The Beaver Population Status in The Upper San Pedro River Basin, Sonora.

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***Abstract**--The beaver (Castor canadensis) inhabits a riparian ecosystem surrounded by grasslands, desert thickets and mountain ranges in the so-called Sky Islands. In the period from december 2015 to november 2016, monitoring was carried out to determine relative abundance by photo trapping and density using the direct observation method. We identified five sites with presence of the species. The first data of relative abundance and density for the area was reported. This work represents a joint effort for beaver conservation among civil society organizations, academics and government agencies; this species is considered endangered in Mexico.*

INTRODUCTION

The beaver (*Castor canadensis*) is considered worldwide a species of least concern by the IUCN list, however, in Mexico it is an endangered species (DOF 2010 NOM-059-SEMARNAT-2010) due mainly to hunting and low availability of habitats among other factors (Ceballos and Oliva 2015, DOF 2010, Cassola 2016). Despite being in this category, the beaver status of the San Pedro River Basin (SPRB) is unknown, but it is presumed that its population persists in small numbers (Ceballos and Oliva, 2015). Beaver populations in northeastern Sonora are located in a region with diverse topography and vegetation, where it is possible to find grasslands and desert thickets that interact with mountain ranges and riparian ecosystems. The beaver is known as the ecosystem engineer for its ability to modify the landscape, since by foraging and building dams is able to create more suitable habitats for the development of aquatic birds, fish, amphibians, reptiles, and invertebrates, as well as the establishment of aquatic and riparian plants; its importance is critical for the regional diversity of riparian species (Browning-Aiken et al. 2004, Jakes et al. 2007, Pelz et al. 2005). Therefore, the purpose of this work was to determine its population status within the San Pedro River Basin.

AREA OF STUDY AND METHODS

Study Area

The San Pedro River Basin is located in northwestern Mexico, in the state of Sonora and southwest of the United States, in Arizona. The Mexican portion is represented by a valley surrounded by mountain ranges, remaining open in its northern portion where it connects with the United States until it joins the Gila River, in Arizona. The present study comprised five observation sites between the municipalities of Cananea and Santa Cruz (Los Fresnos, Las Chivas, Las Nutrias, El Novillo and San Rafael), which encompass a series of continental wetlands, made up of seasonal streams (Figure 1; Juárez 2009).

Materials and Methods

Distribution: The samplings were carried out from December 2015 to November 2016. Two sampling methods were used to determine the presence of the beaver: direct observation using linear transects along the river and the photo-trapping technique. The surveys were carried out monthly in a 1 km linear transect in the five sampling sites. The activity of the beaver was determined by gnawed trees, dams, active burrows and by direct sighting (Nelson and Nielsen 2011, Pelz et al. 2005). The maximum number of beavers seen at the same time was determined (Bau 2001). Additionally, 12 trap cameras were distributed in the sampling sites (Karanth and Nicholson 1998; Table 1). Each camera was placed at 200 linear meters in a 1 km transect, starting from the sites where there was the highest activity, preferably on the river bank. This criterion was based on the semi-aquatic habits of the species (Feldhamer et al. 2003).

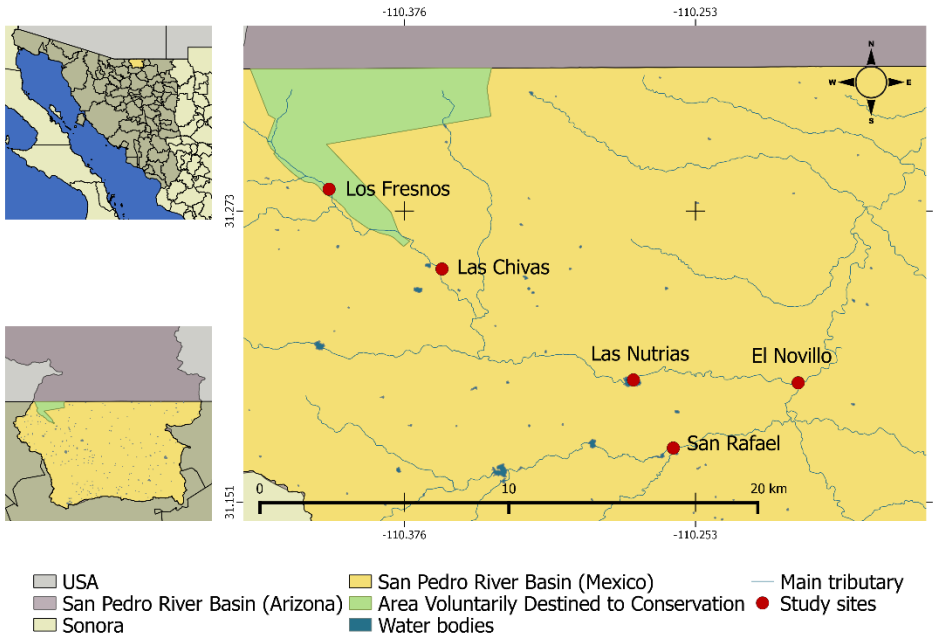

Figure 1. Sampling sites in the San Pedro River Basin, Sonora, Mexico (Map by: Stephanie Olivares).

Relative abundance and density: The photographic records of beaver were separated using the methodology proposed by Kelly et al. (2008). The Relative Abundance Index (RAI = C/MS * 100 trap days) was determined by the capture-recapture method (Chávez et al. 2013). The density was calculated by dividing the estimated abundance by direct observation method between the Effective Sampling Area (ESA), which was 15.02 km^2. This result was reported as individuals per km^2: D = N / A (D = density, N = abundance obtained by direct observation method, A = Effective Sampling Area in km^2).

RESULTS

Distribution

The activities of the beaver extend in 1 km long in a straight line per site. In all the sampling sites, agricultural activities are practiced, such as livestock. Burrows, dams, and recent gnawed trees were recorded throughout the year (Table 2). During the study, 15 beavers were recorded distributed in three of the five sampling sites (Table 3). No beaver could be observed in two sites (Las Chivas and San Rafael), but records of recent traces indicate that their presence is still active in those places, and at least there is one beaver in both sites.

Relative abundance and density

Twelve trapping stations were placed, and the total sampling effort was 1,646 trap days. We obtained a total of 432 photographs of ten species of mammals, of which 169 were of beaver. According to the RAI, the beaver was more abundant during period three (Figure 2). The density obtained by the direct observation method was 1.13 ind/km^2.

Table 1. Number of camera-traps and sampling effort per site in the San Pedro River Basin, Sonora (December 2015 – November 2016).

Site	Camera	Days	
		Dry season (Dec 2015 to Jun 2016	Wet season (Jul to Nov 2016)
Los Fresnos	1	61	43
	2	61	43
	3	28	43
Las Chivas	4	62	99
	5	62	99
Las Nutrias	6	62	17
El Novillo	7	62	100
	8	62	100
	9	62	100
San Rafael	10	61	99
	11	61	99
	12	61	99
	Sampling effort (camera-days)	705	941

Table 2. Traces of beaver (*Castor canadensis*) in each of the five sites sampled within the San Pedro River Basin, Sonora (December 2015 - November 2016).

Site	Gnawed tree	Burrow	Dam
Los Fresnos	37	3	7
Las Chivas	10	5	2
Las Nutrias	42	5	1
El Novillo	33	3	2
San Rafael	20	1	4

Table 3 — Number of beavers sighted within the San Pedro River Basin, Sonora (december 2015 - november 2016).

Site	Number of beavers	Adults	Juveniles
Los Fresnos	6	5	1

Las Chivas	0	0	0
Las Nutrias	7	5	2
El Novillo	2	2	0
San Rafael	0	0	0

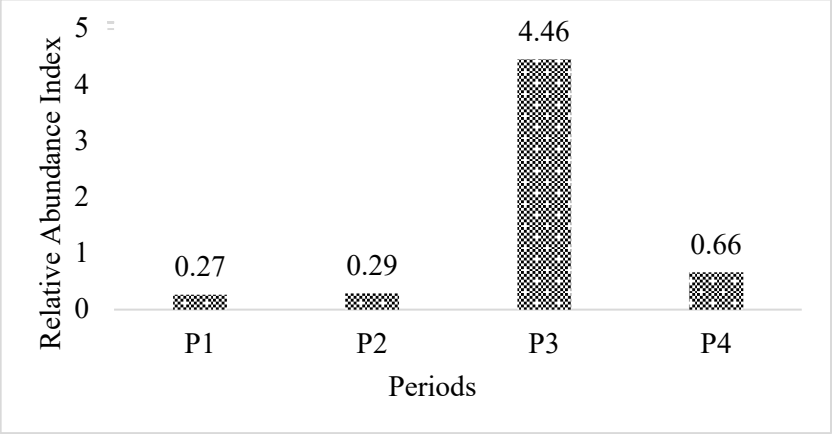

Figure 2. Relative abundance of beaver (*Castor canadensis*) obtained by photo-trapping in the San Pedro River Basin, Sonora (december 2015 – november 2016). *P1: dec 2016-jan 2016; P2: feb-mar 2016; P3: jun-aug 2016; P4: sep-nov 2016.

DISCUSSION

In the five sampling sites the beaver colonies were distributed to no more than one km long in the streams. The home range of the beaver is not documented in Mexico, but there are data reported in the United States and Canada that support these observations: Aleksiuk (1968), and Jenkins and Busher (1979) determined its distribution in 800 m of the river, Müller-Schwarze and Sun (2003) observed traces of beaver at 500 m in Manitoba and Ontario in Canada, while in California it has been observed that they move between 200 and 800 m, reaching 3.4 km in Illinois (Havens et al. 2013). In the San Pedro River Basin (SPRB), the maximum distance travelled in the river was of one km, which coincides with what was previously reported. Regarding beaver abundance, Toyos and Amador (2014) recorded 36 individuals within the SPRB, twice the number of individuals registered in the present study. Mearns (1907) describes beavers as extremely shy and difficult to watch when in contact with potential predators, which is possibly why in two sites no specimen was observed. The density reported in this work is low in contrast to those reported in other regions of its distribution such as: Alberta, Canada (4.6 ind km^{-2}) and New York, United States (4.8 ind km^{-2} (Feldhamer et al. 1982, Novak 1987); but it resembles the results in previous studies in Sierra San Luis, near Aguaprieta, Sonora (Pelz et al. 2005). Nevertheless, the observation of pups tells us that it is possible to recover the numbers that were available in the SPRB in the 19th century (Carrillo et al. 2009). But it must be taken into account that not all currents can withstand high levels of activity by beaver and probably 100 years ago the conditions of the SPRB were different from those currently known. The distance of natural dispersion varies greatly and also depends on the location of the habitat and its quality (Feldhamer et al., 2003). In the literature it is point out that the home range of the beaver depends on many factors: sex, age and family organization; but it mostly depends of water fluctuation and woody material availability (Feldhamer et al. 2003, Fustec et al. 2001, Maringer and Slotta-Bachmayr 2006). In the SPRB there are no records of relative abundance of beaver and the surrounding species using camera-traps, but the species has been intentionally monitored with this technique in some affluents of Mexico and also in different parts of the United States and Scotland to confirm its presence (Campbell-Palmer et al. 2016, Carreón et al. 2016).

CONCLUSIONS AND RECOMMENDATIONS

Among the possible threats, it highlights the overlap with human activities such as livestock; however, the beaver persists in these places, which tells us that it is a species with a plasticity that allows it to coexist within these environments and is not limited due to its crepuscular habits. Even so, it must be considered if the presence of cattle limits population growth due to native vegetation loss, damage of soils and stream banks (contamination of waterways with fecal waste), or if the beaver population has reached its maximum number of members it can hold without depleting the resources. The requirements of the beaver will be different to those registered in other northern regions, because beavers tend to move along the stream depending of the ecological conditions (Pelz et al. 2005). This work shows the first records of relative abundance and density for the beaver within the SPRB, so the continuity of this type of studies is important to understand the dynamism of the population over time. To complement and contrast the indices of abundance, another type of indirect methodologies can be used, such as the registration of traces of footprints and excreta. Although direct observation is the most effective method to document the behavior of the species in its natural environment, it gives us small sample sizes and is much more invasive. It is proposed to continue using both methods as complementary alternatives and not as a substitute for the other.

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