



Occurrence of long–distance migratory fish *Prochilodus lineatus* (Valenciennes, 1837) (Characiformes: Prochilodontidae) in the Mirim lagoon watershed, Uruguay-Brazil: Updating and Distribution

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Abstract. Records of the long-distance migratory *Prochilodus lineatus* extend its distribution to the southernmost part of the Brazilian territory, in the Jaguarão river, and confirm the record for the Uruguayan territory of Mirim lagoon and Tacuarí river. Twenty-two individuals reported body sizes ranging from 320 mm – 540 mm total length.

Key words: spatial distribution, potamodromous, Jaguarão river, Tacuarí river, subtropical lagoon.

Ocorrência do migrador de longa distancia *Prochilodus lineatus* (Valenciennes, 1837) (Characiformes: Prochilodontidae) na bacia hidrográfica da laguna Mirim, Uruguai-Brasil: Atualização e Distribuição. Resumo: Registros do migrador de longa distância *Prochilodus lineatus* que estendem a distribuição para o extremo sul do território brasileiro, no rio Jaguarão, e confirmam os registros no território uruguaio da lagoa Mirim e no rio Tacuarí. Um total de 22 indivíduos foram capturados com comprimento total entre 320 mm e 540 mm.

Palavras-chave: distribuição espacial, potamodromo, rio Jaguarão, rio Tacuarí, lagoas subtropicais.

The Patos-Mirim lagoon system basin covers an area of 201,626 km² and is classified as the Lagoa dos Patos Ecoregion (N° 334, Abell *et al.* 2008). The fish fauna comprises 200 native freshwater species (Bertaco *et al.* 2016) and at least 18 non-native freshwater fish species from diverse origins (Asia, Africa, North America, European and the Río de la Plata basin) (Loureiro *et al.* 2020; Bertaco & Azevedo 2023). However, differences in species distribution are remarkable within each major drainage in Rio Grande do Sul State, but most of these patterns have not been explored or adequately described (Bertaco *et al.* 2016).

The Mirim-São Gonçalo lagoon watershed represents 30.87% (62,250 km²) of the total area of

the Lagoa dos Patos Ecoregion. The body of water in Mirim lagoon has 3,750 Km² of surface area, 2,750 Km² in Brazilian territory, and 1,000 Km² in Uruguayan territory (FAO 1972). Their main rivers are the Cebollatí (17,328 Km²), Tacuarí (5,143 Km²), and Jaguarão (8,188 Km²) (Gouvêa *et al.* 2010). This complex of rivers and lagoons is interconnected with the southern region of the Patos lagoon by the São Gonçalo channel, of natural origin, that extends for 76 km. The main tributaries of the São Gonçalo channel are the Piratini river, with an area ≈ 6,000 km² and the Pelotas river. Among the large rivers, there are small hydrographic basins distributed along the 266 km from the southern end of Mirim lagoon to the connection with the estuary of Patos lagoon.

Landscape changes began in the 1970s, when a sluice dam was built to serve as a freshwater reservoir, whose main environmental effect was the loss of estuarine habitat (Odebrecht *et al.* 2010), with a reduction of the potential estuarine area of 2,536 km² in the São Gonçalo channel Mirim lagoon (Burns *et al.* 2019). Besides, the sluice dam caused the interruption of the movements and migratory routes of marine fish species such as the anadromous catfish *Genidens barbatus* and species of Mugilidae and Sciaenidae.

In the Lagoa dos Patos Ecoregion, at least three species are long-distance potamodromous migratory fish (exclusively freshwater): *Salminus brasiliensis* (Cuvier, 1816), *Prochilodus lineatus* (Valenciennes, 1836), and *Megaleporinus obtusidens* (Valenciennes, 1836) (Alves & Fontoura 2009). Historical records of *Prochilodus lineatus* in the Patos lagoon watershed are restricted: i) the main rivers of the Atlantic Ridge of the Serra do Sudeste

(i.e., Jacuí river and Camaquã river) (Malabarba 1989; Alves & Fontoura 2009); ii) the limnic portion of the Patos lagoon (Garcez & Sanchez-Botero 2005; Ceni *et al.* 2016) and iii) the estuary (BEP 2015, 2016) (Fig. 1). The Piratini river and drainages of the São Gonçalo channel have the southernmost records of these species in the Mirim lagoon watershed (Burns & Cheffe 2018). Furthermore, the Museo Nacional de Historia Natural de Montevideo has a lot of *P. lineatus* collected in 1935 from the Cebollati river basin, which could represent the earliest record for these species in the area (personal communication, Marcelo Loureiro). Today, there is evidence of the presence of *Prochilodus lineatus* in the Mirim lagoon territory, where fishing landings have been reported (Loureiro *et al.* 2023). However, it is necessary to confirm the presence of this species in large rivers and its distribution in the Mirim lagoon.

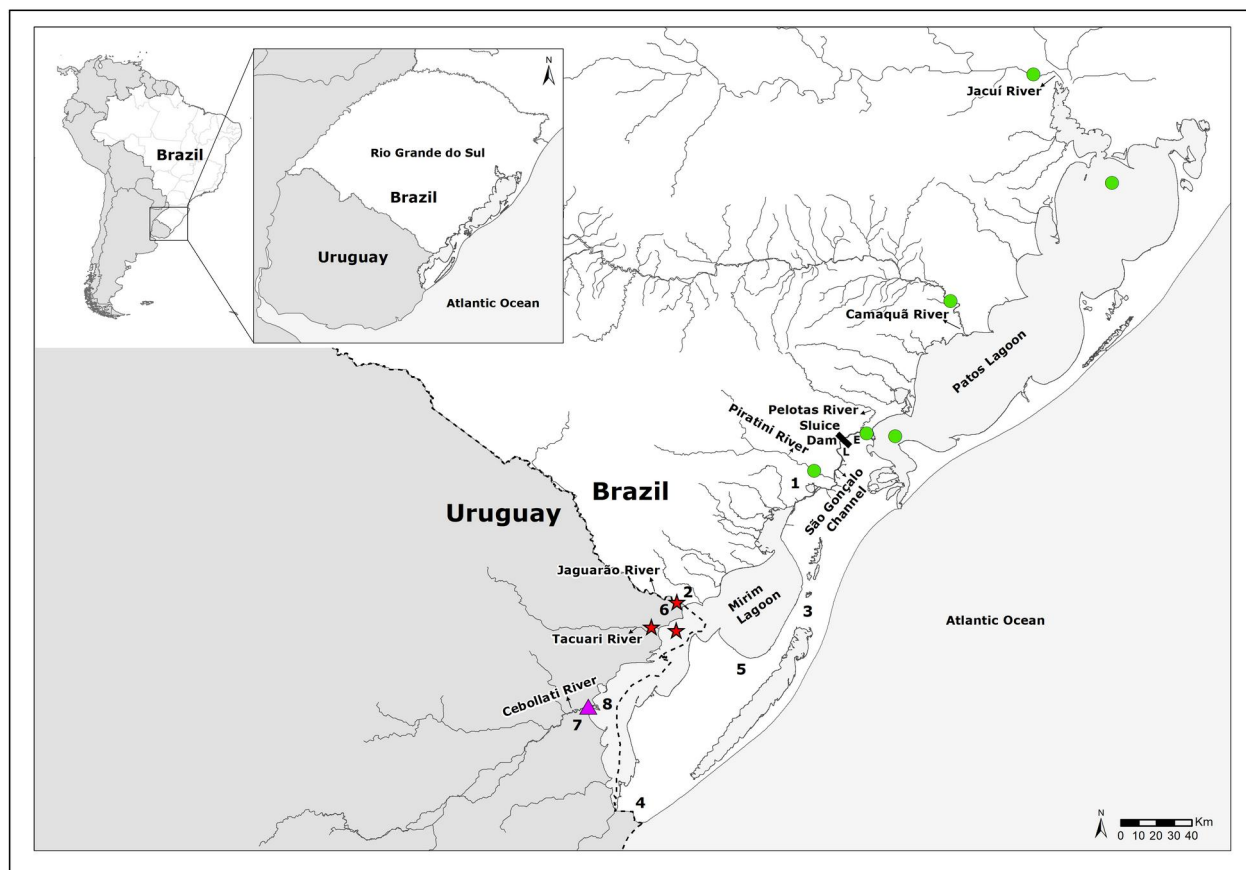


Figure 1. Lagoa dos Patos Ecoregion with the location of historical records of the *Prochilodus lineatus* (Valenciennes, 1836) (Green Circle) and the records confirmed (Red Star) in the Tacuari river, Jaguarão river, Mirim lagoon. Earliest record for these species in the area (Purple Triangle). Landing sites of artisanal fisheries around the Mirim lagoon in Brazil (Sites:1-5) and Uruguay (Sites: 6-8).

During the years 2021 and 2022, 22 individuals of the long-distance migratory *Prochilodus lineatus* were captured in three locations in the Mirim lagoon watershed, with a total length TL (\bar{x} = 461mm; range 340 –540 mm) and total weight Wg (\bar{x} =1234g; range: 500g – 1994g) (Fig. 1; Fig. 2; Table I). The first record was in the Potamal sector of the Jaguarão river during May 2021, with a total of 16 individuals captured with TL (\bar{x} : 486 mm; range: 430 – 540 mm) with a maximum weight reaching 1994g. Subsequently, in the year 2022, two individuals were caught in the Potamal sector of the Tacuarí river and four individuals in the Mirim lagoon. All individual catches were made by artisanal fishermen using gillnets of different mesh sizes. Some individuals were deposited in fish collections in Uruguay (Code number: ZVCP 15721, 15722) and Brazil (Code number: UFRGS 29747). For the fish collected in the Tacuarí river and in the Mirim lagoon, 11 cm and 13 cm knot-to-knot gillnets were used, but for the Jaguarão river, we do not have this information. These records of the occurrence of *P. lineatus* extend its distribution to

the southernmost part of the Brazilian territory, in the Jaguarão river, and confirm the record for the Uruguayan territory of Mirim lagoon and Tacuarí river. Therefore, it can be inferred that the long-distance migrator exhibits a broad spatial distribution within this hydrographic basin for Uruguay territory. On the other hand, no landings of this species have been recorded in fishing activities in the Brazilian territory of the Mirim lagoon (Garcez & Sanchez-Botero 2005), restricting its occurrence in the Jaguarão river and Piratini river (Fig. 1). Probably, factors such as the spatial distribution of rivers along the Mirim lagoon basin and the ecology of *P. lineatus* explain their distribution. To the south, the Mirim lagoon, associated with its proximity to the mouths of large rivers (Cebollati, Tacuarí and Jaguarão), forms a fluviolacustrine habitat in this region, different from its largest lagoon surface area in the Brazilian territory (Fig. 1). Besides, this is consistent with the detritivore feeding and rheophilic behavior habits characteristic of the Prochilodontidae family (Frale et al. 2022). Pattern of migration describes *P.*

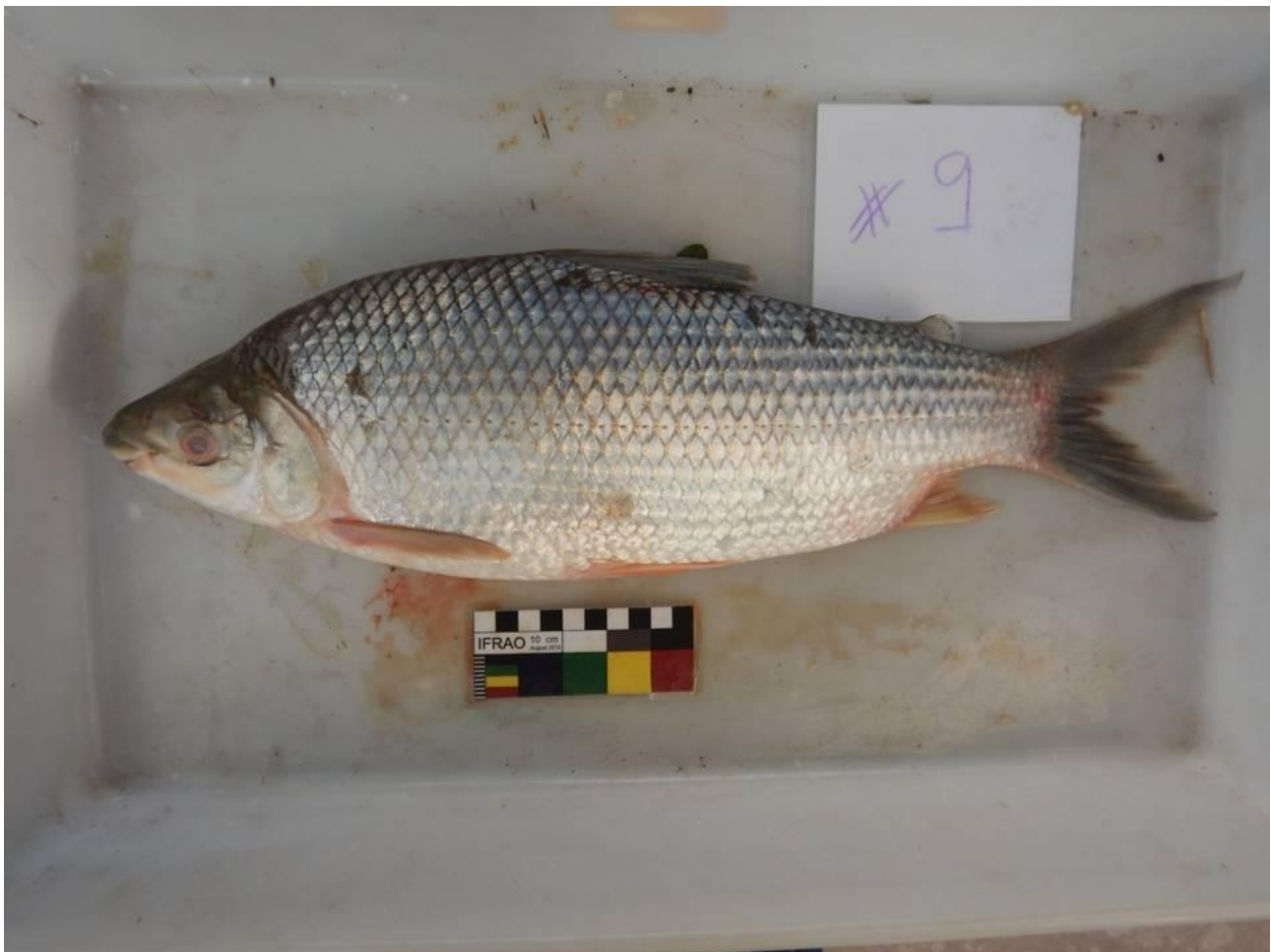


Figure 2. Individual of *Prochilodus lineatus* (Valenciennes, 1836) captured in the Jaguarão river in 2021.

Table I. Information of *Prochilodus lineatus* collected in the Mirim lagoon watershed.

Site	Period	Location	N	TL (mm)			W (g)		
				Mean	min	max	Mean	min	max
Jaguarão river	May/2021	Potamal Sector *	16	486,56	430	540	1392,63	944,00	1994,00
Tacuarí river	June/2022	Potamal Sector (32°46'50.4"S 53°23'56.8"W)	2	445	410	480	1085,25	837,2	1333,3
Mirim lagoon	June/2022	Lagoon (32°47'21.2"S 53°08'44.3"W)	4	368,75	340	435	674,93	500,30	1105,60

* Without geographic coordinates

lineatus performing seasonal reproductive migrations of the population along rivers (e.g. Carolsfeld *et al.* 2004), exploring even estuary regions (Avigliano *et al.* 2017), enhancing the dispersion capacity of its individuals throughout the river, lagoon and estuarine environment of this Ecoregion. Based on the historical record of the Cebollatí river and the presence of adult individuals reported for the large rivers and Mirim lagoon of the Mirim-São Gonçalo lagoon watershed, we hypothesize that the occurrence of *P. lineatus* may be part of native populations in these rivers. In this context, it is necessary to study and understand the diversity of the fish fauna to create protective areas for migratory fish, where large rivers are free-flowing, and to promote support for the sustainability of fishing activities.

Ethical statement

All fish used in the present study were donated by fishermen. The investigation did not require approval by an Ethics Committee.

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References

Abell, R., Thieme, M. L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., Coad, B., Mandrak, N., Balderas, S. L., Bussing, W., Stiassny, M. L. J., Skelton, P., Allen, G. R.,

Unmack, P., Naseka, A., N.g R, Sindorf, N., Robertson, J., Armijo, E., Higgins, J. Y., Heibel, T. J., Wikramanayake, E., Olson, D., López, H. L., Reis, R. E., Lundberg, J. G., Pérez, M. H. S & Petry, P. 2008. Freshwater ecoregions of the world: a new map of biogeographic units for freshwater biodiversity conservation. **Bioscience**, 58 (5): 403-414.

Alves, T. P. & Fontoura, N. F. 2009. Statistical distribution models for migratory fish in Jacuí basin, South Brazil. **Neotropical Ichthyology**, 7 (4): 647 - 658.

Avigliano, E., Pisonero, J., Dománico, A., Sánchez S. & Volpedo, A. V. 2017. Migration and brackish environment use of *Prochilodus lineatus* (Characiformes: Prochilodontidae) inferred by Sr:Ca ratio transects of otolith. **Neotropical Ichthyology**, 15(3): e170055.

Bertaco, V. A., Ferrer, J., Carvalho, F. R. & Malabarba, L. R. 2016. Inventory of the freshwater fishes from a densely collected area in South America — a case study of the current knowledge of Neotropical fish diversity. **Zootaxa**, 4138 (3): 401 – 440.

Bertaco, V. A. & Azevedo, M. A. 2023. Non-native freshwater fish from drainages of Rio Grande do Sul State, Brazil. **Papéis Avulsos de Zoologia**, 63: e202363003. 1-17.

BEP. 2015. **Boletim Estatístico da Pesca Marinha e Estuarina do Sul do Rio Grande do Sul**. Universidade Federal do Rio Grande, Rio Grande, Brasil, 58p.

BEP. 2016. **Boletim Estatístico da Pesca Marinha e Estuarina do Sul do Rio Grande do Sul**. Universidade Federal do Rio Grande, Rio Grande, Brasil, 57p.

- Burns, M. D. M. & Cheffe, M. M. 2018. New records of long-distance migratory fish in São Gonçalo channel basin, southern Brazil. **Pan-American Journal of Aquatic Sciences**, 13(1), 88-92.
- Burns, M. D. M., Velasco, G. & Cheffe, M. M. 2019. São Gonçalo channel as an ecological corridor for the movement of migratory fishes: Environmental history and perspectives for fishery management in the Mirim lagoon, South Brazil. **Revista Costas**, 1(1): 147-164.
- Carolsfeld, J., Harvey, B., Ross, C. & Baer, A. 2004. **Migratory fishes of South America: biology, fisheries and conservation status**. Ottawa, World Fisheries Trust/World Bank/IDRC, 380 p.
- Ceni, G., Fontoura, N. F. & Cabral, H. N. 2016. The freshwater artisanal fishery of Patos Lagoon. **Journal of Fish Biology**, 89 (1): 337-54.
- Food and Agriculture Organization of the United Nations - FAO. 1972. **Desarrollo de la cuenca hidrográfica de la Laguna Merin**. Roma, Italia, 86p.
- Frale, B. W., Melo, B. F., Fontenelle, J. P., Oliveira, C. & Sidlauskas, B. L. 2022. Biogeographic reconstruction of the migratory Neotropical fish family Prochilodontidae (Teleostei: Characiformes). **Zoologica Scripta**, 51 (1) 1–17.
- Garcez, D. S. & Sanches-Botero, J. I. 2005. Comunidades de pescadores artesanais no estado do Rio Grande do Sul, Brasil. **Atlântica**, 27 (1): 17-29.
- Gouvêa, T., Zarnot, D. H. & Alba, J. M. F. 2010. Capítulo 1. Caracterização geoambiental e histórico do processo de desenvolvimento da bacia da Lagoa Mirim. Pp 19-30. *In*: Filippini Alba (Ed). **Sustentabilidade Socioambiental da Bacia da Lagoa Mirim**. Embrapa ClimaTemperado, Pelotas, Brazil, 292 p.
- Loureiro, M., Montenegro, F., Bessonart, J, Díaz, D. & Paullier, S. 2020. Presencia de tres especies de peces nativas de la cuenca del Plata en la cuenca de la Laguna Merín en Uruguay. **Boletín de la Sociedad Zoológica del Uruguay**, 29(1), 13-16
- Loureiro M., González-Bergonzoni I. & Teixeira de Mello F. 2023. **Peces de Agua Dulce de Uruguay**. Segunda Edición. Laboratorio Zoológica de Vertebrados, Facultad de Ciencias, Universidad de la República, 192p.
- Malabarba, L. R. 1989. Histórico sistemático e lista comentada das espécies de peixes de água doce do sistema Lagoa dos Patos, Rio Grande do Sul, Brasil. **Comunicações do Museu de Ciências da PUCRS, Série Zoológica**, 2 (8): 107-179.
- Milani, P. C. C. & Fontoura, N. F. 2007. Diagnóstico da pesca artesanal na Lagoa do Casamento, sistema nordeste da Lagoa dos Patos: uma proposta de manejo. **Biociências**, 15: 82-125.
- Odebrecht, C., Abreu, P. C., Bemvenuti, C. E., Copertino, M., Muelbert, J. H., Vieira, J. P. & Seeliger, U. 2010. Chapter 17. The Patos Lagoon Estuary, Southern Brazil: Biotic Responses to Natural and Anthropogenic Impacts in the Last Decades (1979–2008). Pp. 433-451. *In*: Kennish, M. J. & Paerl, H. W. (Eds). **Coastal lagoons: critical habitats of environmental change**, CRC Marine Science Series, Boca Raton, 541p.

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