TABLE S3 | Detailed final report of the Aquatic Species Invasiveness Screening Kit (AS-ISK) protocol for the target species *Salminus brasiliensis* in the Iguaçu basin (RA).

Taxon and Assessor details	
Category	Fishes and Lampreys (freshwater)
Taxon name	*Salminus brasiliensis*
Common name	Dorado
Assessor	Iago Vinicios Geller
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Basin Iguaçu
Taxonomy	
Native range	Paraná, Paraguay and Uruguay river basins, the drainage of the Patos Lagoon, the upper Chaparé and the Mamoré River basin in Bolivia.
Introduced range	Basin Iguaçu and Guaraguaçu rivers.
URL	

			Response	Justification (references or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1,01	Has the taxon been the subject of domestication?	Yes	It is a highly valued fish due to the excellent quality of its meat (Koch *et al.*, 2000; Zaniboni Filho, 2003) and has been the focus of ongoing research on aquaculture technology (Vega-Orellana *et al.*, 2006; Schütz, 2007; Borghesi *et al.*, 2009; Braun *et al.*, 2010; Portella *et al.*, 2014). Due to its high commercial demand and rapid growth rates, it is considered a promising candidate for aquaculture diversification (Ribeiro, Portella, 2020).	Very high
2	1,02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	This taxon has previously been among the 50 most farmed fish species in Brazil due to reintroduction programs (Vieira, Pompeu, 2001) and commercial fishing (Ostrensky, 2000). Its high commercial demand and rapid growth rates make it a promising candidate for aquaculture diversification (Ribeiro, Portella, 2020), in addition to its continuous introduction through sport fishing (Vitule *et al.*, 2014; Daga *et al.*, 2016).	Very high
3	1,03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	Some studies report established populations where the species has been introduced. Ruschi (1965) documented its presence in the Doce River Basin, Espírito Santo. In the Paraíba do Sul River Basin, it was reported by Alves *et al.* (2007), and in the Ribeira do Iguape River basin by Vitule (2014). In fact, negative effects have already been reported due to the introduction of *S. brasiliensis* in the Iguaçu River basin, particularly related to biotic homogenization and predation pressure on native species (Daga *et al.*, 2016; Ribeiro *et al.*, 2017).	Medium
2. Climate, distribution and introduction risk					
4	2,01	How similar are the climatic conditions between the risk assessment area and the taxon's native range?	High	According to the Köppen-Geiger system (Peel *et al.*, 2007), both the native range of the taxon and the RA (reintroduction area) exhibit a Cfa climate type, indicating similar climatic conditions. A very small natural stretch presents a Cfb climate. According to Ruaro *et al.* (2019), climate modeling for the species predicted that the central-southern portions of the basin (including tributaries on the eastern margin of the upper Paraná River) serve as an important climatic refuge, where the minimum air temperature in the coldest month does not exceed 11–12°C. In the La Plata Basin, water temperature is, on average, 3.56°C (standard deviation = 0.58) higher than air temperature (Gomez *et al.*, 2015), indicating a minimum water temperature of around 14–15°C in winter, a period when individuals generally do not reproduce (see Barbieri *et al.*, 2001b; Agostinho *et al.*, 2003; Zaniboni-Filho *et al.*, 2017). It has been reported that 22°C is the minimum water temperature required for S. brasiliensis spawning in rivers of the La Plata Basin (Ruaro *et al.*, 2019). In the RA, mean temperatures vary from below 18°C in the coldest month to above 22°C in the warmest month. In a study by Azevedo (2006), the annual mean temperature of the basin was reported as 18°C (Caldana *et al.*, 2018).	High
5	2,02	What is the quality of the climate matching data?	Medium	As the classification model used was Köppen-Geiger and the only reference for more recent climate comparison models was Ruaro *et al.* (2019), we consider the data quality to be moderate.	High
6	2,03	Is the taxon known to be present outside of captivity in the risk assessment area?	Yes	The RA is a region where the first record of the taxon was documented in 2010 (Gubiani *et al.*, 2010). Currently, more than 40 occurrences have been recorded through citizen science initiatives (Geller *et al.*, 2021), in addition to reports in other scientific articles and databases such as SpeciesLink, FishBase, and GBIF (see Mezzaroba *et al.*, 2020). Furthermore, numerous observations and reports from researchers confirm the collection of specimens in the Iguaçu River and its mid-region tributaries (2023–2024).	Very high

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
7	2,04	How many potential vectors could the taxon use to enter the risk assessment area?	>1	The primary pathway for introduction into the RA was intentional release for sport fishing (Vitule *et al.*, 2014; Daga *et al.*, 2016), along with improper fish stocking practices (Ribeiro *et al.*, 2017). Notably, fish stocking initiatives in 2024—such as the Iguaçu Dourado program led by the Paraná State Government—have further contributed to its spread. Additionally, environmental laws in Paraná currently protect this invasive species in the RA until 2026 (Geller *et al.*, 2020).	Very high
8	2,05	Is the taxon currently found in close proximity to, and likely to enter, the risk assessment area in the near future (e.g. unintentional or intentional introductions)?	Yes	Not only in nearby areas, but the taxon is already established in the RA, with numerous records documented in recent years (2010–2024) (see Geller *et al.*, 2021).	High
3. Invasive elsewhere					
9	3,01	Has the taxon become naturalised outside its native range?	Yes	Ruschi (1965) documented the presence of S. brasiliensis in the Doce River Basin, Espírito Santo. In the Paraíba do Sul River Basin, it was reported by Alves *et al.* (2007), and in the Ribeira do Iguape River Basin by Vitule (2014). Negative effects of *S. brasiliensis* introduction have already been reported in the Iguaçu River Basin, particularly concerning biotic homogenization and predation pressure on native species (Daga *et al.*, 2016; Ribeiro *et al.*, 2017).	High
10	3,02	In the taxon's introduced range, are there any known adverse impacts to wild or commercial species?	Yes	The introduction of *S. brasiliensis* into environments where it does not occur naturally can cause severe changes in the structure of native communities (Trussel *et al.*, 2006; Heithaus *et al.*, 2008; Karling *et al.*, 2013). Ruschi (1965) reported its presence in the Doce River basin, in Espírito Santo, where the species negatively affected crustacean and fish communities in Rio de Janeiro, in the Paraíba do Sul River basin, where it has caused negative effects mainly related to the predation of native fauna species (Alves *et al.*, 2007).	High
11	3,03	In the taxon's introduced range, are there any known adverse impacts to aquaculture?	No	It was not possible to find scientific studies that demonstrate a relationship between the introduction of the taxon and impacts on local aquaculture. In the Iguaçu River, as in rivers in other ecoregions in the Neotropics, those who raise fish in cages, especially those installed in reservoirs, should be encouraged to use native species (*e.g.*, Agostinho *et al.*, 1999; Orsi & Agostinho, 1999; Lima Jr. *et al.*, 2014).	Medium
12	3,04	In the taxon's introduced range, are there any known adverse impacts to ecosystem services?	Yes	The introduction of S. brasiliensis into environments where it does not occur naturally can cause severe changes in the structure of native communities (Trussel *et al.*, 2006; Heithaus *et al.*, 2008; Karling *et al.*, 2013). In addition, irreversible losses in biodiversity and ecosystem services are expected in the RA due to the Taxon (Daga *et al.*, 2016; Vitule *et al.*, 2014).	Medium
13	3,05	In the taxon's introduced range, are there any known adverse socio-economic impacts?	Yes	The taxon's diet consists of small fish (*Astyanax* spp. and *Psalidodon* spp. (Daga *et al.*, 2016; Esteves, Pinto Lôbo, 2001; Ribeiro *et al.*, 2017). It is noteworthy that the evaluators know that RA is a region with a high quantity of small fish (< 10cm) that have great commercial importance for the region, with inns, typical fishing festivals (For example 15th Lambari Festival (The author, 2025).	High
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4,01	Is the taxon likely to be poisonous or pose other risks to human health?	No	The taxon does not pose a risk to human health, it is one of the meats with high monetary value and many studies are underway to increase its production for human consumption (Ribeiro, Portella, 2020).	Very high
15	4,02	Is the taxon likely to suppress the growth of one or more native species?	Yes	The taxon is one of the largest characins, adults are aggressive visual piscivores (Barzotto, Mateus, 2017; Barbieri *et al.*, 2001; Gubiani *et al.*, 2010). It is a top predator species, feeding on a wide spectrum of prey, such as fish, insects, crustaceans, and occasionally reptiles and birds (Almeida *et al.*, 1997; Gubiani *et al.*, 2010; Karling *et al.*, 2013). The taxon's diet consists of small fish (*Astyanax* spp. and *Psalidodon* spp. (Daga *et al.*, 2016; Esteves & Pinto Lôbo, 2001; Ribeiro *et al.*, 2017).	Very high
16	4,03	Are there any threatened or protected native species that the taxon would parasitise in the risk assessment area?	No	Although there are many species threatened with extinction in RA (see Mezzaroba *et al.*, 2020; Reis *et al.*, 2020), there is no literature in the database that demonstrates that the taxon parasitizes another.	Very high

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
17	4,04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or is likely to invade the risk assessment area?	Yes	There are not many data available on the temperature adaptation of the taxon in the natural environment, few reports are from It was reported that 22ºC is the minimum water temperature for spawning of S. brasiliensis in rivers of the La Plata Basin (Ruaro *et al*., 2019) the minimum water temperature around 14-15ºC in winter, a time when individuals are generally not breeding (see Barbieri *et al*., 2001; Agostinho *et al*., 2003; Zaniboni-Filho *et al*., 2017). Some studies demonstrate a good temperature adaptation in captivity of the taxon between 22º and 28ºC (Donadelli *et al*., 2019; Ribeiro, Portella, 2020).	High
18	4,05	Is the taxon likely to disrupt food-web structure or function in aquatic ecosystems if it has invaded or is likely to invade the risk assessment area?	Yes	It is a top predator species, feeding on a wide spectrum of prey, such as fish, insects, crustaceans, and occasionally reptiles and birds (Almeida *et al*., 1997; Gubiani *et al*., 2010; Karling *et al*., 2013). The taxon's diet consists of small fish (*Astyanax* spp. and *Psalidodon* spp. (Daga *et al*., 2016; Esteves, Pinto Lôbo, 2001; Ribeiro *et al*., 2017). The introduction of the taxon leads to severe changes in the structure of native communities (Trussel *et al*., 2006; Heithaus *et al*., 2008; Karling *et al*., 2013).	High
19	4,06	Is the taxon likely to exert adverse impacts on ecosystem services in the risk assessment area?	Yes	Introduction of the taxon leads to severe changes in the structure of native communities (Trussel *et al*., 2006; Heithaus *et al*., 2008; Karling *et al*., 2013; Vitule *et al*., 2014; Ribeiro *et al*., 2017).	High
20	4,07	Is the taxon likely to host or function as a vector for recognised pests and pathogens that are present in the risk assessment area?	No	There are no reports of this type of host or of it acting as a vector of pests and infectious agents.	Medium
21	4,08	Is the taxon likely to host or function as a vector for recognised pests and pathogens that are absent in the risk assessment area?	No	There are no reports of this type of host or of it acting as a vector of pests and infectious agents.	Medium
22	4,09	Is the taxon likely to be released from captivity?	Not applicable	I believe that the question relates to aquarium species that can be released. Although the taxon has the possibility of being raised as a pet, there are few reports of this species for trade (Magalhaães *et al*., 2017).	High
23	4,10	Is the taxon versatile in habitat use?	Yes	This species preferentially inhabits lotic and waterfall environments (Zaniboni-Filho, 2000). In some cases, it is found in lentic reservoir environments, however, its reproductive power may be affected (Fries *et al*., 2019). However, in the RA, the specimen was captured in a lentic/reservoir environment (Gubiani *et al*., 2010). However, the confidence level assigned by the evaluators was classified as 3 because many studies demonstrate that reservoirs are unfavorable environments for adult migratory fish (Pelicice *et al*., 2015; Cataldo *et al*., 2020). However, it is worth noting that the RA is a region with large favorable habitats (see Ribeiro *et al*., 2017; Vitule *et al*., 2014). The Médio Iguaçu represents a pleasant biotope for *S. brasiliensis*, mainly due to the large currents in the main channel and tributaries free from natural or artificial barriers, such as hydroelectric plants (Evaluators' observation).	Medium
24	4,11	Is it likely that the taxon's mode of existence or behaviours will reduce habitat quality for native species?	Yes	There is no data in the literature on the excretion of by-products of the taxon that affects the behavior of other species. However, it has been shown that habitat quality can be altered through bitoic homogenization (Bezerra *et al*., 2019). In addition to the change in the trophic structure of other native predatory species (such as *H. malabaricus*), see competition between species in captivity (Bozza, Hahn, 2010). In addition to the natural environment (Pereira; Agostinho; Gomes, 2015).	Medium
25	4,12	Is the taxon likely to maintain a viable population even when present in low densities (or persist in adverse conditions by way of a dormant form)?	Yes	Studies show that the population of this taxon can stabilize even with the introduction of a few individuals, especially in the RA (Gubiani *et al*., 2010, Viltule *et al*., 2014; Ribeiro *et al*., 2018). However, the evaluators preferred a reliability level of 3 due to the lack of an official record of the number of individuals released. It is worth noting that there were many reports heard by the evaluators of individuals of this taxon present in small tributaries of the RA – it is not known whether the population is large.	Medium

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
5. Resource exploitation					
26	5,01	Is the taxon likely to put threatened or protected native species under predation or competitive pressure in the risk assessment area?	Yes	They are aggressive visual piscivores (Barbieri *et al*., 2001; Gubiani *et al*., 2010; Barzotto, Mateus, 2017). It is a top predator species, feeding on a wide range of prey, such as fish, insects, crustaceans, and occasionally reptiles and birds (Almeida *et al*., 1997; Gubiani *et al*., 2010; Karling *et al*., 2013). The taxon's diet consists of small fish (*Astyanax* spp. and *Psalidodon* spp. (Daga *et al*., 2016; Esteves, Pinto Lôbo, 2001; Ribeiro *et al*., 2017). It is noteworthy that the RA has approximately 60% endemism, with the vast majority being small (Mezzaroba *et al*., 2020; Reis *et al*., 2020). *Astyanax gymnogenys*, *Hasemania maxilaris*, *Hasemania melanura*, *Austrolebias carvalhoi* and *Hyphessobrycon taurocephalus* are some species classified as endangered (MMA Ordinance No. 445, 2014) that can be consumed by the taxon (ICMBio, 2018). It is worth noting that evaluators observed dead *S. brasiliensis* individuals with many small species in their stomachs.	Very high
27	5,02	Is the taxon likely to sequester resources to the detriment of native species in the risk assessment area?	Yes	There may be competition in the RA with other native predatory species (such as *H. malabaricus*). See competition between species in captivity (Bozza, Hahn, 2010). In addition to the natural environment (Pereira; Agostinho, Gomes, 2015). The level of confidence was low because there is no study to date that proves any type of interference in food resources in the RA.	Medium
6. Reproduction					
28	6,01	Is the taxon likely to exhibit changes in reproductive strategy in response to environmental conditions?	No	After spawning, it does not perform parental care (Graça, Pavanelli, 2007; Barzotto, Mateus, 2017). The reproductive strategy of this species allows it to be classified as seasonal (*sensu* Winemiller, 1989), which includes fish with late sexual maturity, high fecundity, short spawning season, absence of parental care and the ability to perform long reproductive migrations annually (Winemiller 1989, 1992). The species presents total spawning, without care for the offspring (Nakatani *et al*., 2001).	Medium
29	6,02	Is the taxon likely to produce viable gametes or propagules in the risk assessment area?	Yes	Observations by evaluators of female individuals (dead) with a high oocyte rate. It is also possible to verify individuals with gamete production through Citizen Science (Geller *et al*., 2021). Personal observations also of juvenile individuals present in the AR.	Very high
30	6,03	Is the taxon likely to hybridise with native species under natural conditions?	No	Four valid species of *Salminus* are currently recognized: *S. brasiliensis*, *S. franciscanus*, *S. hilarii* and *S. affinis* (Rosso *et al*., 2017). There are no reports of hybridization with native taxa.	High
31	6,04	Is the taxon likely to be hermaphroditic or to exhibit asexual reproduction?	No	There is no report or material about the taxon being hermaphrodite or reproducing asexually.	Very high
32	6,05	Is the taxon dependent on the presence of another species (or specific habitat features) to complete its life cycle?	No	The taxon does not need other species to complete its life cycle.	Very high
33	6,06	Is the taxon likely to produce a large number of offspring or propagules?	Yes	Mature ovaries represent up to 16% of body weight and contain approximately 2.6 million mature oocytes with an average diameter of 1.35 mm. Dourado is a species with external fertilization, total annual spawning, and has semi-dense eggs (Vazzoller, 1996; Godoy, 1975). Specimens of *Salminus brasiliensis* can reach more than one meter in length and more than 30 kg, especially females (Britski *et al*., 1999; Latini *et al*., 2016; Barzotto, Mateus, 2017).	Very high
34	6,07	How many time units (days, months, years) does the taxon require to reach the age at first reproduction?	2	The size of first maturation of females varies between 370 and 450 mm and of males between 320 and 350 mm (Barbieri *et al*., 2001; Suzuki *et al*., 2004; Rodríguez-Olarte, Taphorn, 2006;), which occurs around two years of age (Latini *et al*., 2016). Unit of time: Year	Very high
7. Dispersal mechanisms					
35	7,01	How many potential vectors or pathways could the taxon use to disperse within the risk assessment area (with suitable habitats nearby)?	>1	Within the RA, the taxon could be dispersed by sport fishermen who carried out its intentional introduction (Vitule *et al*., 2014; Daga *et al*., 2016), in addition to the path through incorrect stocking (Ribeiro *et al*., 2017) as in 2024 – Iguaçu Dourado – by the Government of Paraná, in parallel with environmental laws of Paraná that protect the invasive species in the RA until 2026 (Geller *et al*., 2020).	High

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
36	7,02	Will any of these vectors or pathways bring the taxon in close proximity to one or more protected areas?	Yes	Along the course of the Iguaçu River there are many protected areas, including the species already present in tributaries in protected areas (for example: Environmental Protection Area - APA Serra da Esperança Environmental Protection Area & Wildlife Refuge - RVS Palmas Wildlife Refuge). For more nearby areas see IAT – Data on conservation units (Paraná).	High
37	7,03	Does the taxon have a means of actively attaching itself to hard substrata such that it enhances the likelihood of dispersal?	No	There is no scientific report of this type of activity by taxon.	Very high
38	7,04	Is natural dispersal of the taxon likely to occur as eggs or as seeds or spores in the risk assessment area?	No	The dispersion of the taxon occurred exclusively through human activity, whether through sport fishing or repopulation actions.	High
39	7,05	Is natural dispersal of the taxon likely to occur as larvae or juveniles or as fragments or seedlings in the risk assessment area?	Yes	The species was introduced into the RA clandestinely for sport fishing and restocking purposes (Ribeiro *et al*., 2017). This release was carried out with juveniles (rarely adults). Reports from the community to the evaluator support this hypothesis, with several people mentioning the introduction of the species into the RA through juveniles obtained from fish farms. Where the taxon is invasive, there are records of releases, such as in Lagoa da Pampulha (in Belo Horizonte, Minas Gerais), which were carried out with approximately 3,000 fry of the species, originating from the Furnas Hydrobiology and Fish Farming Station (Minas Gerais Power Plant). Other releases may have occurred in many watercourses in the region (Latini *et al*., 2016). It is also worth mentioning that the taxon has a diet when juvenile (as previously mentioned) that may facilitate its feeding in the RA.	High
40	7,06	Are any life stages of the taxon likely to migrate into the risk assessment area for reproduction?	Yes	Yes, its reproductive activity in the natural environment is well known in the scientific literature. Its reproductive period extends from October to January and adults are typically long-distance migrants for reproduction - up to 1,000 km (Petrere Jr., 1985; Suzuki *et al*., 2004; Latini *et al*., 2016;). This species, highly appreciated in artisanal and sport fishing, migrates long distances (about 1,400 km; Esteves, Pinto Lobo, 2001). The RA area has the main channel in the middle region of the Iguaçu without any type of dam or barrier, being favorable for the migration of the taxon; many tributaries of the Iguaçu basin also have this profile.	Very high
41	7,07	Are propagules or eggs of the taxon likely to be dispersed in the risk assessment area by other species?	No	There is no record in the scientific literature of the taxon being accidentally dispersed by other fish or any animal: such as aquatic birds or similar. Only human activity.	High
42	7,08	Is dispersal of the taxon along any of the vectors or pathways mentioned in the previous seven Questions (35–41: i.e. either unintentional or intentional) likely to be rapid?	Yes	The first record of the taxon in the RA was in 2010 (Gubiani *et al*., 2010) and in recent years its presence in the RA has been recognized by the entire scientific community and local lay community, in 2021 (Geller *et al*., 2021) there were already more than 50 official records of the taxon in the RA, many adults weighing more than 20 kg.	High
43	7,09	Is dispersal of the taxon density dependent?	Yes	Not necessarily, the answer was yes with a low confidence level due to the lack of scientific literature showing a density required for the invasion of the taxon. However, as already mentioned in Latini *et al*., 2016, the invasion of the taxon in other locations may be due to the release of a few individuals (3,000) in certain locations. There are also reports from the RA community that the density of individuals released in the RA was not high, and was done sporadically. This hypothesis was brought by Vitule *et al*., 2014; Daga *et al*., 2016; Ribeiro *et al*., 2017).	Medium
8. Tolerance attributes					
44	8,01	Is the taxon able to withstand being out of water for extended periods at some stage of its life cycle?	No	The taxon does not have the capacity to withstand a hypoxic environment; there are no reports in the literature of adult or juvenile survival for long periods out of water. On the contrary, the literature shows that the species prefers a highly oxygenated lotic environment for its activities (Zaniboni Filho, 2000). However, there are many records in reservoir environments (Baumgartner *et al*., 2012; Latini *et al*., 2016). The Dourado is quite sensitive to low dissolved oxygen values, probably requiring concentrations higher than 2.0 mg/m (Zaniboni Filho, 2003).	Very high

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
45	8,02	Is the taxon tolerant of a wide range of water quality conditions?	Yes	It has been reported that 22ºC is the minimum water temperature for spawning of S. brasiliensis in rivers of the La Plata Basin (Ruaro *et al*., 2019). The minimum water temperature is around 14-15ºC in winter, a time when individuals are generally not reproducing (see Barbieri *et al*., 2001b; Agostinho *et al*., 2003; Zaniboni-Filho *et al*., 2017). In a fish farming environment, the water temperature maintained around 26 °C, hatching occurs in 15 hours (Zaniboni Filho, 2003). After spawning, the eggs hatch around 15 hours, at a water temperature of 26 °C (Della Flora *et al*., 2010). A low confidence level was used for this question, as the evaluators consider the good adaptation of the taxon in the RA with average temperatures of 18ºC for the Iguaçu Basin, in addition to reports from the community of the capture of individuals in winter, where temperatures are below 14ºC, as previously mentioned.	Medium
46	8,03	Can the taxon be controlled or eradicated in the wild with chemical, biological or other agents and means?	Yes	The eradication of exotic species in invaded, natural or fragmented environments is practically impossible (Latini *et al*., 2016). There are no studies in the literature that demonstrate any type of eradication of the species in a controlled manner or without affecting local biodiversity, and there are no studies of sexual reversion for control, as in tilapia species (Utete, Muposhi, 2012). In fish farming systems, this species is sensitive to changes in water parameters and also to management (Zaniboni Filho, 2003; Flora *et al*., 2010; Braun *et al*., 2013; Donadelli *et al*., 2019). Therefore, it is possible to achieve eradication by changing biotic parameters, but it is a risky situation; the evaluators preferred a Yes answer, with a lower confidence level.	Medium
47	8,04	Is the taxon likely to benefit from environmental or human disturbance?	No	In its natural habitat, the taxon has been strongly negatively affected by human presence, dam construction, and similar factors. Fish species with a large home range, such as *S. brasiliensis*, are subject to a series of anthropogenic impacts, especially habitat fragmentation due to the construction of reservoirs for energy generation (Hahn *et al*., 2007; Agostinho; Pelicice; Gomez, 2008). Thus, populations of migratory species may collapse or even disappear in intensely regulated stretches (Agostinho; Pelicice; Gomez, 2008). Recent studies also demonstrate the impact of dams on the taxon (De Fries *et al*., 2019).	Very high
48	8,05	Is the taxon able to tolerate salinity levels that are higher or lower than those found in its usual environment?	No	There is no report in scientific material of the occurrence of the taxon in environments with salinity, nor are there any experiments in fish farming that show that the taxon survives in changes in salinity.	High
49	8,06	Are there effective natural enemies of the taxon present in the risk assessment area?	No	The top predator species that occurs naturally in the RA is *H. malabaricus*, but its hunting habits are very different from those of the taxon, and there are currently no studies demonstrating predation of the taxon in the RA. It is noteworthy that the RA is a region of high endemism of small-sized species (see the list by Mezzaroba *et al*., 2020; Reis *et al*., 2020). This list includes 30 species that are not native to the RA, but none of them are effective predators for the taxon.	High
C. Climate change					
9. Climate change					
50	9,01	Under the predicted future climatic conditions, are the risks of entry into the risk assessment area posed by the taxon likely to increase, decrease or not change?	Not applicable	The taxon is already present in the RA.	Very high
51	9,02	Under the predicted future climatic conditions, are the risks of establishment within the risk assessment area posed by the taxon likely to increase, decrease or not change?	Increase	Projections of the occurrence of the taxon carried out by (Ruaro *et al*., 2019) show the RA as a likely area for the occurrence of the taxon. It is worth mentioning that the climate (average temperature of the basin) of the RA is considered somewhat low for the taxon, and with a future increase in temperatures it is possible to consider that the taxon will benefit from the location. Climate and human activity projections proposed by Peluso *et al*. (2022) can also be considered for an increase in global temperature and consequently an increase in the temperature of the RA, leading to a greater chance of success of the taxon's invasion.	Medium

TABLE S3 | (Continued)

			Response	Justification (references or other information)	Confidence
52	9,03	Under the predicted future climatic conditions, are the risks of dispersal within the risk assessment area posed by the taxon likely to increase, decrease or not change?	Increase	See previous justification.	Medium
53	9,04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts by the taxon on biodiversity or ecosystem integrity and status?	Higher	Due to the taxon having voracious habits and being a top-of-the-chain predator, the RA region is predominantly of small species, and future climate projections indicate a possible increase (or even refuge) of the species and its establishment, major impacts related to local biodiversity are believed (Gubiani *et al*., 2010; Vitule *et al*., 2014; Daga *et al*., 2016; Ribeiro *et al*., 2017; Geller *et al*., 2020). Based on climate projections by Ruaro *et al*., (2019). The risk of endemism is discussed in Dos Reis *et al*. (2022) and streams (Larenti *et al*., 2022).	Medium
54	9,05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts by the taxon on ecosystem structure or function?	Higher	There are no studies directly on the ecosystem function of the taxon or in the RA. However, it is possible to categorize at a low confidence level a biotic homogenization of the region, in addition to habitat changes.	Low
55	9,06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts by the taxon on ecosystem services and related socio-economic factors?	Higher	There are no socioeconomic studies of the taxon in relation to future climate conditions. However, the evaluators believe that there may be changes in local tourism in the RA, migrating from a Lambari culture (small species) to the taxon in question (dourado – large size – sport fishing).	Low

Statistics	
Scores	
BRA	**38**
BRA Outcome	**-**
BRA+CCA	**48**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**22**
1. Domestication/Cultivation	4
2. Climate, distribution and introduction risk	4
3. Invasive elsewhere	14
B. Biology/Ecology	**16**
4. Undesirable (or persistence) traits	7
5. Resource exploitation	7
6. Reproduction	1
7. Dispersal mechanisms	3
8. Tolerance attributes	-2
C. Climate change	**10**
9. Climate change	10
Answered Questions	
Total	**55**
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	3
2. Climate, distribution and introduction risk	5
3. Invasive elsewhere	5

TABLE S3 | (Continued)

Statistics	
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	12
5. Resource exploitation	2
6. Reproduction	7
7. Dispersal mechanisms	9
8. Tolerance attributes	6
C. Climate change	**6**
9. Climate change	6
Sectors affected	
Commercial	**19**
Environmental	**17**
Species or population nuisance traits	**19**
Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.74**
BRA	**0.77**
CCA	**0.5**
Date and Time	
28/12/2024 14:49:15	

REFERENCE

- **Agostinho AA, Gomes LC, Suzuki IS, Júlio-Junior HF.** Riscos da implantação de cultivos de espécies exóticas em tanques-redes em Reservatórios do rio Iguaçu. Cad Biodivers. 1999; 2:1–09.
- **Agostinho AA, Gomes LC, Suzuki HI, Júlio-Junior HF.** Migratory fishes of the upper Paraná River basin, Brazil. In: Carolsfeld J, Harvey B, Ross C, Baer A, editors. Migratory fishes of South America: biology, fisheries and conservation status. Ottawa: World Fisheries Trust; 2003. p.19–99.
- **Agostinho AA, Pelicice FM, Gomes LC.** Dams and the fish fauna of the Neotropical region: impacts and management related to diversity and fisheries. Braz J Biol. 2008; 68:1119–32.
- **Almeida VLL, Hahn NS, Vazzoller AEAM.** Feeding patterns in five predatory fishes of the high Paraná River floodplain (PR, Brazil). Ecol Freshw Fish. 1997; 6(3):123–33. https://doi.org/10.1111/j.1600-0633.1997.tb00154.x
- **Alves CBM, Vieira F, Magalhães ALB, Brito MFG.** Impacts of non-native fish species in Minas Gerais, Brazil: Present Situation and Prospects. In: Bert TM, editor. Ecological and genetic implications of aquaculture activities. Dordrecht: Springer; 2007. p.291–314.
- **Azevedo LC, Andrade AR, Sousa P, Nery JT.** Influence of the El Niño phenomenon on the flow of the Iguaçu River Basin-PR. Perspect Geogr. 2006; 2(2):51–65.
- **Barbieri G, Salles FA, Cestarolli MA.** Reproductive and nutritional dynamics of *Salminus maxillosus* Valenciennes, 1849 (Pisces, Characidae) at Mogi Guaçu River, state of São Paulo, Brazil. Acta Sci Biol Sci. 2001; 23:441–44.
- **Barzotto E, Mateus L.** Reproductive biology of the migratory freshwater fish *Salminus brasiliensis* (Cuvier, 1816) in the Cuiabá River basin, Brazil. J Appl Ichthyol. 2017; 33(3):415–22. https://doi.org/10.1111/jai.13262
- **Baumgartner G, Pavanelli CS, Baumgartner D, Bifi AG, Debona T, Frana VA.** Peixes do baixo rio Iguaçu. Maringá: EDUEM; 2012.

- **Bezerra LAV, Ribeiro VM, Freitas MO, Kaufman L, Padial AA, Vitule JRS.** Benthification, biotic homogenization behind the trophic downgrading in altered ecosystems. Ecosphere. 2019; 10(6):e02757. https://doi.org/10.1002/ecs2.2757
- **Borghesi R, Dairiki JK, Cyrino JEP.** Apparent digestibility coefficients of selected feed ingredients for dourado *Salminus brasiliensis*. Aquac Nutr. 2009; 15(5):453–58. https://doi.org/10.1111/j.1365-2095.2008.00611.x
- **Bozza AN, Hahn NS.** Uso de recursos alimentares por peixes imaturos e adultos de espécies piscívoras em uma planície de inundação neotropical. Biota Neotrop. 2010; 10:217–26. https://doi.org/10.1590/S1676-06032010000300025
- **Braun N, Lima RL, Baldisserotto B, Dafre AL, Nuñer APDO.** Growth, biochemical and physiological responses of *Salminus brasiliensis* with different stocking densities and handling. Aquaculture. 2010; 301(1–4):22–30. https://doi.org/10.1016/j.aquaculture.2010.01.027
- **Britski HA, Silimon KS, Lopes BS.** Peixes do Pantanal: manual de identificação. Brasília: Embrapa; 1999.
- **Caldana SN, Júnior GMY, Moura DAV, Costa ABF, Caramori PH.** Ocorrências de alagamentos, enxurradas e inundações e a variabilidade pluviométrica na bacia hidrográfica do rio Iguaçu. Rev Bras Climatol. 2018; 23.
- **Cataldo D, Gattás F, Leites V, Bordet F, Paolucci E.** Impact of a hydroelectric power plant on migratory fishes in the Uruguay River. River Res Appl. 2020; 36(8):1598–611. https://doi.org/10.1002/rra.3670
- **Daga VS, Debona T, Abilhoa V, Gubiani EA, Vitule JRS.** Non-native fish invasions of a Neotropical ecoregion with high endemism: a review of the Iguaçu River. Aquat Invasions. 2016; 11(2):209–23. http://dx.doi.org/10.3391/ai.2016.11.2.10
- **Della Flora MA, Maschke F, Ferreira CC, Pedron FA.** Biologia e cultivo do dourado (*Salminus brasiliensis*). Acta Vet Bras. 2010; 4(1):7–14.
- **Donadelli RA, Aguilar FAA, Sonoda DY, Cyrino JEP.** Poultry by-product meal as dietary protein source for dourado, *Salminus brasiliensis*: an economic appraisal. Sci Agric. 2019; 76:190–97.
- **Esteves KE, Pinto Lôbo AV.** Feeding pattern of *Salminus maxillosus* (Pisces, Characidae) at Cachoeira das Emas, Mogi-Guaçu River (São Paulo State, Southeast Brazil). Rev Bras Biol. 2001; 61:267–76.
- **de Fries L, Hahn L, Meneses BA, Câmara LFD, Becker FG, Hartz SM.** Movement and longitudinal distribution of a migratory fish (*Salminus brasiliensis*) in a small reservoir in southern Brazil. Neotrop Ichthyol. 2019; 17(3):e180119. https://doi.org/10.1590/1982-0224-20180119
- **Geller IV, Garcia DAZ, Casimiro ACR, Pereira AD, Jarduli LR, Vitule JRS *et al.*** Good intentions, but bad effects: environmental laws protect non-native ichthyofauna in Brazil. Fish Manag Ecol. 2020; 28:14–17. https://doi.org/10.1111/fme.12446
- **Geller IV, Garcia DAZ, Pereira AD, Casimiro ACR, Cochak C, Vitule JRS *et al.*** New conservation opportunities: using citizen science in monitoring non-native species in Neotropical region. J Appl Ichthyol. 2021; 37(5):779–85. https://doi.org/10.1111/jai.14231
- **Gómez SE.** Temperatura del agua continental y su influencia en las migraciones de los peces en la cuenca del Río De La Plata. Rev Mus Argent Cienc Nat. 2015; 17(1):43–49.
- **Graça WJ, Pavanelli CS.** Peixes da planície de inundação do alto rio Paraná e áreas adjacentes. Maringá: EDUEM; 2007.
- **Gubiani EA, Frana VA, Maciel AL, Baumgartner D.** Occurrence of the non-native fish *Salminus brasiliensis* (Cuvier, 1816), in a global biodiversity ecoregion, Iguaçu River, Paraná River basin, Brazil. Aquat Invasions. 2010; 5(2):223–27. https://doi.org/10.3391/ai.2010.5.2.17
- **Hahn L.** Deslocamento de peixes migradores no rio Uruguai e no sistema misto de migração da barragem de Itaipu. Foz do Iguaçu: Itaipu Binacional; 2007.
- **Heithaus MR, Frid A, Wirsing AJ, Worm B.** Predicting ecological consequences of marine top predator declines. Trends Ecol Evol. 2008; 23:202–10.
- **Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).** Livro vermelho da fauna brasileira ameaçada de extinção: Volume VI – Peixes. Brasília: ICMBio/MMA; 2018.

- **Karling LC, Isaac A, Affonso IP, Takemoto RM, Pavanellii GC.** The impact of a dam on the helminth fauna and health of a neotropical fish species *Salminus brasiliensis* (Cuvier 1816) from the upper Paraná River, Brazil. J Helminthol. 2013; 87:245–51. https://doi.org/10.1017/S0022149X1200034X
- **Koch WR, Milani, PC, Grosser, KM.** Guia ilustrado de peixes, Parque Delta do Jacuí. Porto Alegre: Fundação Zoobotânica do Rio Grande do Sul; 2000.
- **Larentis C, Kliemann BCK, Neves MP, Delariva RL.** Effects of human disturbance on habitat and fish diversity in Neotropical streams. PLoS ONE. 2022; 17(9):e0274191. https://doi.org/10.1371/journal.pone.0274191
- **Latini AO, Resende DC, Pombo VB, Doradin L.** Espécies exóticas invasoras de águas continentais do Brasil. Brasília: MMA; 2016.
- **Lima-Junior DP, Lima LB, Vitule JRS, Orsi ML, Azevedo-Santos VM.** Modificação das diretrizes do CONAMA no 413/2009 sobre o licenciamento ambiental da aquicultura: retirando os "obstáculos normativos" para a criação de espécies não nativas em águas continentais brasileiras. Bol Assoc Bras Limnol. 2014; 40:3–11.
- **Magalhães AL, Orsi ML, Pelicice FM, Azevedo-Santos VM, Vitule JR, Lima-Junior DP *et al.*** Small size today, aquarium dumping tomorrow: sales of juvenile non-native large fish as an important threat in Brazil. Neotrop Ichthyol. 2017; 15:e170033.
- **Mezzaroba L, Debona T, Frota A, Graça WJ, Gubiani EA.** From the headwaters to the Iguassu Falls: inventory of the ichthyofauna in the Iguassu River basin shows increasing percentages of nonnative species. Biota Neotrop. 2021; 21(2):e20201083. https://doi.org/10.1590/1676-0611-bn-2020-1083
- **Nakatani K, Agostinho AA, Bialetzki A, Baumgartner G, Sanches PV, Makrakis MC *et al.*** Manual de identificação de ovos e larvas de peixes brasileiros de água doce. Maringá: EDUEM; 2001.
- **Orsi ML, Agostinho AA.** Introdução de espécies de peixes por escapes acidentais de tanques de cultivo em rios da Bacia do Rio Paraná, Brasil. Rev Bras Zool. 1999; 16(2):557–60. http://dx.doi.org/10.1590/S0101-81751999000200020
- **Ostrensky AO.** Milagre da multiplicação dos peixes. Folhas técnicas em Aqüicultura. Série Opinião. 2000;1:1–07.
- **Peel MC, Finlayson BL, McMahon TA.** Updated world map of the Köppen-Geiger climate classification. Hydrol Earth Syst Sci. 2007; 11:1633–44. https://doi.org/10.5194/hess-11-1633-2007
- **Pelicice FM, Pompeu PS, Agostinho AA.** Large reservoirs as ecological barriers to downstream movements of Neotropical migratory fish. Fish Fish. 2015; 16(4):697–715.
- **Peluso LM, Mateus L, Penha J, Bailly D, Cassemiro F, Suárez Y *et al.*** Climate change negative effects on the Neotropical fishery resources may be exacerbated by hydroelectric dams. Sci Total Environ. 2022; 828:154485. https://doi.org/10.1016/j.scitotenv.2022.154485
- **Pereira LS, Agostinho AA, Gomes LC.** Eating the competitor: a mechanism of invasion. Hydrobiologia. 2015; 746:223–31.
- **Petrere Jr. M.** Migraciones de peces de agua dulce en América Latina; algunos comentarios. Rome: COPESCAL; 1985.
- **Portella MC, Jomori RK, Leitão NJ, Menossi OCC, Freitas TM, Kojima JT *et al.*** Larval development of indigenous South American freshwater fish species, with particular reference to pacu (*Piaractus mesopotamicus*): a review. Aquaculture. 2014; 432:402–17. https://doi.org/10.1016/j.aquaculture.2014.05.017
- **Reis RB, Frota A, Deprá GC, Ota RR, Graça WJ.** Freshwater fishes from Paraná state, Brazil: an annotated list, with comments on biogeographic patterns, threats, and future perspectives. Zootaxa. 2020; 4868(4):451–94. http://dx.doi.org/10.11646/zootaxa.4868.4.1
- **Ribeiro FF, Portella MC.** Intracohort cannibalism in Dourado (*Salminus brasiliensis*): ontogeny, behavior and morphological limitation. Aquaculture. 2020; 528:735541. https://doi.org/10.1016/j.aquaculture.2020.735541
- **Ribeiro VR, Silva PRL, Gubiani EA, Faria L, Daga VS, Vitule JRS.** Imminent threat of the predator fish invasion *Salminus brasiliensis* in a Neotropical ecoregion: eco-vandalism masked as an environmental project. Perspect Ecol Conserv. 2017; 15:132–35. https://doi.org/10.1016/j.pecon.2017.03.004

- **Rodríguez-Olarte D, Taphorn DC.** Abundance, feeding and reproduction of *Salminus sp.* (Pisces: Characidae) from mountain streams of the Andean piedmont in Venezuela. Neotrop Ichthyol. 2006; 4(1):73–79. https://doi.org/10.1590/S1679-62252006000100007
- **Rosso JJ, Rueda EC, Sanchez S, Bruno MC, Casciotta J, Aguilera G *et al.*** Basin-scale distribution and haplotype partitioning in different genetic lineages of the Neotropical migratory fish *Salminus brasiliensis*. Aquat Conserv Mar Freshw Ecosyst. 2018; 28(2):444–56. https://doi.org/10.1002/aqc.2830
- **Ruaro R, Conceição EO, Silva JC, Cafofo EG, Angulo-Valencia MA, Mantovano T *et al.*** Climate change will decrease the range of a keystone fish species in La Plata River Basin, South America. Hydrobiologia. 2019; 836:1–19. https://doi.org/10.1007/s10750-019-3904-0
- **Ruschi A.** Lista dos tubarões, raias e peixes de água doce e salgada do estado do Espírito Santo e uma observação sobre a introdução do dourado no rio Doce. Bol Mus Biol Mello Leitão. 1965; 25: 1–23.
- **Schütz JH, Nuñer APDO.** Growth and survival of dorado *Salminus brasiliensis* (Pisces, Characidae) post-larvae cultivated with different types of food and photoperiods. Braz Arch Biol Technol. 2007; 50:435–44. https://doi.org/10.1590/S1516-89132007000300014
- **Suzuki HI, Vazzoler AEAM, Marques EE, Lizama MLA, Inada P.** Reproductive ecology of the fish assemblage. In: Thomaz SM, Agostinho AA, Hahn NS, editors. The Upper Paraná River and its floodplain: physical aspects, ecology and conservation. Leiden: Backhuys Publishers; 2004. p.271–92.
- **Trussell GC, Ewanchuk PJ, Matassa CM.** Habitat effects on the relative importance of trait- and density-mediated indirect interactions. Ecol Lett. 2006; 9(11):1245–52. https://doi.org/10.1111/j.1461-0248.2006.00981.x
- **Vazzoler AEAM.** Biologia da reprodução de peixes teleósteos: teoria e prática. Maringá: EDUEM; 1996.
- **Vega-Orellana OM, Fracalossi DM, Sugai JK.** Dourado (*Salminus brasiliensis*) larviculture: weaning and ontogenetic development of digestive proteinases. Aquaculture. 2006; 252(2–4):484–93. https://doi.org/10.1016/j.aquaculture.2005.07.014
- **Vieira F, Pompeu PS**. Peixamentos uma alternativa eficiente? Cienc Hoje. 2001; 30(175):28–33.
- **Vitule JRS, Bornatowski H, Freire CA, Abilhoa V.** Extralimital introductions of *Salminus brasiliensis* (Cuvier, 1816) (Teleostei, Characidae) for sport fishing purposes: a growing challenge for the conservation of biodiversity in neotropical aquatic ecosystems. BioInvasions Rec. 2014; 3(4):291–96. http://dx.doi.org/10.3391/bir.2014.3.4.11
- **Zaniboni Filho E.** Larvicultura de peixes. Inf Agropecu. 2000; 21(203):69–77.
- **Zaniboni Filho E.** Piscicultura das espécies nativas de água doce. In: Aqüicultura – Experiências Brasileiras. Florianópolis: Editora da UFSC; 2003. p.337–69.
- **Zaniboni Filho E, Ribolli J, Hermes-Silva S, Nuñer APO.** Wide reproductive period of a long-distance migratory fish in a subtropical river, Brazil. Neotrop Ichthyol. 2017; 15(1):e160135.

Neotropical Ichthyology

OPEN ACCESS

Official Journal of the
Sociedade Brasileira de Ictiologia

SBI

HOW TO CITE THIS ARTICLE

- **Geller IV, Vitule JRS, Ferraz JD, Pereira AD, Orsi ML.** Current and future invasion of a predator with potential for impact negative in a region of high neotropical endemism. Neotrop Ichthyol. 2025; 23(2):e250056. https://doi.org/10.1590/1982-0224-2025-0056