

Monitoring native killifish in the La Paz metropolis by citizen scientists: advantages and opportunities

Monitoreo de peces killis nativos en la metrópoli de La Paz por científicos ciudadanos: ventajas y oportunidades

SHORT COMMUNICATION/ NOTA CIENTÍFICA

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ABSTRACT

The Metropolitan Region of La Paz (MRDLP) in Bolivia has grown with minimal planning, leading to major changes to the natural habitat. Currently, citizen science is becoming an important contributor of information on the biodiversity of urban areas. This study presents novel records of native Andean killifish (*Orestias* spp.) in the MRDLP obtained from the iNaturalist website, expanding its distribution and highlighting the important role of citizen participation as a tool to expand biodiversity knowledge and monitoring of ecosystems sensitive to climate change

Keywords: Conservation, *Orestias*, La Paz valley, iNaturalist, Bolivia

RESUMEN

La Región Metropolitana de La Paz (RMDLP) en Bolivia ha crecido con una planificación mínima, modificando el hábitat natural. Actualmente, la ciencia ciudadana se está convirtiendo en un importante contribuyente de información sobre la biodiversidad de las áreas urbanas. Este estudio presenta registros de peces killis nativos de los Andes (*Orestias* spp.) en el RMDLP, obtenidos del sitio web iNaturalist. Este estudio aporta

nuevos registros de *Orestias* en el RMDLP, ampliando su distribución y destacando el importante papel de la participación ciudadana como herramienta para ampliar el conocimiento de la biodiversidad y el seguimiento de los ecosistemas sensibles al cambio climático

Palabras clave: Conservación, *Orestias*, Valle de La Paz, iNaturalist, Bolivia

INTRODUCTION

Current environmental problems create severe challenges for conserving the environment and its biodiversity. Today, our planet's biological and physical systems are undergoing rapid rates of change as the impact of human activities becomes increasingly evident (Pimm & Raven 2000, Steffen *et al.* 2011). Cities have multiplied and expanded worldwide (McMichael 2000), associated with stress factors for nature such as deforestation, climate change, and urbanization. It is estimated that the major cities in the tropical Andean region will experience a high population growth rate and a consequent increase in water demand, making the region's aquatic environments vulnerable (Alcamo *et al.* 2007, Kinouchi *et al.* 2019).

In Bolivia, over the last 30 years, El Alto, the highest city in the world and the largest city on the Altiplano, has been one of the fastest-growing urban areas in South America (Archundia *et al.* 2017). This city, which before 1985 was a suburb of La Paz, has grown with minimal land planning, accompanied by a rapid population increase. Currently, as a result of the process of urbanization and population growth, eight municipalities, including El Alto and La Paz city, constitute the Metropolitan Region of the Department of La Paz (MRDLP), where the main economic, political, and social activities are concentrated (GAMLP 2017). This growth of the MRDLP brought with it a loss of habitat, extinguishing aquatic ecosystems inhabited by the carachi (*Orestias* spp), native killifish of the Andes (Parenti 1984, Lauzanne 1992). The genus *Orestias* is an endemic group inhabiting freshwater systems in the inter-Andean basin between Peru (Ancash), Bolivia (La Paz, Oruro, Potosí), and Chile (Antofagasta), distributed from 11° to 12° S, in altitudes from 2 800 m to 4 600 m of elevation (Parenti 1984, Lauzanne 1992, Vila *et al.* 2010, De La Barra *et al.* 2020). To date, the *Orestias* records in the MRDLP are distributed from Lake Titicaca's tributary rivers to La Paz's valley, mainly in lake and wetland systems. The presence of this native fish has been confirmed in the Achocalla lagoon, Huni, in Alto de Animas in La Paz (Sarmiento & Barrera 2017), and small wetlands near Lake Titicaca in Laja and Pucarani (Loayza & Miranda-Chumacero, personal observation). However, their situation in the rest of the MRDLP is poorly known, and the *Orestias* populations that existed in other aquatic systems in the valley of La Paz may be considered extinct. As native fish, conservation efforts are needed for carachi, which

require knowledge about the distribution of the species. Nonetheless, obtaining information on all small aquatic ecosystems in the MRDLP is a challenge.

Currently, public participation is a crucial factor for monitoring, as it holds great potential to gather information. Furthermore, activities such as the annual *City Nature Challenge* make cities aware that they are also part of nature (Wallace *et al.* 2019). Therefore, the effectiveness of potential conservation efforts in cities requires public input, participation, and engagement in developing and monitoring solutions. Here we describe how citizen science can contribute inputs and provide opportunities to the conservation of carachi in the MRDLP. These actions are especially relevant because of the imminent impacts of climate change, including the reduction of glacier cover surrounding the MRDLP and the reduction of water availability due to the loss of small lakes.

MATERIAL AND METHODS

Study area

The MRDLP covers the municipalities of La Paz, El Alto, Palca, Mecapaca, Achocalla, Viacha, Pucarani and Laja. The MRDLP covers 7 284 km² with a total population of 1 831 350 inhabitants. It is located between two large physiographic units, the Cordillera and the Altiplano, divided into 13 subunits (GAMLIP 2017). This variety of subunits is generated due to the sharp altitudinal gradient that ranges from 400m altitude in the Andean foothills to 6 450 m at the summit of the Illimani mountain (Wallace *et al.* 2019). However, water bodies occupy only 1% of the total area. The MRDLP includes four Level 4 river basins: the Guaquirá River, the Kaka River, the Kusillo Jahuira River, and the Sehuenca River (Figure 1) (GAMLIP 2017).

Existing water bodies along the MRDLP are not well studied. The rivers that enter the La Paz valley originate in the Eastern Cordillera, in the snow-capped peaks of Chacaltaya, Charquini, Mururata, and Illimani. There are 352 temporary streams in this valley, whose hydrological regime is strongly dependent on the climatic seasonality of the region (Marin *et al.* 2017). Additionally, the valley's wetlands and lagoons have been modified to increase the volume of water stored to supply the city of La Paz, and for recreation, such as the Achocalla Lagoon.

Only three fish species are reported in the La Paz valley: rainbow trout (*Oncorhynchus mykiss*) and carp (*Cyprinus carpio*), which are both introduced species. The third is the carachi (*Orestias agassizii*), the only native killifish widely distributed in the Bolivian Altiplano (Sarmiento & Barrera 2017). The latter was previously reported in wetlands (bofedales) and lake systems.

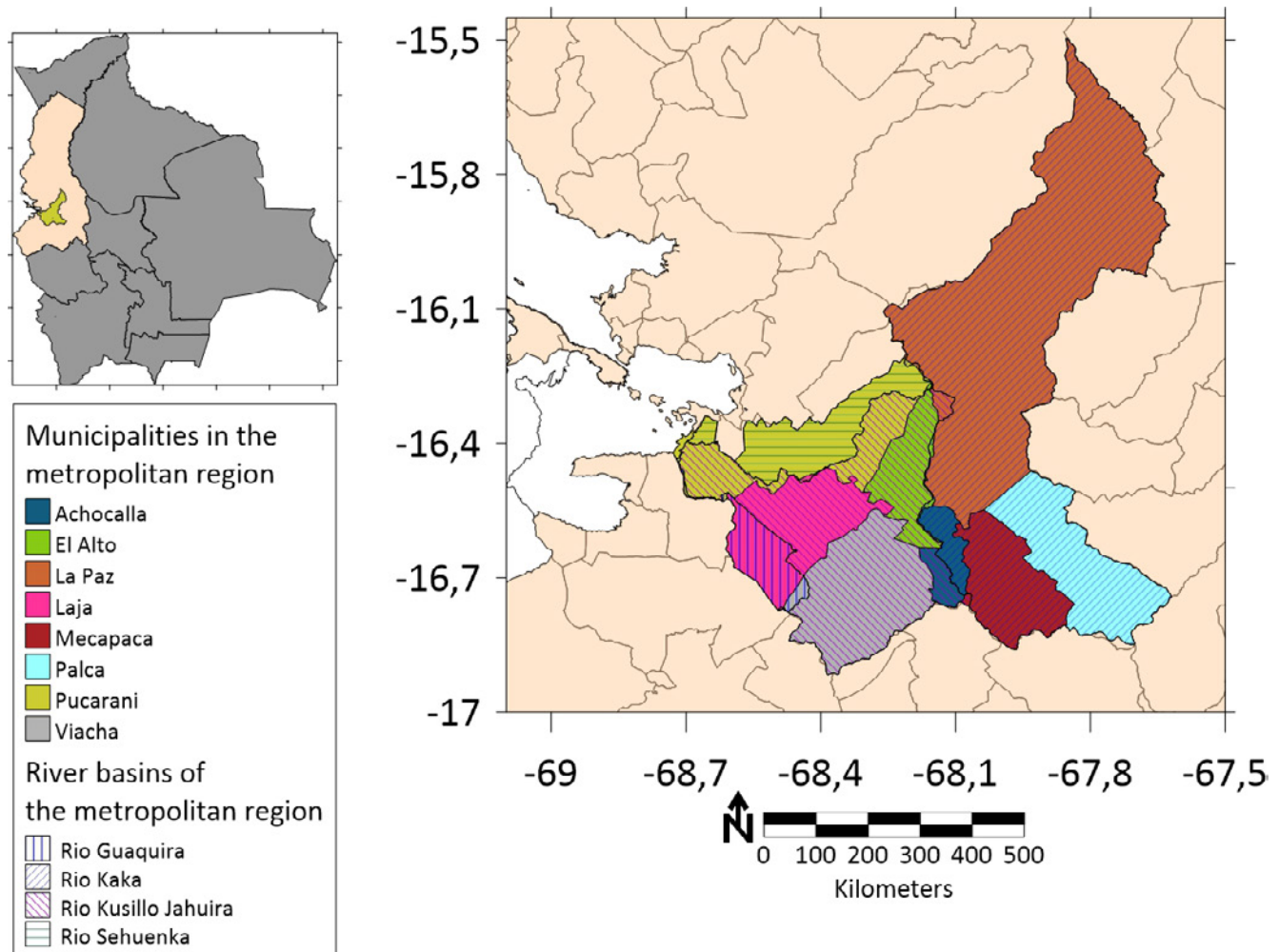


FIGURE 1. Map of the Metropolitan Region of the Department of La Paz (MRDLP)

Data collection

The data were extracted from the iNaturalist platform (www.inaturalist.org), as this was the free application used during the *City Nature Challenge* in La Paz in 2019. This application has more than 105 million biodiversity records worldwide since 2008.

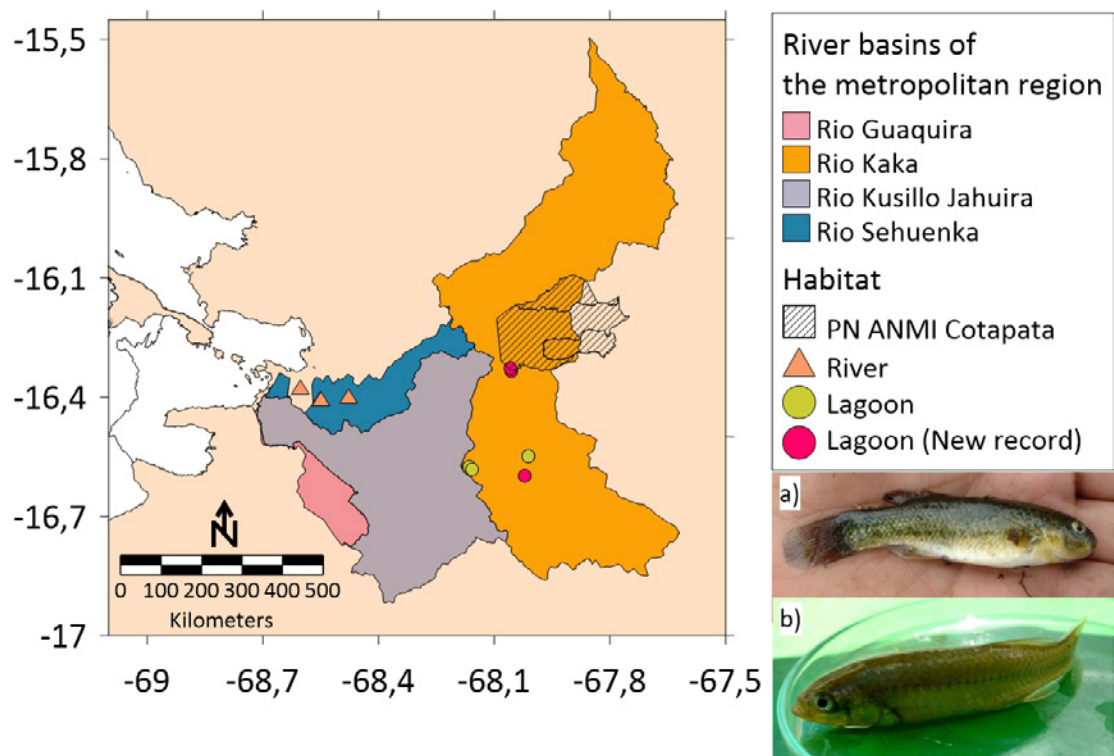
On the iNaturalist platform, the “explore” tab was selected, and “Orestias” entered as species and “Bolivia” as Location in the search. Then in the filters tab, “Fish” was clicked in categories and “download”. The latter generates a new window where the filters were further defined: in Export Observations: (section 1 Create Query), the area delimited search was restricted to south latitude: -16.916 and north latitude -16.32. No longitude delimitation was applied, and the other sections (2 and 3) were left as default. Then in section 4, Create Export was selected and the CVS file downloaded. The observations range from April 2019 to the file creation date (October 2021).

We reviewed the data in the CVS file. Firstly, we corroborated the consistency of the geographic position of the records. Additionally, the type of environment of the record was noted, differentiating between rivers, wetlands, and lagoons. In addition, the altitude of each record was obtained through Google Earth software. Finally, we eliminated duplicate records based on the geographic position and date to avoid data redundancy.

RESULTS

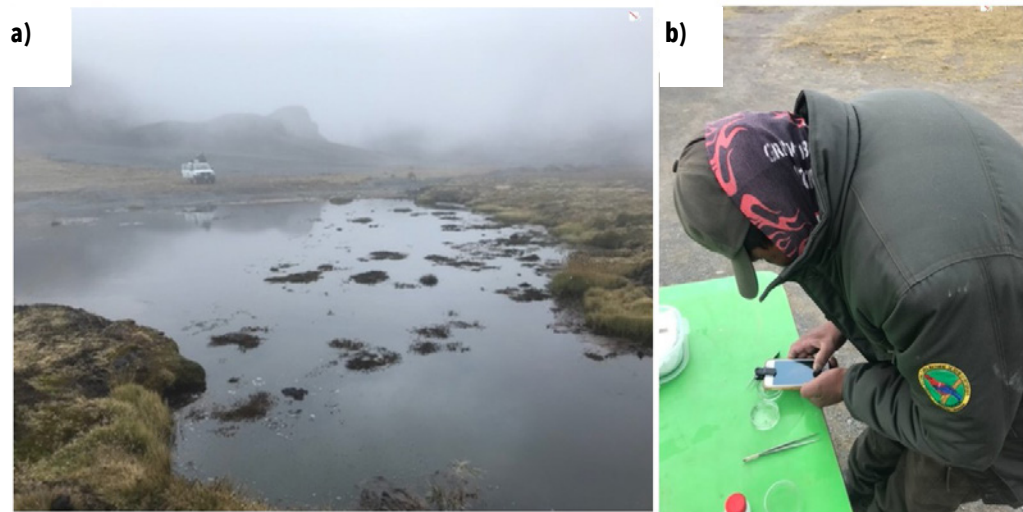
A total of 32 records were obtained. However, ten were wrongly positioned and ten were redundant records. Therefore, only 12 records were used. All user records made in lagoons (8 records) belong to the Kaka River basin, mainly in Achocalla and Huni lagoon. The records from the Sehuenca River basin were in the riverbed (4 records).

Furthermore, two records were obtained from lagoons where *Orestias* was not previously reported. The most outstanding is the record of *Orestias agassizii* in the Cotapata lagoon, in the sub-basin of the Kaka River. This lagoon is located within the Cotapata National Park and Natural Integrated Management Area (PNANMI Cotapata), so the presence of *Orestias* would add to the list of fish species present in this national park.



The records' altitude ranged from 3 652 m to 4 797 m. One record reported in the *City Nature Challenge* in La Paz was the highest record for *Orestias* (4 797 m) within PNANMI Cotapata (Figure 3a), thus exceeding the maximum altitude reported for this endemic genus (Parenti 1984, Sarmiento & Barrera 1997, Vila *et al.* 2010, Sarmiento & Barrera 2017).

FIGURE 3. Records from the *City Nature Challenge* in La Paz, 2019: a) Cotapata lagoon, Kaka River basin in PNANMI Cotapata (4 797 m); b) PNANMI Cotapata park rangers photographically recording the park's biodiversity during the *City Nature Challenge* in La Paz, 2019.



DISCUSSION

Citizen science can be defined as involving the public in a scientific project, producing data and information that is reliable and usable by scientists, decision-makers, or the people, and that is open to the same system of peer review that applies to conventional science (McKinley *et al.* 2017). The public can contribute to science by collecting data, as this scientific note shows.

Citizen participation allows a larger area to be covered, as well as evaluation over time. For example, information generated through citizen science is useful for biological monitoring, allowing the generation of migration patterns in birds (Schubert *et al.* 2019) or tracking fish migrations (Johnson *et al.* 2021). It is also possible to take advantage of these tools to monitor the resilience of fauna to the advance of urbanization, or climate change, particularly in sensitive ecosystems.

In the case of the Altiplano in Bolivia, where an increase of 4 °C by 2100 is projected (Anthelme *et al.* 2014), events such as the *City Nature Challenge* in La Paz in 2019 are generating many iNaturalist records. This challenge achieved second place in observations (> 46 000 observations) and third place in participation with 1 500 observers (Wallace *et al.* 2019), including more than 50 researchers from different scientific institutions. Strengthening, supporting, and increasing

this activity will bring the population closer to scientific research. In addition, by supporting the dissemination of applications such as iNaturalist, it is possible to exploit the growing attraction of trekking in the Apolobamba, Choro, and Takesi mountain ranges to increase the descriptions of the country's biodiversity (Figure 3b). Taking advantage of citizen records increases the sampling effort, which is usually a limitation in scientific expeditions. For instance, new knowledge about the altitudinal distribution of the genus *Orestias* was obtained within this note, as two records exceeded the altitudinal limit described for this genus in the literature. Furthermore, involving citizens in monitoring fish, especially in extreme conditions such as the High Andes, could be a tool to generate early warnings of situations that can be mitigated before entire fish populations are lost forever.

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