

# Local Community Knowledge and Perceptions towards Amphibians in Urban and Rural Settings: Tools for Biological Conservation

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## Research

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## Abstract

**Background** Human perceptions determine the degree to which people can coexist with biodiversity. It is, therefore, important to identify the sociodemographic factors that determine these local perceptions to adjust amphibian conservation strategies. In this research, the effect of the urban or rural location where people live, as well as their gender, age and educational level, concerning the knowledge and perceptions about amphibians was determined.

**Methods** The data were collected through individual semi-structured surveys, which sought to evaluate changes in the perceptions, of 401 participants, about amphibians. We measured seven response variables through the Likert scale, which ranges from 1 (totally disagree) to 5 (totally agree): composition of taxonomic groups, number of known taxonomic groups, species composition of anurans, number of species of anurans, level of importance of amphibians in nature, positive perceptions about amphibians and negative beliefs about amphibians. For each response variable, a Bray-Curtis matrix was generated and multivariate analysis of variance (PERMANOVA).

**Results** Ninety-two percent of people correctly recognized frogs and toads as amphibians, but there was confusion in classifying caecilians and salamanders within this group, or including reptiles (lizards, turtles and snakes) within the group of amphibians. This confusion was more evident for women from urban locality. No one recognized the five native species shown in the study, although the inhabitants of the rural locality recognized more species than those of the urban locality. Positive perceptions of amphibians varied between urban and rural locality for young adults, people with a high school education level, and people without formal education. Negative beliefs varied between urban and rural locations for women, adolescents, young adults, and professionals with undergraduate studies. Half of the people accepted information on the conservation of amphibians.

**Conclusion** Positive perceptions of people about amphibians should be used as a flag to strengthen environmental educational strategies that seek to change negative attitudes about this group. Field activities are crucial to consolidating the positive perceptions of people about amphibians, mainly in urban locations. The results suggest that amphibian conservation plans that aim to inform and educate the public should be focused differently for age groups, genders, and educational level for people in urban and rural locations.

## Background

The perceptions of local human communities towards fauna have a great influence on the conservation of biodiversity, especially in those species in which the perceptions are positive. Perceptions and empathy are generated by aesthetic aspects, customs, folklore, and even evolutionary divergence [1, 2]. However, for those species that are not conspicuous for the common citizen (e.g. due to their cryptic coloration or nocturnal habits), or for which there is a negative perception, it is a challenge to carry out conservation programs, due to reduced interest and limited funds available for a program [3].

Amphibians are a highly diverse group in terms of shapes and number of species (more than 8,200 species globally; [4]. Some can be very showy and charismatic, while others are cryptic and warty [3]. In general terms, the positive perception of people about amphibians is due to ecosystem functions they fulfill (e.g. in their role as pest controllers) and the utility they have, highlighting their use as a source of food, fishing lures, in medicine, and as pets, biological laboratory models, and teaching material [1, 5–9] This positive perception has historically been reflected in art, literature, music, and religion and has acquired cultural status within society [10]. In some religions, amphibians have been considered as deities and some species are used in religious practices [11]. However, in the Catholic religion amphibians have been considered as symbols of the devil [12].

Some studies show that negative perceptions about amphibians are influenced by gender, level of education, and the locality where people live (rural or urban), factors that are related to negative experiences or oral tradition [1, 13, 14]. Multiple beliefs such as that amphibians "inflate until they explode", "spill toxic milk through the skin", "generate warts to the touch" or that "they are useful for witchcraft", originated in this way [3, 15–17]. The negative image of amphibians forged by oral tradition is exacerbated by the poor knowledge of the common people about these organisms, since generally people who dislike amphibians ignore their importance in the ecosystem [13]. This type of negative perception generates repulsion, persecution and sacrifice of this taxonomic group, as well as the apathy of the general public [1] and it reduces the viability of implementing conservation strategies with local communities [18]

Colombia has the second-highest species richness of amphibians in the world, but it is the first country in number of threatened species (296 species; [19]) due to the transformation of ecosystems, pathogens, and climate change, and other factors [20]. By 1930, 70% of Colombians lived in rural locations, but by 2005 there was an abrupt change in the population, so that now 76% of the population lives in cities [21]. This shift towards the massive occupation of cities in the country may increase the degree of uprooting of nature, because they lose direct contact with biodiversity [22]. In Colombia, there are few studies that relate sociodemographic variables with the perceptions of people towards amphibians. Nates and Lindemann-Matthies (2015a) [8] report a negative perception of rural and semi-urban people towards amphibians related to a high degree of ignorance towards this group. In other human communities, a positive perception about reptiles and a negative one about amphibians was found, which varied depending on the origin and gender of the people [9]

The Colombian Caribbean region is characterized by having a high degree of mestizo mixed populations where indigenous, black people and peasants have been in contact for a long time and so have been immersed in many traditions and mythology about herpetofauna [23, 24]. In this

region, 41% of the tropical dry forest of the country is found, of which only 6% of mature forests remain [25]. Only a few studies on fauna are available [26], and a very low representation of amphibians is found in the system of protected natural areas [27]. For this reason, it is necessary to know the perception of people towards amphibians, in order to value conservation from a more comprehensive level, and to change negative perceptions so that conservation and environmental educational programs are supported. This study seeks to (I) determine the effects of sociodemographic variables (gender, age and level of studies) on the knowledge about amphibians, as well as on the types and number of amphibians; (II) evaluate the effect of the urban or rural location, gender, age range and educational level on the positive and negative perceptions of people; (III) classify the interviewees based on their positive perceptions, as well as their use and beliefs about amphibians; (IV) understand the degree of interest of urban and rural people in receiving information on how to conserve amphibians based on the socio-demographic variables of the people, as well as their perceptions, uses, and beliefs about amphibians. Negative perceptions of amphibians are expected to be mainly present in urban locations; and these are probably more common among women than men, as well as among adults and older adults than in adolescents and youth. It is also expected that people in rural localities with a higher level of education will be more interested in learning about amphibian conservation strategies.

## Methods

### Study area

This study was carried out in the rural and urban area of the city of Santa Marta (11°14'24.81 "N and 74°12'43.94" W, Altitude 12 m) which has an area of 2,393.35 km<sup>2</sup> of which 2,227.13 km<sup>2</sup> are rural and 166.22 km<sup>2</sup> urban (Fig. 1). In environmental terms, the Santa Marta district is a heterogeneous area that is home to a great diversity of organisms and ecosystems. This environmental heterogeneity is a reflection of the life zones produced by the elevation of the Sierra Nevada de Santa Marta (SNSM), an isolated coastal mountain massif that functions as a biogeographic island that rises from sea level to perpetual snow (5775 msnm; [28]). In the low altitudinal band there is the typical vegetation of the tropical dry forest zonobiome and the humid equatorial zonobiome, which are succeeded by orobiomes of the sub-Andean forest, Andean forest, paramo, super-paramo and nival (snow zone), as the altitude increases [29,30]. All these biomes are sheltered to some extent by two protected areas, the "Tayrona" and "Sierra Nevada de Santa Marta" National Parks, covering important areas from the coastal strip to the high mountains of the region and favoring the protection of critical ecosystems such as dry, humid, montane forests, and paramos [31].

The economy of the region is based on tourism, trade, shipping activity, fishing and agriculture. The main agricultural products are bananas, coffee, cocoa, fruit trees and cassava [32]. The district of Santa Marta has been affected by the internal armed conflict in Colombia, where armed groups such as guerrillas and right-wing paramilitary groups have been reported, causing the displacement of people from the rural areas [33,34]. The population of the district of Santa Marta has been increasing since 1835 when it had 6000 inhabitants and now registers a population of 499,331 in 2019. Of the current population, 48.8% are men and 52.2% are women, made up of Afro-descendants, indigenous, white and mestizo people. 96% of the population lives in urban locations and the other 3% live in the rural areas of 4 townships: Bonda, Guachaca, Taganga and Minca [32]. For this study, Minca was chosen as the rural town which is located at 456 meters above sea level (11°8'34.12"N and 74°7'0.04"W) in the Sierra Nevada de Santa Marta.

The Sierra Nevada de Santa Marta corresponds to the mountain system with the highest proportion of endemic amphibians in the northern Andes [35,36]. In the district of Santa Marta, 38 species of amphibians have been registered (35 anurans, one salamander and one caecilian), of which 21 inhabit the low altitudinal range (<1000 masl), 18 are endemic to the SNSM (> 400 masl) , one endemic to the trans-Andean region of Colombia, and nine periurban species [37–41]).

### Design of the investigation

#### Pilot test

To find out how understandable the survey questions were for people from urban and rural towns in the Santa Marta district, a pilot test was carried out in January 2017, based on work by Nates and Lindemann-Matthies (2015a; 2015b) [8,42]. For this test, 30 people between 15 and 80 years old in the Minca district and 20 people in parks and shopping centers in the urban area of the Santa Marta district, between 16 and 60 years old, were chosen. All the participants stated that they had a clear understanding of all the questions, which is why the formal data collection phase was carried out.

#### Survey

In March 2017, 200 surveys were carried out in Minca, a rural area of Santa Marta. The study participants were randomly selected (94 women and 106 men), aged between 10 years and 87 years. In the urban town, 201 surveys were conducted in April 2017; the participants were randomly selected (98 Women and 103 Men) with ages ranging from 15 to 72 years. In both locations, people were approached in parks, cemeteries, markets and, in the case of adolescents, in schools during class hours (See Additional file 1).

Each person was asked if they would be willing to participate in a survey lasting 15 minutes, and 90% of the people agreed to participate. Each participant was asked to sign a consent form for the survey and in the case of minors that they had the authorization of their parents. Anonymity was

guaranteed to all study participants. The semi-structured survey was conducted in person and was complemented with imaging tests [8,42]. The first part of the survey was the characterization of each person based on their age, gender, level of education and locality where they live (rural or urban). To learn about people's perceptions, participants were asked to indicate whether they considered amphibians to be important in nature, as well as positive perceptions (medicinal use, food, pleasant, use as a pet, control of harmful insects, singing behaviors) and negative perceptions (they secrete milky substances, inflate or explode, cause warts in people, carry diseases and are harmful). The responses to each of the questions were expressed on the Likert scale, which ranges from 1: totally disagree; 2: disagree; 3: neither agree / nor disagree; 4: agree; 5: totally agree [43]. Finally, the respondents were asked if they would be willing to learn more about amphibian conservation.

### Picture test

To assess people's knowledge about amphibians, an image test was given where digital photographs of the following animals were shown: dog, bird, turtle, snake, frog, toad, lizard, salamander and caecilian. After the photos were displayed, the respondents were asked to choose from the images which of these they considered to be amphibians. To investigate the ability of the participants to identify amphibian species in the area, photographs of five frog species that occur frequently in the region were shown [44,45]. In addition, a foreign frog to Colombia was included as a control for the perception of local species by the participants. The photographs were of good quality, taken under similar lighting conditions and with the intention of presenting the view from a dorso-lateral aspect. Participants were asked to identify the species by their common name and to indicate whether they were present in the area.

The species included the following. *Rhinella horribilis* (Wiegmann, 1833) is a common species in the Colombian Caribbean region that is very common in urban and rural areas of the district due to its wide phenotypic plasticity that allows it to be in a great variety of ecosystems [44]. The second species was *Atelopus laetissimus* (Ruíz-Carranza, Ardila-Robayo & Hernández-Camacho, 1994) an endemic species of the Sierra Nevada de Santa Marta, of diurnal activity and present in streams [45]. *Leptodactylus fuscus* (Schneider, 1799) the beaked or whistling frog is common in the lowlands of the Colombian Caribbean [44]. *Boana pugnax* (Schmidt, 1857) belonging to the Hylidae family, is a common frog that lives in semi-urban areas in the Colombian Caribbean region, especially in banana crops, for which it is called a banana frog [44]. Finally, *Calyptocephalella gayi* (Duméril & Bibron, 1841), an endemic species from Chile that is not present in Colombia was included as the control.

### Data Analysis

For the division of ages into groups, four groups were considered: adolescence (12-18 years), young adults (19-30 years), adults (31-60 years) and older adults (61- 84 years). Changes in knowledge and perceptions of each of the 401 people interviewed about amphibians were evaluated based on seven response variables: (1) composition of taxonomic groups (salamanders, caecilians, frogs and toads); (2) number of known taxonomic groups; (3) composition of anuran species (four species present in the area and one non-native: *C. gayi*, *L. fuscus*, *B. pugnax*, *A. laetissimus* and *R. horribilis*); (4) number of species of anurans; (5) level of importance of amphibians in nature; (6) positive perceptions about amphibians (medicinal use, food, pleasant, use as a pet, control insects harmful to people, singing); and (7) negative beliefs about amphibians (they secrete milky substances, inflate or explode, cause warts in people, carry disease and are harmful). Additionally, we searched for changes on (8) the degree of interest of people to receive information on how to conserve amphibians. For each response variable, a Bray-Curtis matrix previously transformed to square root was generated and a multivariate analysis of variance based on 9,999 permutations (PERMANOVA) with partial sum of squares (type III) and the permutation of residuals under a reduced model was utilized. The experimental design consisted of four fixed factors: locality (levels: urban and rural), gender (levels: male and female), age range (levels: adolescent, young adult, adult and older adult), educational level (levels: none, primary, secondary, technical, professional) and their interactions. To determine the differences between factors, a posterior pairwise comparison was made with the t statistic based on 9,999 permutations.

The eleven perceptions (six positive perceptions with the five negative beliefs) of the people interviewed in urban and rural locations were visualized from the Whittaker (1952)[46], association index. In the heatmap analysis, the Whittaker association index ranges from 0 to 4, showing a pattern of colors (from less warm to warmer) with those surveyed with warmer colors being those who agreed or totally agreed with that perception. The dendrogram for the classification of the people and the one for the classification of the variables were statistically validated using similarity profiles with 9,999 MonteCarlo simulations (SIMPROF routine; [47]).

A Pearson linear correlation was performed between the sociodemographic variables of the people and their knowledge and perception of amphibians to identify collinear variables to exclude from the subsequent analyses. The binary variables were converted to presence-absence (gender, locality), and the level of studies was converted to values from 0 (without formal studies) to 4 (professional with undergraduate studies), for a total of 17 predictive variables that were standardized from their mean and standard deviation. Linear models based on distances (DistLM ritual) were carried out to explain the degree of interest of people to receive information on how to conserve amphibians (response variable ranging from 1 = totally disagree to 5 = totally agree) based on the 17 socio-demographic variables of the people and their perceptions about amphibians. The best fitted models were classified using the Akaike information criterion for small samples (AICc). All analyses were carried out using the PRIMER v7 and PERMANOVA + add on programs [47,48].

## Results

401 people (192 women and 209 men) were interviewed, of which 200 people lived in rural areas and 201 in urban areas. The level of study was represented by 15 people without formal studies, 136 people who attended primary school, 126 secondary school, 31 did technical studies and 92 were professionals or with undergraduate studies.

## Knowledge

Most of those surveyed considered frogs and toads as amphibians (92.26% and 92%, respectively), but a lower proportion of people did so in the case of caecilians and salamanders (31.42% and 61.3%, respectively). However, a large proportion of those surveyed considered reptiles also amphibians (lizards = 42.1%, turtles = 32.16%, and snakes = 33.41). People's knowledge of the taxonomic groups that make up amphibians (salamanders, caecilians, frogs and toads) varied between the urban and rural localities (Pseudo-F = 4.94; p-perm = 0.0001), where the respondents from the first zone recognized reptile groups as amphibians to a greater extent. Variation was also detected among the age ranges (Pseudo-F = 3.254; p-perm = 0.009) showing less knowledge in people between 19 and 30 years of age. Additionally, there was an effect on the interaction between the locality and gender (Pseudo-F = 2.456; p-perm = 0.032), although there were only significant differences between women from urban and rural localities (Pseudo-t = 27.79; p-perm = 0.0005) (Table 1).

Survey results suggested that people are unfamiliar with local amphibian species. *Rhinella horribilis* was the most frequently recognized species (53.11%), followed by *B. pugnax* (36.15%). On the other hand, 29.17% of those surveyed said they had seen the alien species *C. gayi*, a total of 117 people, of which 84.61% of these were participants in the urban sector. The knowledge of the people surveyed on the local species was very poor where 35.15% of the total managed to identify with great difficulty only two species and 21.5% failed to identify any of the species shown in the questionnaire. The number of species known for amphibians varied between urban and rural locations (Pseudo-F = 1.554; p-perm = 0.0001) and in the interaction between the location and level of studies (Pseudo-F = 0.6; p-perm = 0.042). However, there were only significant differences between people with a technical training level between urban and rural localities (Pseudo-t = 2.39; p-perm = 0.023) (Table 1).

Knowledge of the composition of the five species of anurans present in the area varied between the urban and rural localities (Pseudo-F = 2,983; p-perm = 0.0001) and in the interaction between the locality with the age range (Pseudo-F = 0.28; p-perm = 0.009) and with the educational level (Pseudo-F = 0.6; p-perm = 0.042). Contrast tests showed differences between urban and rural localities for adolescents (Pseudo-t = 2.15; p-perm = 0.0013), young adults (Pseudo-t = 2.4; p-perm = 0.0005) and professionals (Pseudo-t = 2.01; p-perm = 0.004) (Table 1). Knowledge of the richness of the five species of anurans present in the area varied between the urban and rural locality (Pseudo-F = 3.017; p-perm = 0.0013) and in the interaction between the locality with the genus (Pseudo-F = 1.11; p-perm = 0.028) and with the age range (Pseudo-F = 0.08; p-perm = 0.009). Contrast tests showed differences between urban and rural localities for women (Pseudo-t = 2.04; p-perm = 0.043) and adolescents (Pseudo-t = 2.4; p-perm = 0.0005) (Table 1).

## Perceptions of people

91% of those surveyed have a positive view of amphibians and their role in nature, but there was a significant difference in the interaction between the urban and rural localities with the age range (Pseudo-F = 1.19; p-perm = 0.025). Contrast tests showed differences between urban and rural localities for young adults (Pseudo-t = 2.23; p-perm = 0.044) and adults (Pseudo-t = 2.26; p-perm = 0.037) (Table 1).

Positive perceptions about amphibians varied between urban and rural localities (Pseudo-F = 3.537; p-perm = 0.0001) and in the interaction between the locality with the age range (Pseudo-F = 0.99; p-perm = 0.04) and with the level of education (Pseudo-F = 1.002; p-perm = 0.044). Contrast tests showed differences between urban and rural localities for young adults (Pseudo-t = 1.72; p-perm = 0.036), people with high school education (Pseudo-t = 1.77; p-perm = 0.02) and people without formal studies (Pseudo-t = 2.38; p-perm = 0.047) (Table 1).

Negative perceptions about amphibians varied between urban and rural localities (Pseudo-F = 6.26; p-perm = 0.002) and in the interaction between the locality with gender (Pseudo-F = 2.57; p-perm = 0.038), the age range (Pseudo-F = 2.08; p-perm = 0.037) and with the level of education (Pseudo-F = 1.85; p-perm = 0.037). Contrast tests showed differences between urban and rural localities for women (Pseudo-t = 1.94; p-perm = 0.013), adolescents (Pseudo-t = 1.174; p-perm = 0.033), young adults (Pseudo-F = 1.74; p-perm = 0.043) and professionals with undergraduate studies (Pseudo-t = 2.12; p-perm = 0.006) (Table 1).

The heat map shows that, according to the value of the eleven positive and negative perceptions evaluated, these are grouped into 6 groups as follow: use for food and pets; inflate or explode; they are harmful, cause warts and carry disease; they secrete milky substances; control harmful insects and sing; and they are nice and have medicinal use. Likewise, the people surveyed were grouped, according to their perceptions, into 54 different groups (Figure 2). However, there was no linear correlation between any of these perceptions, nor between those with sociodemographic factors (age, gender, locality or level of studies) (Table 2). 49.2% of the people stated that they fully agreed to receive information on amphibian conservation, followed by 26.2% who agreed and 12.5% of the people who remained neutral (See Additional file 2).

## Interest in conservation of amphibians

The degree of interest of urban and rural people in receiving information on how to conserve amphibians varied between the urban and rural locality (Pseudo-F = 1.51; p-perm = 0.0001) and in the interaction between the locality with the age range (Pseudo-F = 0.51; p-perm = 0.038) and with the level of education (Pseudo-F = 0.44; p-perm = 0.028). Contrast tests showed differences

between urban and rural localities for adolescents (Pseudo-t = 2.453; p-perm = 0.018), young adults (Pseudo-t = 2.748; p-perm = 0.007) and professionals with undergraduate studies (Pseudo-t = 2.39; p-perm = 0.017) (Table 1). This degree of people's interest was explained by different variables depending on the locality. In the city, the two best adjusted models included between two and four variables: that they are considered pleasant, that they can be used as pets, that they control insects and that they secrete milky substances; in the field, the best adjusted model (F = 8.22; p-perm = 0.0001; adjusted R<sup>2</sup> = 22) included eight variables: medicinal use, food use, controlling insects, singing, knowledge of greater number of groups of amphibians (salamanders, caecilians, frogs and toads), which inflate or explode, age and level of studies. 73% of adolescents, 90% of adults and 70.6% of young adults agreed (sum of responses in categories totally agree and agree) to receive additional information (Additional file 2). Regarding the level of studies, all the people without formal training fully agreed to receive additional information on amphibian conservation, while among 67.7% of the people with technical training, 71.7% of the professionals, the 73% of the people with secondary education and 80% of the people with primary school agreed (sum of responses in categories, totally agree and agree) (Additional file 2).

## Discussion

This is the first study carried out on the perception and knowledge of amphibians in the Colombian Caribbean region by people who inhabit urban and rural localities. This research is of the utmost importance for the characterization of interest groups to better target conservation strategies in the territory.

The results of this study show factors that guide and influence knowledge and perceptions towards amphibians, as well as the interactions between sociodemographic variables, such as gender, age and educational level.

### Knowledge

Most of the participants associated frogs and toads with the amphibian group, but very few people managed to classify salamanders and caecilians with this taxonomic group. The foregoing represents a challenge to increase the state of knowledge of the 27 salamanders and 33 caecilians of Colombia [49], species that have low abundances, are highly cryptic (in the case of salamanders) or live under the ground (in the case of caecilians). Another challenge for future environmental education schemes is that many people classified lizards, turtles and snakes as amphibians, which shows a lack of knowledge of the unique characteristics that amphibians have within the group of vertebrate animals.

Also people's knowledge about local amphibians was poor, most of the respondents only identified one species, others recognized at least two of those shown in the image tests, and very few managed to exceed that figure, showing a very poor familiarity with native amphibians. The scenario of ignorance could be even worse if it is considered that the five species chosen for the present study (of the 38 species of amphibians in the region) are among the most common in terms of high abundance or probability of detection [45,50–53].

This study showed results similar to those of Nates and Lindemann-Matthies (2015a) and Ríos-Orejuela et al. (2020) [8,9], where respondents showed difficulties in differentiating amphibians and little familiarity with local species. Despite this shortcoming, several people mentioned general aspects of amphibian biology, such as Respondent # 94: "For me all toads are just as ugly, I see them it evoke disgust" Urban woman 20 years old; or respondent # 282 "I have nothing against them but they do disgust me"; Rural man 34 years old "com pers" (see Figure 2). Statistical tests showed differences between the genera where women from both localities more frequently included reptiles as amphibians (57.85%), which may be due to the fact that these species are normally associated with unpleasant and frightening physical aspects ([3,16]).

Respondents between the ages of 19 and 30 also made this identification error (confusing amphibians with reptiles) (63.34%), likewise, participants between the ages of 12-18 years also more frequently identified the reptiles in this group (37, 15%) showing that the concept of amphibian is not clear. One reason for this conceptual flaw can be inferred as a limitation of the educational system in the areas of natural sciences, where they are based only on the texts that teachers handle, leaving aside the practical part such as visits to museums, zoos or field trips that enrich students' knowledge about local species. In addition, at this level of education teaching does not take into account or is not clear about the importance of species that are not charismatic, so their biology and ecological aspects are not studied in depth [54–56].

Familiarity with local species was very low. The participants showed great difficulty in identifying the species shown in the images and this was more frequent with the inhabitants of the urban locality. This pattern was previously reported by Nates & Lindemann-Matthies (2015a, b) [8,42] where respondents from sectors closer to the field had more affinity with local species, which is very understandable due to the fact that direct experiences are a rich source of knowledge of wildlife ([57]). Works such as that of Brom et al. (2020) [3] in South Africa mention in their results that many of the respondents who had encounters with these species in their childhood showed a broader knowledge about them and a greater retention of this knowledge.

Continuing with the familiarity of people with local amphibians, the most frequently recognized species for both urban and rural sectors was *R. horribilis* (36.15%), which can be attributed to the fact that this species is quite common and can be found in a great diversity of ecosystems,

including those with great anthropic activity [58]. Regarding gender, we found that 60% of the women expressed dislike and repulsion for the images shown during the survey, an aspect that exacerbates their fear or disinterest in amphibians [59]. The gender difference in knowledge about the richness and composition of local species in the rural sector may be due to the traditional assignment of roles where from an early age, girls are asked to collaborate with their mothers in housework, while male children are sent with their parents to work in the field. The latter being in closer contact with nature have more knowledge about native species [60].

Concerning knowledge of the local species recognized by the respondents, we found that a large percentage of the urban population indicated that they recognized *C. gayi*, an endemic species of Chile with no presence in the country (24.61%). Perhaps this is due to the little contact they have with amphibian populations in the urban area, so its knowledge is built upon foreign biodiversity documentaries seen on television.

### **Positive and negative perceptions towards amphibians**

The positive perceptions about amphibians in this study varied between locality, gender, age groups and level of study, showing the high degree of complexity that people have about amphibian species. We found differences in the perceptions of people at the level of gender and academic training concerning the premise about the medicinal use of amphibians. Women from both localities and participants in studies at the primary level disagreed, unlike the rest of the participants, especially some respondents from rural areas and people with professional training who gave examples for the use of amphibians in traditional medicine that have been documented both in Latin America and Europe [61,62]. The idea about the nutritional value of amphibians yielded significant differences at the local level, academic training and ages, where participants from the rural sector, adolescents and people without formal education stated that they disagreed with the inclusion of these species in the gastronomic spectrum of people. This is consistent with works such as that of Ellen et al. (1976) [63] in Indonesia where only a select group of some traditional tribes were those that consumed these species. Also, in Pakistan Ali et al. (2017) [64] found that only 3% of the surveyed population responded that amphibians could be used as food; however, our results showed that people with professional studies and from the urban sector were in agreement with this premise by having a broader gastronomic vision. In the Colombian Amazon, some indigenous communities capture more than 180 species of fauna for their consumption of which 8 are amphibians [65]. The results obtained contrast with other studies carried out in China where some 225 species of amphibians are found and 75% are used as food and for medicinal purposes [42,66]. Likewise, in Nepal amphibians are often consumed and hunting frogs for food is a fairly common practice in districts such as Gorkha [67]. These results differ significantly from those obtained in the present study.

Aesthetics played an important role and was a great influence on the sympathy or aversion that people feel towards amphibians. Women from rural localities and adolescents with primary and secondary studies considered amphibians to be unpleasant, and they regularly give value judgments to these species [16]. In contrast, men from both localities and people with professional training considered amphibians pleasant. These perceptions can be regulated by the knowledge obtained in their education or in their social environment or by direct experiences. Brom et al. (2020) [3] mention that many times the interactions of people with amphibians in their childhood expanded the knowledge of these people about these species and were mostly related to their positive feelings for amphibians.

Another positive perception that varied between gender and locality was the use of amphibians as pets, where 80.48% of the rural population stated that they were against this use, while in the urban population only 40.7% had the same perception. This may be due to the fact that in rural townships there is a greater predilection for domestic pets, and they do not have much fascination for wild species, an aspect that is more common in the city [68,69]. However, the highest percentage of respondents who strongly disagreed that amphibians can be pets were urban women. Among other beliefs that enhance people's positive perceptions of amphibians, we found that the majority of respondents agreed with premises such as that amphibians consume harmful mosquitoes, which is to be expected since these species are considered mostly controllers of pests [70]. Only a small percentage of women in the urban sector responded that they did not agree with this belief. On the other hand, the majority of the surveyed population agreed that amphibians can sing. Several participants even made sounds made by frogs and toads that they had heard.

Negative perceptions about fauna are largely influenced by the beliefs and folklore of the region where they give superstitious connotations to animals. In the case of amphibians these are commonly associated with witchcraft and diseases, giving it a negative image in society [1]. In the present study, differences were found between the public surveyed at the local, gender and school level, where the rural sector, mainly adolescent women distributed between primary and secondary schools were in total agreement with premises such as that amphibians shed milk through their skin, myths that have been transmitted from generation to generation in various human communities [7,15]. In contrast, urban young adults with technical and professional academic levels disagreed with these negative myths.

As for whether the respondents considered amphibians harmful, a small percentage distributed among women in the rural sector and some adolescent respondents stated they fully agree with this premise. Likewise, this group considered that amphibians can be carriers of diseases, which can be a confusion with the production of toxins by some species [71]. However, people's perceptions of amphibians did not have negative values as broad as those exposed in work published by Prokop and Fancovicová (2012) [13] in Slovakia, where respondents (mainly owners of farms and ponds in the rural sector) claim to feel a strong hatred and repulsion towards amphibians to the point of responding that they felt like killing them. It is possible that the negative results of the present study are less radical due to the poor knowledge of people about amphibians, which may lead to little interest in these species.

## Interest in conservation of amphibians

We understand perception as a constructive process where people organize the stimuli received by the senses to form a conscious or unconscious impression of things in the environment [72]. In this sense, this interpretation is of great importance in the field of amphibian conservation since people's efforts to conserve species will depend on how they are perceived. Understanding the degree of interest of urban and rural people in receiving information on how to conserve amphibians is one of the objectives of this study. Most of the participants had a positive response to being linked to amphibian conservation programs, in urban areas people interested in conserving amphibians consider them pleasant and useful (for controlling insects or serving as pets). In the rural area, the interested people had a greater knowledge of the amphibian groups (salamanders, caecilians, frogs and toads), they recognized other uses (medicinal and food), and they liked their song because it has direct interaction with them. This interest in rural people was greater in adolescents, adults and young adults.

It was also found that people with a low level of education in rural areas had a greater interest in learning more. Perhaps the people who live in rural areas, by coexisting in the habitat of amphibians due to their direct relationship with amphibians, have generated greater interest because they are able to hear their songs in the reproductive season and they know about other ecological attributes, unlike people who live in the city where they do not interact with amphibians. Nates & Lindemann-Matthies (2015a) [8] mention that households in rural and remote regions were more dependent on natural resources and more connected to the local environment than households in more urban regions, especially when they had low income and have a higher direct relationship with frogs and greater knowledge about them. Several studies have determined that direct experience with fauna increases knowledge and interest in conserving it [1,14]. For example, Brom et al. (2020) [3] report that there is a relationship between knowledge and taste for amphibians; and in addition, the positive experiences of people increase their environmental behavior.

All the perceptions of people must be considered, regardless of their origin or veracity. One of the goals of amphibian conservation is to inform and educate the public about the importance of amphibians in ecosystems, and the support of people could make conservation much more successful [73]. For example, the few participants who were able to identify the endemic amphibian *A. laetissimus* gave valuable information about its habitat, commenting that they had seen it in the daytime and in a stream in the region. The participatory inventories and the knowledge of the people who live with the species day by day is very important, since they are species that were believed to be extinct and have been re-registered in areas where they had not been studied, such as the harlequin frog *Atelopus lozanoi* which was sighted by farmers in the eastern mountain range of Colombia and had not been sighted for more than 20 years [74,75]).

In the rural area of Santa Marta there is a high diversity of amphibians, some of them endemic, such as the monotypic genus such as *Geobatrachus*, as well as the presence of frogs of the genus *Atelopus* with good populations [45]. This is an area with high potential for ecotourism. Especially an economic strategy including herpetology for tourists could improve the income of families in the Sierra Nevada de Santa Marta [76]. However, the local inhabitants have great ignorance about these species, and this could hinder conservation programs and deteriorate the area due to unsustainable ecotourism (example soil compaction, erosion and habitat alteration), since the area does not have strong environmental institutions to protect the environment [77], which makes environmental education a fundamental component in wildlife conservation planning. It is necessary to have an informed public about the problems and knowledge of the local amphibian species to lead towards more positive perceptions of the local communities towards amphibians. As decision makers have more knowledge and positive perceptions about amphibians, there will be a greater willingness to conserve these species [78]. The 21st century is considered the century of extinctions, as some have argued, people will only understand the importance of species if they know them and if they have developed an experiential relationship that mediates significant learning, that is, people will not notice the absence of a species of which they have no knowledge; or they will not be worried about species' extinctions, which raises much concern due to the poor knowledge that local actors have about amphibians and how some negative attitudes reduce the conservation interest for these species [79,80].

## Conclusion

This is the first study on amphibian' ethnobiology conducted in the Colombian Caribbean region where 70% of the research on amphibians are focused on species abundance, distributions, and checklists [26]. Understanding people's perceptions and attitudes on non-charismatic species of fauna will refine and focalize conservation and management efforts, especially in megadiverse countries like Colombia. In this study, people's knowledge of amphibians reflected the little interest that urban people had on native biodiversity. Aesthetics was the main factor affecting the perception of amphibians, with comments about how disgusting are those organisms for people even from a picture. This type of comment occurred mainly in the urban sector, generating great concern about the conservation interest on amphibians in the face of the current extinction crisis. Experiential or direct experience is crucial to consolidating the positive perceptions of people about amphibians, and this highlights the importance of zoos and participatory sampling in meaningful learning. Every amphibian conservation project must have a component that facilitates knowing the perceptions and attitudes of local actors and decision-makers to ensure the persistence of amphibian populations in transformed landscapes.

## Abbreviations

SNSM

Sierra Nevada de Santa Marta

PERMANOVA



## Declarations

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### Authors' contributions

All authors worked equally on this manuscript. All authors read and approved the final manuscript.

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### Availability of data and materials

A complete survey model can be found as Additional file 1. Survey format.

Description of the number of people interviewed by socio-demographic and geographic factors (age, gender, educational level and location) in Additional file 2.

Data collected from surveys are available in Additional file 3. Surveys data

### Ethics approval and consent to participate

The study conforms to the code of ethics of the International Society of Ethnobiology [81].

Prior informed consent was obtained from all participants before interviews.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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## Tables

**Table 1.** PERMANOVA summary tables reporting the contribution of locality, gender, age range, and educational level to the variation of knowledge and perception of amphibians of the people interviewed in urban and rural locations in the Caribbean region of Colombia. Significant sources of variation are highlighted in bold at P(perm) column.

Response variable	Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms	Estimates of components of variation	
								Estimate	Sq.root
KNOWLEDGE: Composition of taxonomic groups	Locality (Lo)	1	6845	6845	4.94	<b>0.0001</b>	9953	29.803	5.4592
	Gender (Ge)	1	536.56	536.56	0.60654	0.6117	9951	1.7446	-1.3208
	Age range (AR)	3	8637.7	2879.2	3.2547	<b>0.0019</b>	9947	26.417	5.1397
	Educational level (EL)	5	7643.9	1528.8	1.7282	0.0673	9922	19.382	4.4025
	LoxGe	1	2173.1	2173.1	2.4565	<b>0.0327</b>	9954	13.035	3.6104
	LoxAR	3	2836.3	945.43	1.0687	0.3942	9950	2.8992	1.7027
	LoxEL	3	901.65	300.55	0.33975	0.9163	9940	63.76	-7.985
	GexAR	3	2850.3	950.1	1.074	0.3651	9940	1.8496	1.36
	GexEL	4	4121.9	1030.5	1.1649	0.3082	9933	7.4541	2.7302
	RAxEL	8	6.12E+03	765.1	0.86488	0.5915	9915	19.413	-4.4061
	LoxGexRA	2	1.62E+03	810.03	0.91568	0.4776	9953	6.5117	-2.5518
	LoxGexEL	2	3624.3	1812.2	2.0485	0.0778	9947	192.01	13.857
	LoxARxEL	2	498.15	249.07	0.28156	0.8985	9942	167.6	-12.946
	GexARxEL	5	2961.6	592.31	0.66956	0.7508	9934	94.819	-9.7375
	Res	356	3.15E+05	884.63				884.63	29.743
	Total	399	3.66E+05					1531.3282	
KNOWLEDGE: Number of known taxonomic groups	Locality (Lo)	1	1670.9	1670.9	1.554	<b>0.0001</b>	6170	7.3917	2.7188
	Gender (Ge)	1	38.31	38.31	0.19383	0.7576	9943	-7.6547	-2.7667
	Age range (AR)	2	29.183	14.591	0.073828	0.9656	9937	-20.876	-4.569
	Educational level (EL)	4	254.33	63.582	0.3217	0.7199	9910	-20.16	-4.49
	LoxGe	1	33.364	33.364	0.16881	0.7152	9906	-17.863	-4.2264
	LoxAR	2	121.71	60.853	0.30789	0.6971	9935	-21.577	-4.6451
	LoxEL	3	358.92	119.64	0.60533	<b>0.0426</b>	9935	-17.611	-4.1965
	GexAR	3	371.9	123.97	0.62723	0.4372	9928	-13.951	-3.7351
	GexEL	4	750.86	187.71	0.94977	0.2983	9920	-1.7544	-1.3245
	RAxEL	8	1137.6	142.2	0.71948	0.4312	9927	-12.032	-3.4688
	LoxGexRA	2	33.288	16.644	0.084213	0.9357	9915	-55.08	-7.4216
	LoxGexEL	2	235.05	117.52	0.59463	0.3661	9923	-27.943	-5.2861
	LoxARxEL	2	45.282	22.641	0.11456	0.8943	9924	-65.246	-8.0775
	GexARxEL	5	416.16	83.233	0.42113	0.7124	9938	-37.112	-6.0919
	Res	356	70361	197.64				197.64	14.059
	Total	399	78316						
KNOWLEDGE: Composition of anuran species	Locality (Lo)	1	48661	48661	2.983	<b>0.0001</b>	9965	235.96	15.361
	Gender (Ge)	1	132.94	132.94	0.094865	0.9288	9958	-60.935	-7.8061
	Age range	2	3345	1672.5	1.1935	0.3041	9942	30.93	5.5615

	(AR)								
	Educational level (EL)	4	7698.2	1924.5	1.3734	0.1546	9912	78.683	8.8704
	LoxGe	1	566.47	566.47	0.40425	0.7547	9957	-90.775	-9.5276
	LoxAR	2	791.04	395.52	0.28225	<b>0.0094</b>	9946	-158.65	-12.596
	LoxEL	3	1774.7	591.57	0.42216	<b>0.0092</b>	9935	-182.81	-13.521
	GexAR	3	2691.5	897.16	0.64023	0.7777	9933	-95.462	-9.7705
	GexEL	4	5026	1256.5	0.89667	0.5695	9930	-25.588	-5.0585
	RAxEL	8	5322.3	665.28	0.47476	0.9858	9906	-159.74	-12.639
	LoxGexRA	2	3806.1	1903.1	1.3581	0.2356	9946	152.69	12.357
	LoxGexEL	2	5068.6	2534.3	1.8085	0.0857	9928	395.16	19.879
	LoxARxEL	2	980.28	490.14	0.34977	0.904	9942	-339.71	-18.431
	GexARxEL	5	4522.1	904.41	0.64541	0.8421	9895	-161.18	-12.696
	Res	356	4.99E+05	1401.3				1401.3	37.434
	Total	399	6.34E+05						
KNOWLEDGE: Number of species of anurans	Locality (Lo)	1	3220.5	3220.5	3.017	<b>0.0013</b>	9068	14.626	3.8244
	Gender (Ge)	1	1.8187	1.8187	0.0062423	0.9814	9925	-13.91	-3.7296
	Age range (AR)	2	598.01	299	1.0262	0.3634	9958	0.872	0.93381
	Educational level (EL)	4	2352.6	588.14	2.0186	0.0846	9939	44.629	6.6805
	LoxGe	1	326	326	1.1189	<b>0.0289</b>	9921	3.7668	1.9408
	LoxAR	2	51.681	25.84	0.088689	<b>0.0094</b>	9953	-41.882	-6.4716
	LoxEL	3	322.61	107.54	0.36908	0.7975	9962	-41.501	-6.4421
	GexAR	3	132.07	44.023	0.1511	0.9403	9956	-46.835	-6.8436
	GexEL	4	1351.8	337.94	1.1599	0.3286	9955	8.2314	2.869
	RAxEL	8	1182.3	147.79	0.50725	0.8636	9932	-31.158	-5.5819
	LoxGexRA	2	13.422	6.711	0.023033	0.9926	9949	-86.621	-9.307
	LoxGexEL	2	1370.7	685.33	2.3522	0.0954	9952	137.41	11.722
	LoxARxEL	2	112.08	56.038	0.19233	0.8511	9959	-87.734	-9.3667
	GexARxEL	5	1523	304.6	1.0455	0.3987	9955	4.296	2.0727
	Res	356	1.04E+05	291.36				291.36	17.069
Total	399	1.21E+05							
PERCEPTIONS: Level of importance of amphibians in nature	Locality (Lo)	1	110.7	110.7	2.8634	0.0891	4410	0.36022	0.60019
	Gender (Ge)	1	32.956	32.956	0.90412	0.3137	9916	-0.16791	-0.40977
	Age range (AR)	2	20.098	10.049	0.27568	0.7245	9958	-3.011	-1.7352
	Educational level (EL)	4	28.623	7.1558	0.19631	0.9051	9948	-4.4054	-2.0989
	LoxGe	1	32.826	32.826	0.90054	0.2965	9903	-0.39422	-0.62787
	LoxAR	2	87.36	43.68	1.1983	<b>0.0253</b>	9944	1.1402	1.0678
	LoxEL	3	39.324	13.108	0.3596	0.7081	9943	-5.2702	-2.2957
	GexAR	3	92.36	30.787	0.8446	0.4017	9949	-1.0726	-1.0357

GexEL	4	121.97	30.493	0.83654	0.4328	9930	-1.0529	-1.0261
RAxEL	8	232.4	29.05	0.79696	0.4884	9942	-1.6062	-1.2674
LoxGexRA	2	101.1	50.55	1.3868	0.2125	9941	4.2903	2.0713
LoxGexEL	2	11.484	5.7418	0.15752	0.816	9947	-10.711	-3.2727
LoxARxEL	2	43.113	21.556	0.59138	0.4943	9941	-5.5533	-2.3565
GexARxEL	5	201.22	40.244	1.104	0.3121	9942	1.2301	1.1091
Res	356	12977	36.451				36.451	6.0375
Total	399	15498						

PERCEPTIONS: Positive perceptions about amphibians

Locality (Lo)	1	1459.6	1459.6	3.537	<b>0.0001</b>	9961	6.7956	2.6068
Gender (Ge)	1	61.403	61.403	0.65112	0.5986	9954	-1.5807	-1.2573
Age range (AR)	2	270.01	135	1.4316	0.209	9947	4.6416	2.1544
Educational level (EL)	4	603.9	150.98	1.6009	0.0919	9925	8.5222	2.9193
LoxGe	1	19.449	19.449	0.20623	0.8504	9954	-8.1394	-2.853
LoxAR	2	188.19	94.096	0.99778	<b>0.0436</b>	9953	-0.032972	-0.18158
LoxEL	3	283.6	94.535	1.0024	<b>0.0444</b>	9933	0.051875	0.22776
GexAR	3	147.31	49.103	0.52068	0.8371	9939	-8.5597	-2.9257
GexEL	4	140.37	35.093	0.37212	0.9496	9935	-10.464	-3.2348
RAxEL	8	711.93	88.991	0.94366	0.5404	9914	-1.1532	-1.0739
LoxGexRA	2	120.55	60.274	0.63914	0.692	9950	-10.356	-3.2181
LoxGexEL	2	286.51	143.26	1.5191	0.1787	9938	17.073	4.1319
LoxARxEL	2	182.67	91.336	0.96852	0.4539	9941	-1.1069	-1.0521
GexARxEL	5	442.37	88.474	0.93817	0.5221	9922	-1.8916	-1.3754
Res	355	33478	94.305				94.305	9.7111
Total	398	42726						

PERCEPTIONS: Negative beliefs about amphibians

Locality (Lo)	1	820.58	820.58	6.26	<b>0.002</b>	9962	3.3358	1.8264
Gender (Ge)	1	130.21	130.21	0.95271	0.4237	9957	-0.31054	-0.55726
Age range (AR)	2	871.94	435.97	3.1899	<b>0.0082</b>	9956	34.132	5.8423
Educational level (EL)	4	826.22	206.56	1.5113	0.1257	9930	10.509	3.2418
LoxGe	1	352.23	352.23	2.5772	<b>0.0388</b>	9959	23.438	4.8413
LoxAR	2	569.29	284.65	2.0827	<b>0.0376</b>	9951	23.341	4.8312
LoxEL	3	762	254	1.8584	<b>0.0376</b>	9951	26.488	5.1467
GexAR	3	757.76	252.59	1.8481	0.0706	9931	21.95	4.6851
GexEL	4	974.99	243.75	1.7834	0.0619	9940	18.922	4.3499
RAxEL	8	1462.9	182.87	1.338	0.1472	9910	10.027	3.1665
LoxGexRA	2	251.06	125.53	0.91849	0.4891	9950	-3.3901	-1.8412
LoxGexEL	2	196.01	98.006	0.71709	0.6265	9956	-13.486	-3.6723
LoxARxEL	2	306.4	153.2	1.1209	0.3681	9948	6.1616	2.4823
GexARxEL	5	662.8	132.56	0.96991	0.4836	9915	-1.3343	-1.1551
Res	355	48519	136.67				136.67	11.691

	Total	398	62405						
CONSERVATION: Interest of people to receive information on how to conserve amphibians	Locality (Lo)	1	3727	3727	1.51	<b>0.0001</b>	7210	18.116	4.2563
	Gender (Ge)	1	32.4	32.4	0.30234	0.5879	9928	-3.5919	-1.8952
	Age range (AR)	2	82.087	41.044	0.38299	0.6746	9926	-7.5408	-2.7461
	Educational level (EL)	4	127.96	31.991	0.29851	0.8389	9948	-11.305	-3.3623
	LoxGe	1	22.994	22.994	0.21457	0.6333	9910	-9.1524	-3.0253
	LoxAR	2	110.5	55.249	0.51554	<b>0.0382</b>	9944	-8.1893	-2.8617
	LoxEL	3	144.43	48.143	0.44924	<b>0.0285</b>	9955	-13.326	-3.6504
	GexAR	3	89.141	29.714	0.27727	0.8141	9960	-14.666	-3.8296
	GexEL	4	113.56	28.389	0.26491	0.8769	9941	-13.921	-3.7311
	RAxEL	8	383.34	47.918	0.44713	0.8444	9944	-12.859	-3.5859
	LoxGexRA	2	79.057	39.529	0.36885	0.6599	9944	-20.583	-4.5368
	LoxGexEL	2	88.763	44.382	0.41414	0.6165	9935	-21.898	-4.6795
	LoxARxEL	2	225.73	112.87	1.0532	0.3274	9937	2.1249	1.4577
	GexARxEL	5	11.298	2.2596	0.021085	0.9999	9950	-34.029	-5.8334
	Res	356	38151	107.17				107.17	10.352
	Total	399	45022						

**Table 2.** Pearson correlation coefficient between knowledge and perception of amphibians with sociodemographic variables of the people interviewed in urban and rural locations in the Caribbean region of Colombia.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Medicinal use (1)																
Use for food (2)	0.28															
Are nice (3)	0.17	0.05														
Use for pets (4)	0.05	0.17	0.03													
Control harmful insects (5)	0.01	-0.02	0.12	0.01												
Sing (6)	-0.02	0.02	0.09	-0.10	0.20											
Secrete milky substances (7)	-0.13	-0.08	-0.13	0.02	0.10	0.13										
Inflate or explode (8)	0.01	0.06	-0.03	-0.03	-0.05	0.12	0.21									
Cause warts (9)	0.09	0.12	-0.11	0.00	-0.11	-0.09	0.20	0.27								
Carry diseases (10)	-0.04	0.10	-0.23	0.07	-0.13	-0.08	0.07	0.12	0.34							
Are harmful (11)	-0.09	-0.04	-0.39	0.10	-0.09	-0.16	0.06	0.13	0.21	0.24						
Number of known taxonomic groups (12)	0.10	0.03	-0.03	0.12	-0.07	-0.06	-0.03	-0.11	0.00	0.00	0.03					
Number of species of anurans (13)	0.14	0.07	0.10	0.08	0.03	0.06	-0.02	0.01	-0.03	-0.07	0.01	0.06				
Age (14)	0.05	-0.03	0.23	-0.20	0.14	0.26	0.03	0.19	-0.10	-0.21	-0.19	-0.13	0.11			
Gender (15)	-0.10	-0.02	-0.13	-0.07	-0.02	0.04	0.05	0.10	0.10	0.05	0.06	-0.08	-0.08	0.00		
Locality (16)	-0.17	-0.24	-0.10	-0.03	0.15	0.20	0.18	0.16	0.00	0.03	0.01	-0.22	-0.18	0.07	-0.02	
Educational level (17)	0.21	0.22	0.21	-0.04	-0.10	-0.02	-0.26	-0.02	-0.07	-0.12	-0.08	0.20	0.18	0.12	0.00	-0.65

**Table 3.** Adjusted models explaining people's interest in receiving information on how to conserve amphibians in urban and rural areas in the Caribbean region of Colombia. Best adjusted model per each locality is highlighted in bold.

	AICc	RSS	Number of variables	Selected variables
Urban locality	1014.8	30691	1	3
	<b>1013.1</b>	<b>30128</b>	<b>2</b>	<b>3;4</b>
	1013.6	29895	3	3;4;7
	1014.2	29662	4	3-5;7
	1015	29473	5	3-5;7;9
	1016.3	29352	6	3-7;9
	1037.3	29098	16	All
Rural locality	751.36	8625.8	1	14
	743.18	8190.9	2	5;14
	740.58	7999.6	3	5;12;14
	737.98	7811.4	4	5;8;12;14
	736.02	7652.1	5	5;8;12;14;16
	735.18	7537.1	6	2;5;8;12;14;16
	734.84	7442.2	7	2;5;6;8;12;14;16
	<b>734.56</b>	<b>7349.8</b>	<b>8</b>	<b>1;2;5;6;8;12;14;16</b>
	747.23	7138.4	16	All

1 = Medicinal use; 2 = Use for food; 3 = Are nice; 4 = Use for pets; 5 = Control harmful insects; 6 = Sing; 7 = Secrete milky substances; 8 = Inflate or explode; 9 = Cause warts; 10 = Carry diseases; 11 = Are harmful; 12 = Number of known taxonomic groups; 13 = Number of species of anurans; 14 = Age; 15 = Gender; 16 = Educational level

## Figures

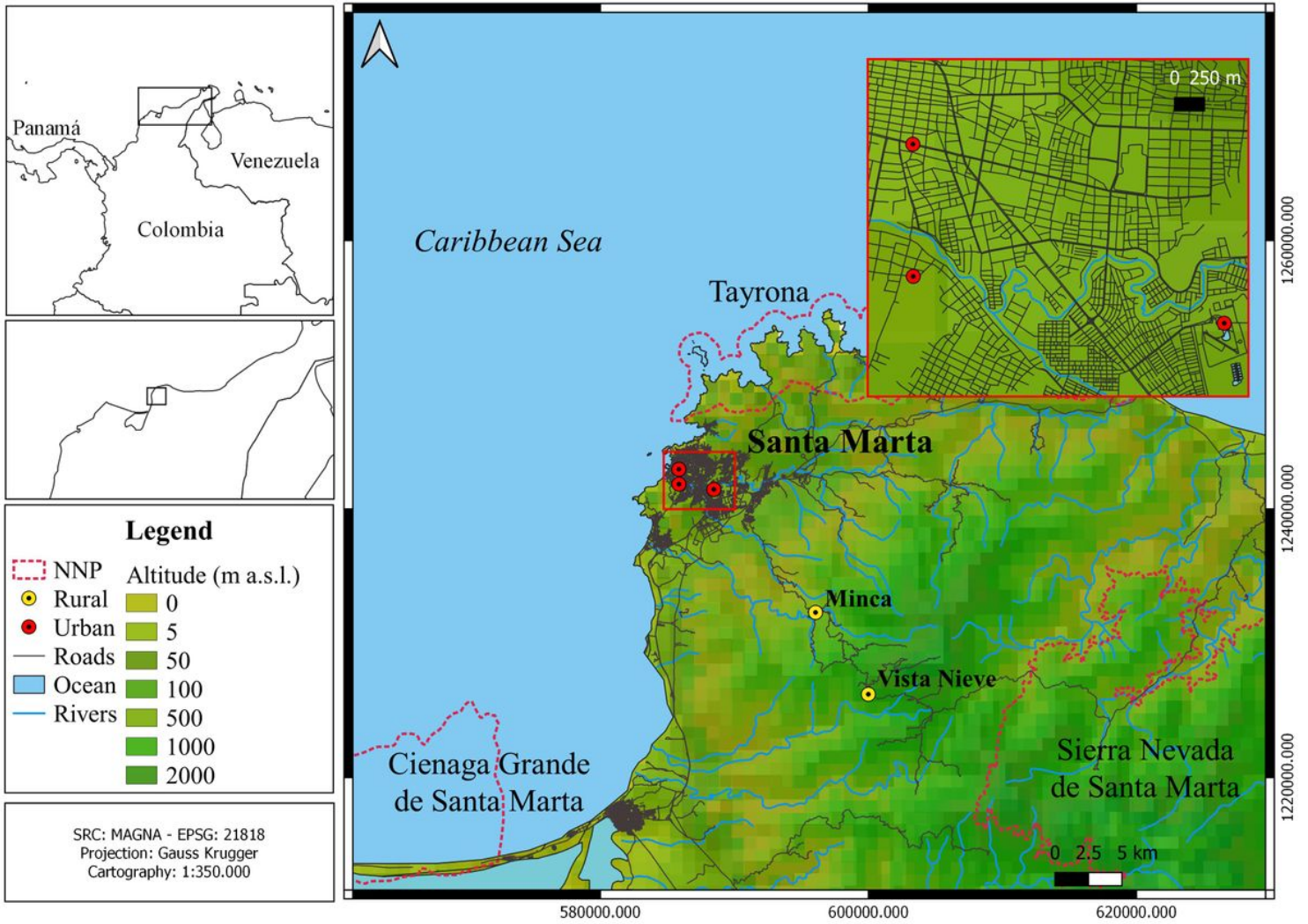
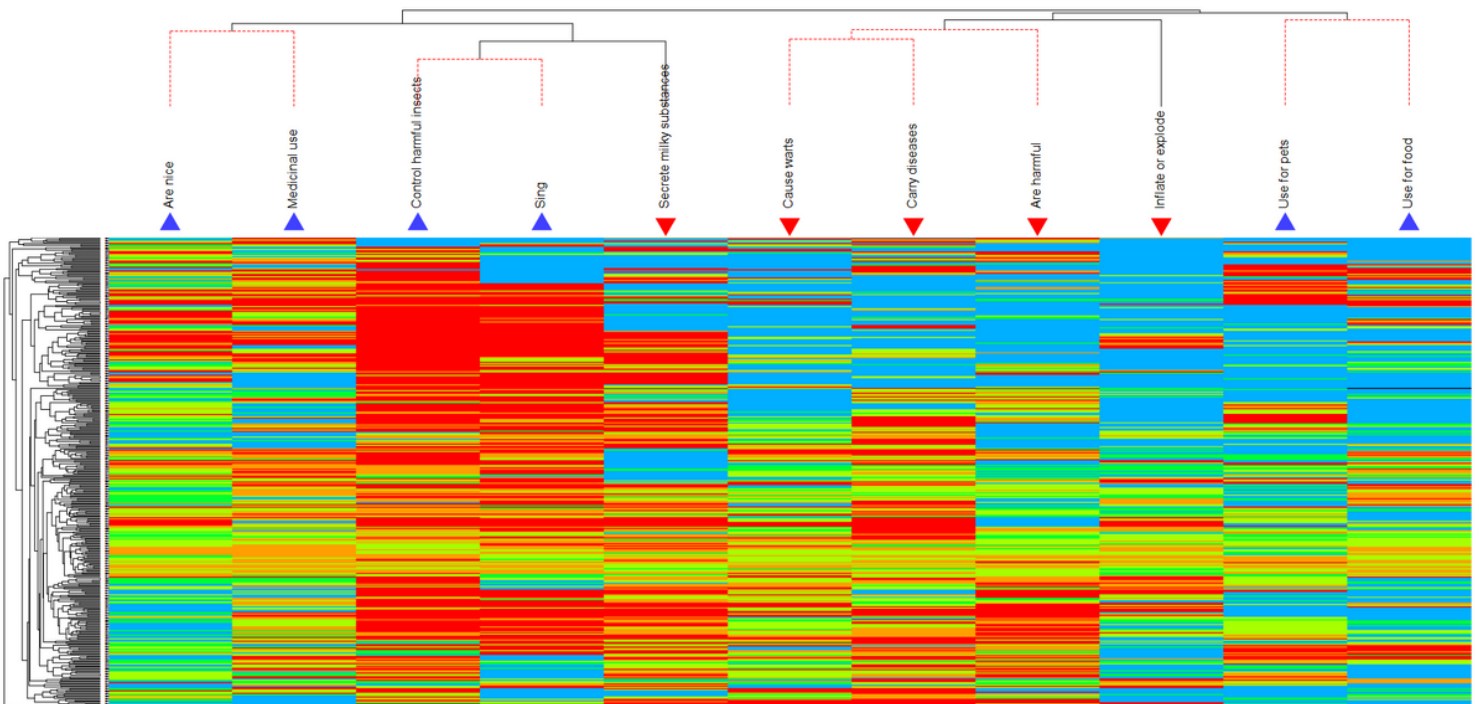


Figure 1

Study area in Santa Marta, Colombia.



## Figure 2

A species heat map of the perceptions of amphibians of the people interviewed in urban and rural locations in the Caribbean region of Colombia. For each person (left tree) their association degree with perception is represented (Whittaker index) with a color palette that goes from red to blue; the hotter tones represent the highest level of association of a person for a specific perception. Positive perceptions are showed by a blue triangle and negative perceptions with a red inverse triangle and were classified into six groups with a mix of positive and negative perceptions.

## Supplementary Files

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