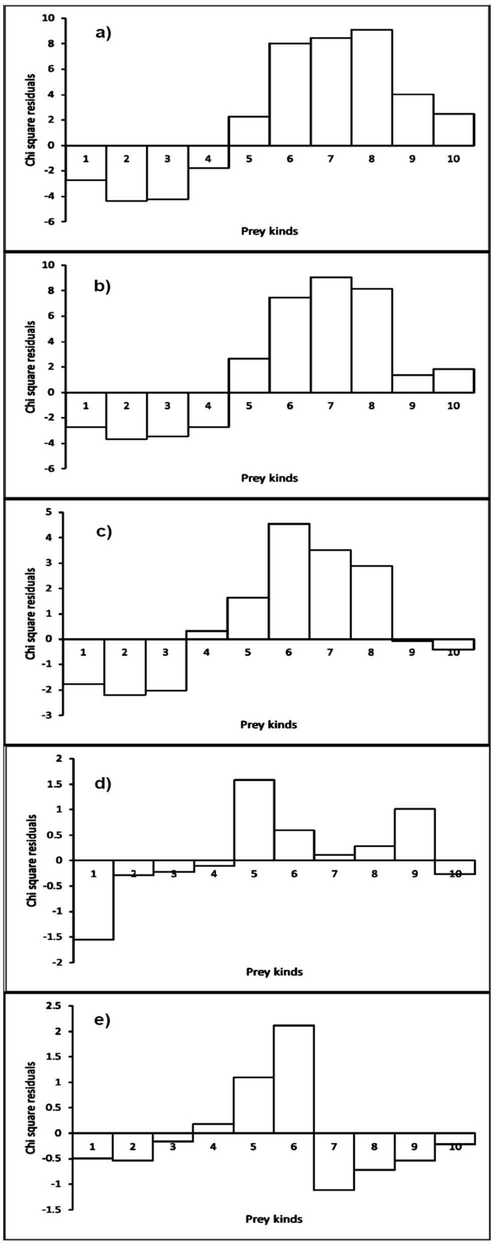
The standardized residuals of a chi-square test were calculated using the following formula [17]:

$$SR = \frac{O - E}{\sqrt{E}}$$

where the expected value (E) was the number of species present for each size category of the RSP within the range of the focal species, and the observed value (O) was the total number of species belonging to the same size category observed in the literature collection of the same species. Thus, positive residual values indicate that a size category is more often used by the analyzed felid species than what would be expected due to the availability of body sizes within its range. On the contrary, negative values indicate that a size category is less used by the felid species than would be expected from the availability of body sizes within its range. From these residuals, the largest and smallest prey-kinds with positive residuals were taken to define the minimum and maximum limits of the restricted prey size interval, assuming that everything that falls within the limits of the restricted interval would be consumed by the felid species.

File S2. Restricted niche model results.

Standardized residuals of the chi-squared test, where the numbers on the “x” axis represent the prey-kinds in ascending order, that is, 1 is the prey-kind with the smallest prey size and 10 the prey-kind for the largest prey size, while on the y axis the residuals of the chi-squared test are shown for the five species of cats ordered according to their decreasing body size where: a) jaguar, b) cougar, c) ocelot, d) jaguarundi and e) margay.


a)
b)
c)
d)
e)
Chi square residuals
Prey kinds
1
2
3
4
5
6
7
8
9
10

File S3. Predators species traits

Regarding the foraging strata, all predator species forage on the ground with the exception of the margay, which forages both at ground level and on trees (i.e., scansorial; Table S1). Regarding the activity period, the jaguar and the cougar are active all day (i.e., cathemeral), the ocelot has nocturnal activity, the jaguarundi presents diurnal-crepuscular activity and the margay nocturnal-crepuscular activity (Table S1). According to our literature review, prey-size intervals among the five predator species varied according to their body sizes. Large predator species (jaguar and cougar) showed broader intervals with larger prey-kinds being preferred, whereas medium predator species (ocelot and jaguarundi) consumed a wide range of prey sizes but preferred medium size prey-kinds and the smallest predator species (margay), showed the narrowest interval and preferred small preys (Table S1).

Table S1. Trait data used for constructing the interaction models for each of the five predator species information. NM and RNM report the feeding range intervals according to the Niche Model (NM) and the Restricted Niche Model (RNM), respectively.

Predator species	Activity	Foraging strata	NM		RNM	
			Min(g.)	Max(g.)	Min(g.)	Max(g.)
Margay(*Leopardus wiedii*)	Nocturnal crepuscular	Scansorial	6.7	3949.0	107.6	4375.8
Jaguarundi (*Herpailurus yagouaroundi*)	Diurnal crepuscular	Ground	7.4	75901.3	367.6	169496.6
Ocelot (*Leopardus pardalis*)	Nocturnal	Ground	4.8	75901.3	107.6	48144.9
Cougar (*Puma concolor*)	All day	Ground	24.5	461900.8	367.6	624577.1
Jaguar (*Panthera onca*)	All day	Ground	107.6	293781.6	367.6	624577.1

File S4 Predator-prey interaction properties

At the species-level and considering all the prey observed for each predator species in the literature review, the observed mean prey size (MPS) varied according to the body sizes of the predator species, where the largest MPS was that of the jaguar, followed by the cougar, the ocelot and the jaguarundi, and the lowest MPS being that of the margay (Table S2). Regarding the predator-prey ratio (PPR), the observed (reference) values were not close to unity for any predator species, with the lower values being that of the jaguarundi (PPR = 2.55, Table S2). We found that the PPR was larger (range: 4.16-5.73) for the largest and smallest predators 'species (i.e., jaguar, cougar and margay), whereas the predators of intermediate size (i.e., ocelot and jaguarundi) presented lower values (3.93 and 2.55 respectively).

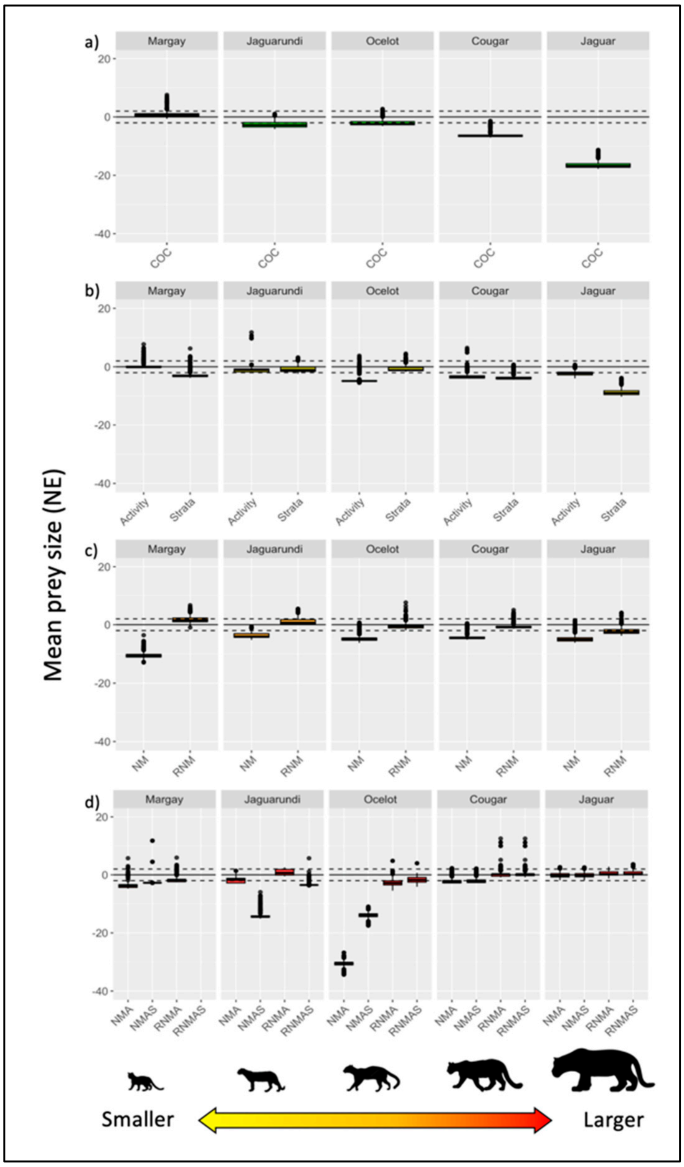
At the locality-level, predators' MPS showed a similar pattern to that at the species-level where the jaguar had the highest MPS, followed by the cougar, the ocelot, jaguarundi, and the margay with the lowest value. However, the medium and small sized predator species (ocelot, jaguarundi and margay) did not maintain this pattern in some localities and any of these three could be the one with the lowest or highest MPS at different localities (see table S2). PPR at the locality-level in general showed lower values for the two largest predators – jaguar and cougar –, and higher values in the ocelot, jaguarundi, and margay. PPR values of the larger predators were consistent across locations, whereas the ocelot, jaguarundi, and margay showed greater variability, having values close to unity in some locations and two orders of magnitude larger at other locations (see table S2).

Table S2. Mean Prey Size (MPS) and mean Predator Prey ratio (PPR) for each felid species and locality.

Author	Margay (n = 6)		Jaguarundi (n = 7)		Ocelot (n = 21)		Cougar (n = 9)		Jaguar (n = 5)	
	MPS	PPR	MPS	PPR	MPS	PPR	MPS	PPR	MPS	PPR
Abreu et al					2658.2	4.5				
Benitez			38.7	177.7	5565.9	2.1	24683.4	2.2		
Bianchi et al a	240.7	13.6	88.8	77.4	3768.8	3.2				
Bianchi et al b					18737.7	0.6				
Bianchi & Mendez					3988.6	3.0				
Booth-Binczik					5746.7	2.1				
Chinchilla					943.6	12.6	5438.7	9.9	11950.2	7.0
Ciocheti et al							20676.7	2.6		
De Villa-Meza					7641.3	1.6				
Emmons					5967.9	2.0			11889.9	7.1
Farrell					512.1	23.2	26279.7	2.1	35604.1	2.4
Gómez	1741.55	1.9	7102.9	1.0	1699.9	7.0	12130.5	4.4	15883.9	5.3
Konecny	116.3	28.1	256.8	26.8	3000.6	4.0				
Martins et al					2138.3	5.6	6083.4	8.9		
Menéndez et al					27586.7	0.4				
Moreno et al a					4775.1	2.5	5566.1	9.7		
Moreno et al b					2056.4	5.8				
Palacio					7750.7	1.5	9816.0	5.5	11437.6	7.3
Rinaldi	830.82	3.9	983.7	7.0						
Rocha et al			2596.4	2.6	1505.8	7.9				
Sánchez et al					1869.2	6.4				
Santos et al							4966.0	10.9		
Seibert et al	49.63	65.9								
Silva-Pereira et al			44.0	156.2	67.2	176.9				
Wang et al	867.23	3.8			2715.3	4.4				
Species mean*	637.9	5.13	2696.29	2.55	3026.55	3.93	12970.4	4.16	14650.44	5.73

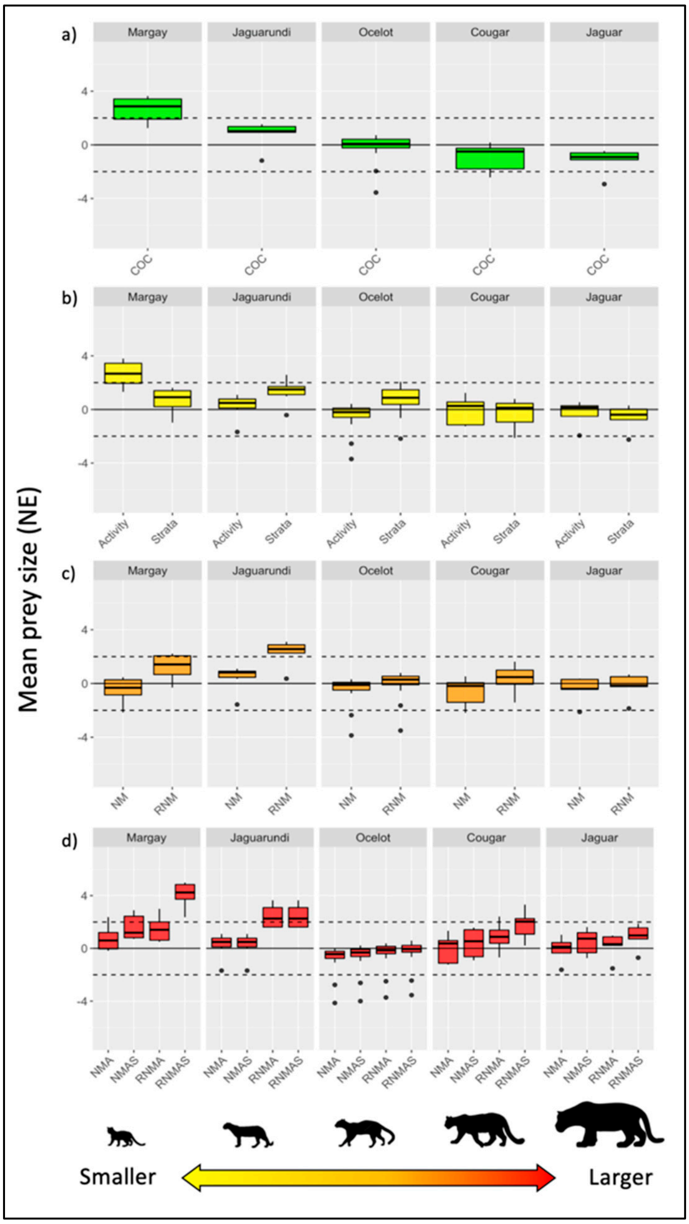
*Mean of all species in the literature review for that species

Figure S1: Normalized error (NE) of the mean prey size (MPS) for the nine models evaluated at the predator species-level for each predator species



Normalized error (NE) of the mean prey size (MPS) for the nine models evaluated at the predator species-level for each predator species, and the y-axis shows the normalized errors for a) co-ocurrence model, b) spatio-temporal models, c) body size models and d) saturated models. The upper horizontal dashed line indicates the reference value plus two standard deviations, while the lower horizontal dashed line indicates the reference value minus two standard deviations and the continuous horizontal line indicates the reference value. See Table 1 and methods for model definitions.

Figure S2: Normalized error (NE) of the mean prey size (MPS) for the nine models evaluated at the locality-level for each predator species



Normalized error (NE) of the mean prey size (MPS) for the nine models evaluated at the locality-level for each predator species where the x-axis shows the different predator species and models and the y-axis shows the normalized errors for a) co-occurrence model, b) Spatio-temporal models, c) body size models and d) saturated models. The upper horizontal dashed line indicates the reference value plus two standard deviations, while the lower horizontal dashed line indicates the reference value minus two standard deviations and the continuous horizontal line indicates the reference value. See Table 1 and methods for model definitions.

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