



## Encouraging alternative livestock: public policies and legal Amazon continental aquiculture growth (1988-2023)

### *Incentivando pecuárias alternativas: política públicas e o crescimento da aquicultura continental na Amazônia Legal (1988-2023)*

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**ABSTRACT:** The present study is an analysis on the impact of public policies on Brazilian Legal Amazon continental aquaculture growth (1988-2023), which requires less resource-intensive livestock models. Production data and legislative document analysis revealed a three-stage evolution of the activity, namely: initial institutional fragility phase and fragmented state actions followed by deeper federal intervention and; finally, a time marked by excessive State responsibilities, environmental setbacks and the beginning of a neoliberal agenda. Although this process was essential for the aquaculture expansion in the 21st century, it also led to normative contradictions, policy discontinuities and to the perpetuation of a development paradigm that does not comply with sustainability. In conclusion, turning aquaculture into a viable alternative in the Amazon requires both robust legal support frameworks (particularly funding mechanisms) and overcoming legal uncertainties.

**Keywords:** Legal Amazon; aquiculture; legislation.

**RESUMO:** A pesquisa analisou o impacto das políticas públicas no crescimento da aquicultura continental na Amazônia Legal (1988-2023), região que demanda modelos pecuários menos intensivos em recursos naturais. Com base em dados produtivos e exame documental de legislações, os resultados revelaram uma evolução em três estágios: fase inicial de fragilidade institucional e ações estaduais fragmentadas (1988-2002), seguida por maior intervenção federal (2003-2013), e por fim, um período marcado pela sobrecarga de responsabilidades aos estados e retrocessos na governança ambiental e o início de uma agenda neoliberal (2014-2023). Embora esse processo tenha sido fundamental para a expansão aquícola no século XXI, ele simultaneamente gerou contradições normativas, descontinuidades políticas e a perpetuação de um paradigma desenvolvimentista

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incompatível com a sustentabilidade. Conclui-se que a consolidação da aquicultura como alternativa viável na Amazônia exige, além de arcabouços legais, robustos de fomento, a superação das inseguranças jurídicas.

*Palavras-chave:* Amazônia Legal; aquicultura; legislação.

## 1. Introduction

The following Federative Units (UFs) form the Legal Amazon: Acre (AC), Amapá (AP), Amazonas (AM), Maranhão (MA), Mato Grosso (MT), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO). This geographic delimitation was established by the Federal Government (Brazil, 1953) and it became the very basis for developmental public policies launched between the 1960s and 80s. At that time, colonization projects run by the National Institute of Colonization and Agrarian Reform (INCRA) granted rural land in “pioneer fronts” in Southern and Southeastern Brazil to civil entities and businessmen (Mello, 2006) in order to foster the creation the first regional economic bases (Oliveira & Piffer, 2017).

Immigrants, who held little prior knowledge about both the Amazonian climate and low-fertility soil, faced lack of infrastructure and technical assistance, but they quickly replaced native vegetation by pastures for cattle grazing based on the “slash-and-burn” method (Loureiro, 1992). Cattle ranching rusticity in the Amazon was based on lack of mineral supplementation, silage or confinement grains, as well as on slaughter carried out under precarious sanitary conditions, which were obsolete practices inherited from the colonial period (Prado Júnior, 2012). This activity initially worked to secure land tenure rather than to foster a virtuous regional

production system (Dias-Filho, 2016).

Difficulties in establishing sustainable cattle ranching in the Legal Amazon region became clear with the pasture deterioration observed after two or three year trampling, which resulted in sharp cattle carcass: weight ratio decline (Falesi, 1976). This process forced continuous forest clearing to open room for forage crops or to increase pasture stocking rates; however, it led to soil compaction and to erosion processes caused by rain and wind (Borghi *et al.*, 2018). Wildfires and large deforestation in the Amazon biome became a global concern (Costa, 2008), and it put pressure over ranchers to adopt conservation practices aimed at promoting the land-saving effect (Kaimowitz & Angelsen, 2008).

Aquaculture, or controlled aquatic-species farming for commercial purposes, has emerged as promising sustainable option for the Legal Amazon among likely alternative solutions, since it requires smaller production areas than livestock farming, besides accounting for higher yield (MacGrath *et al.*, 2020). This activity has been authorized for exploitation in Permanent Protection Areas (PPAs), in compliance with the applicable State Legislation, according to which, rural property owners must respect the parameters provided for in the new Forest Code (Brazil, 2012). The aim of this legislation is to integrate the environment to agricultural production to achieve appropriate soil and water resources’ management aimed at

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restoring their filtration and long-term use.

The Amazonian aquaculture mostly uses native fish such as ‘tambaqui’ (*Colossoma macroporum*), ‘matrinxã’ (*Brycon cephalus*) and ‘curimatã’ (*Prochilodus nigricans*), which are highly valued in local markets (Moraes & Schor, 2011) and whose demand is growing abroad (Pedroza Filho & Rocha, 2024). Some of the advantages observed for this farming type include ease granting of environmental licenses, prevention of exotic animals’ proliferation, a fact that threaten local biodiversity (Pincinato & Asche, 2016). This synergy is conducive to expansion given the huge variety of fish species distributed in the basins of Amazon, Araguaia-Tocantins and Paraguay rivers (Moro *et al.*, 2013), besides having the potential to form socio-biodiversity bioeconomies (Oliveira *et al.*, 2024a; 2024b).

Consolidating aquaculture practices in the Legal Amazon focused on sustainability depends on continuous and inclusive public policies (Acermoglu & Robinson, 2012). The Brazilian State ensured to commit with this agreement through provisions in the 1988 Federal Constitution (CF/88), which was enacted after 21 years of military dictatorship (1964-1985). The new *Magna Carta* provides for the population’s inclusion in decision-making processes due to its involvement in organized debates that end up turned into demands and, later on, into laws (Abrúcio, 2011). This legal framework regulates and encourages economic activities aimed at opening room for prosperity cycles in society and for the mitigation of past mistakes.

Accordingly, the present research is an analysis of the role played by public policies validated

between 1988 and 2023 by legislative matters focused on Legal Amazon continental aquaculture growth. In order to do so, the nature of these laws was assessed as method to correlate actions taken by authorities to production variations, overtime. Thus, the study provides a critical perspective on the government’s role in promoting regional sustainable development through alternative live-stock farming.

## 2. Materials and methods

The study only took into consideration legislative norms in force, revoked, amended or extinguished after 2-year validation, between 1988 and 2023, published in official gazettes as public policies that were the main research source. State regulation texts had to refer to the aquaculture chain. Furthermore, the adopted fish production analysis targeted human consumption. Therefore, administrative or advisory topics provided for in ordinances and decrees were excluded from the analysis, as well as topics related to traditional or industrial fishing, mariculture, ornamental fish farming and marine species, and guidelines issued by municipalities (which are, oftentimes, of specific nature).

The large legislation on aquaculture (Tiago, 2011) had to be organized into a spreadsheet comprising 138 federal and state level acts (only for the Legal Amazon) that were separated by origin, enactment year, registration number and by other relevant information. This process allowed preparing a legislative summary. This set of information formed the supplementary material and covered the time from democracy reestablishment (1988)

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to the post COVID-19 pandemic (2023).

A timeline was used to represent the chronology of federal and state laws applicable to aquaculture. The research covered a 25-year timeframe (1988-2023) and its result analysis was fragmented into smaller time intervals. The first phase of the chronological framework corresponded to the initial Brazilian Democracy reestablishment stage (1988-1995). A five-year analysis was adopted up to 2015 due to the systematic fish farming records of the Legal Amazon. The study followed four-year time interval from 2016 onward, until the end of the analysis time.

Procedures related to laws were defined and a method was outlined to identify their impact on the Legal Amazon's production. Thus, information collected from official government agencies (ICMBIO, 2023; IBGE, 2024) on fishery traded amounts was added to the research database, but it only took into account species intended for human consumption. The analysis identified expansion or contraction periods in this activity after the enactment or revocation of regulatory documents. This scenario highlights the nature of public policies formulated to boost the development of the continental aquaculture sector. Finally, consultation to secondary sources from scientific research helped to better understand the phenomena discussed in the results section.

### ***3. Results and discussions***

A categorization process was carried out to distribute the legal acts into five thematic axes in order to better understand the set of analyzed regulations:

(I) "Direct incentives" (53 laws), covers aquaculture promotion policies such as sectoral programs, financing lines and tax benefits;

(II) "Regulation" (43 laws), covers the legal framework on this activity's authorizations, duties and procedures;

(III) "Environment" (27 laws), regulations on environmental licensing and water resources' sustainable management;

(IV) "Exotic species" (9 laws), it mainly deals with the introduction and cultivation of non-native organisms; and

(V) "Others" (7 laws), it includes several provisions such as commemorative dates and recognition of entities' public utility in this sector.

The significant variations observed through the production analysis applied to the Legal Amazon continental aquaculture over the 1990s led to distrust regarding information reliability and, consequently, the period was excluded from the final analysis. The assessed period-of-time meets a transitional phase in Brazilian institutions, which were adjusting themselves to a more pluralistic and participatory environment overwhelmed by new demands (Abrúcio, 2011). The aquaculture sector regulation, for example, was managed by the Brazilian Institute for the Environment and Renewable Natural Resources, also known as IBAMA, which is primarily focused on monitoring and preserving fish stocks, since traditional fishing was an outstanding activity in the herein assessed region (Goularti Filho, 2017). This situation changed after the 2000s, when aquaculture production became more stable (Figure 1).

Information accuracy from 2000 onward

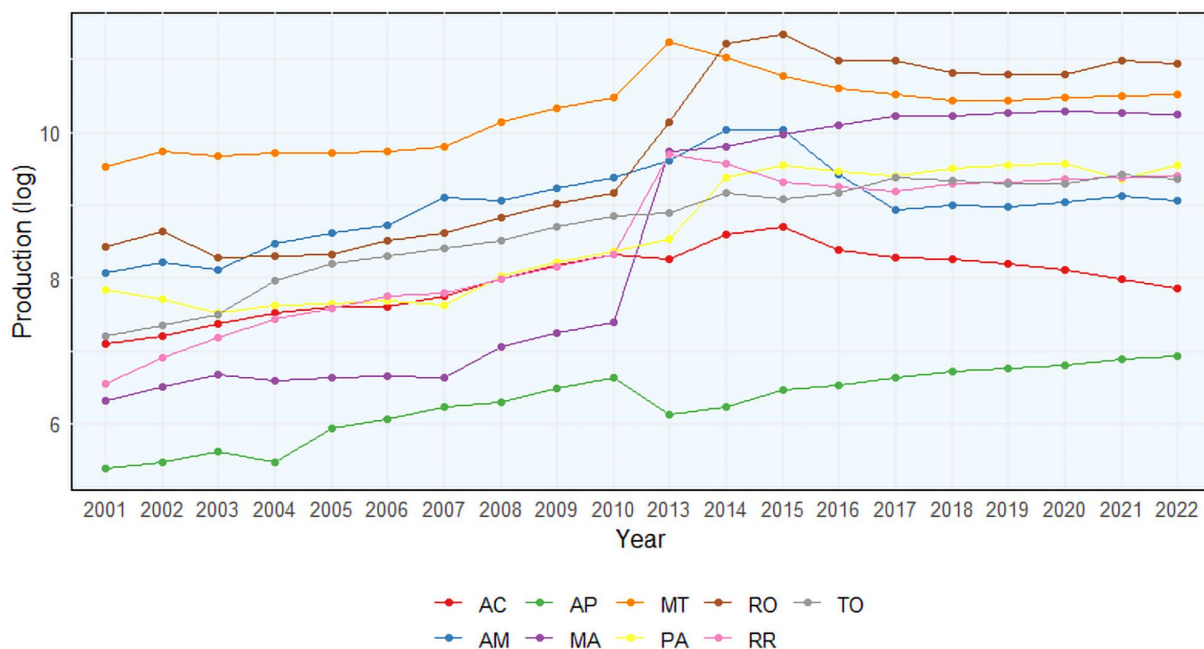


FIGURE 1 – Continental aquaculture production evolution in Brazilian Amazon Federation Units (UFs) (2001-2023, base year: 2000).

SOURCE: ICMBIO, 2023 and IBGE, 2024. The years of 2011 and 2012 were excluded due to data inconsistencies likely caused by methodological changes in the data collection process, whose responsibility was transferred from IBAMA to the Ministry of Fishery and Aquaculture (MPA), and back to IBGE in 2014.

(Figure 1), except for 2011 and 2012, meets traditional fishing (whether for commercial or subsistence purposes) decline. Fishing communities and small industries linked to this production type were deeply affected by deforestation by riverbanks and headwaters, by disorderly land occupation and by the construction of hydroelectric power plants (Freitas *et al.*, 2016), in addition to strong lobby by agrarian elites to free the fishing sector from large-scale fish production control, which demands incentives and subsidies from government officials in return (Goularti Filho, 2017). Mato Grosso State stands out for have been consolidating its position as leading producer of fish for food in the Legal Amazon over this

structural-change context (Figure 1).

Pressure put by private entities allowed creating the Special Secretariat for Aquaculture and Fisheries of the Presidency of the Republic (SEAP/PR) in 2003, which limited Ibama's power over fishery resources' management. Nonetheless, Amazonas and Tocantins states recorded significant increase in aquaculture production in the years after its creations, as observed in Acre and Roraima states. Positive changes also took place in Rondônia, Maranhão and Pará states. Actually, the early 21st century witnessed a new era for Amazonian aquaculture, which was featured by the rise of yield levels, advance in research and entry into new foreign markets (Pincinato & Asche, 2016).

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However, the global 2007-2008 financial crisis had deep effect on aquaculture production in the Legal Amazon. This impact got stronger after the 2014-2016 political and institutional instability, which led to the impeachment of President Dilma Rousseff and to a liberal-conservative shift. It added to the severe water shortage episodes that have plagued Brazil at that time. Images depicted in Figure 1 have shown the stagnation observed since then. Mato Grosso State lost its leadership position to Rondônia State, which kept its position until the end of the analyzed period-of-time. At the same time, Amazonas State experienced significant production decline. Acre and Amapá states are playing secondary roles in the regional aquaculture mix, whereas Maranhão State deserves special mention, since its production has been getting closer to that by Rondônia and Mato Grosso, since 2016.

Uncertainties that marked both the 1990s and the years from 2014 onward raised the first questions about Amazonian aquaculture capacity to create sustainable and inclusive economic systems. It is worth observing that this activity is mostly family-based (Oliveira *et al.*, 2024a); yet, it has recently witnessed higher growth than traditional livestock farming such as beef cattle, which has been in place in Brazil since the 1500s, or swine and poultry farming. All these sectors are closely linked to the globalized agribusiness (Hopewell, 2016). The first legislation to provide for aquaculture was implemented in 1994, six years after the 1988 Federal Constitution enactment. It prohibited African catfish (*Clarias gariepinus*) and channel catfish (*Ictalurus punctatus*) production in the basins of Amazonas and Paraguay rivers (IBAMA Ordinance n. 142/94).

Effective regulation by the Federal government only happened in 1995 through Decree n. 1.695/95, during the post-Real Plan context, which controlled the inertial inflation inherited from the late 1980s and brought along the long-awaited macroeconomic stability. Mato Grosso and Rondônia states had approved policies to encourage aquaculture production in 1992 by granting credit and tax concessions without the prior regulation of this activity. There was no specific environmental legislation for the Legal Amazon between 1988 and 1995 (Figure 2).

The management of natural resources in aquaculture production was formalized as legal norm in 1997 after the National Water Resources Policy (Federal law n. 9.433/97) was enacted and aquaculture environmental licensing criteria were defined (CONAMA Resolution n. 237/97). Furthermore, back in 1997, Rondônia emerged as the first state in the Legal Amazon to establish guidelines to protect, restore, control, inspect and improve environmental fish-farming quality (State Decree n. 7.903/97). Although other Federal interventions have emerged between 1996 and 2000, few Amazonian states, except for Tocantins, regulated this activity within their territories (State Law n. 13/97) and committed to monitor these changes (Figure 3).

The economic crisis at late 1990s forced the raise of interest rates in order to hold public debt. The crisis in combination to electricity rationing at the early 21st century hampered domestic economic growth (Goldenberg & Prado, 2003). The federal government focused on solving these problems and left continental aquaculture growth to the background. A change in this approach

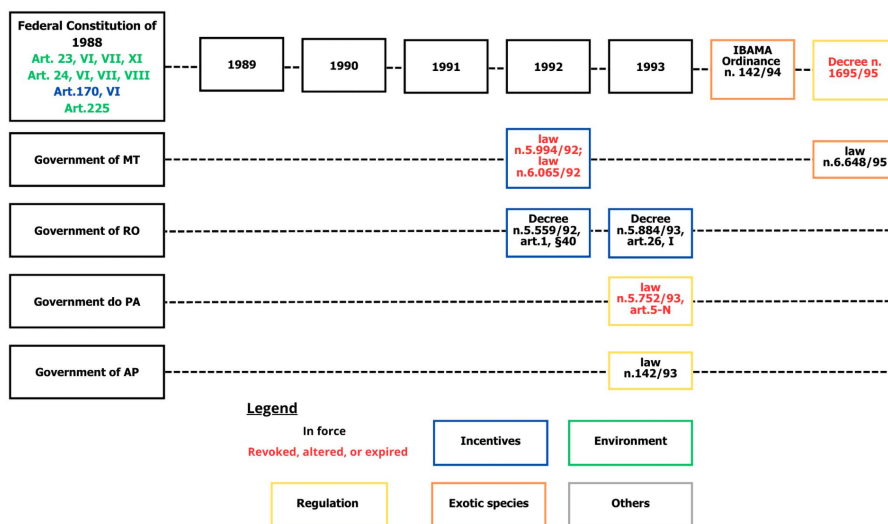


FIGURE 2 – Legislation providing for the Legal Amazon continental aquaculture (1988-1995).

NOTE: Amapá State created the Amapá Rural Development Fund, also known as FRAP (State law n. 39/92). However, the text only mentions artisanal fishing as one of the beneficiaries of these financial resources, and it highlighted its importance for the Legal Amazon in the early 1990s.

SOURCE: research results. Elaborated by the authors.

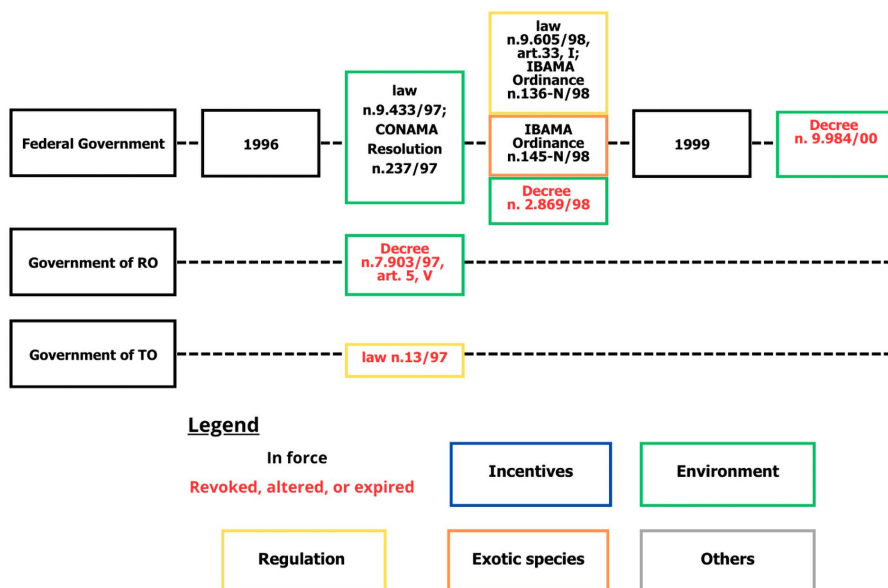


FIGURE 3 – Legislation providing for Legal Amazon continental aquaculture (1996-2000).

SOURCE: research results. Elaborated by the authors.

was observed in 2002 due to the regulation of Permanent Preservation Areas (PPAs) in artificial reservoirs (CONAMA Resolution n. 303/02) and to the establishment of the public water concession regime enacted by Federal Decree n. 4.895/03 (Matias, 2012). At the same time, the Special Secretariat for Aquaculture and Fisheries of the Presidency of the Republic (SEAP/PR)

was created by provisions in Article 30, VII of Federal law n. 10.683/03 (Figure 4). This process reinforced this new institutional framework, which was marked by direct State intervention in the organization of the aquaculture sector.

Amazonas and Maranhão states made significant initial efforts to establish a competitive aquaculture between 2001 and 2005, whereas

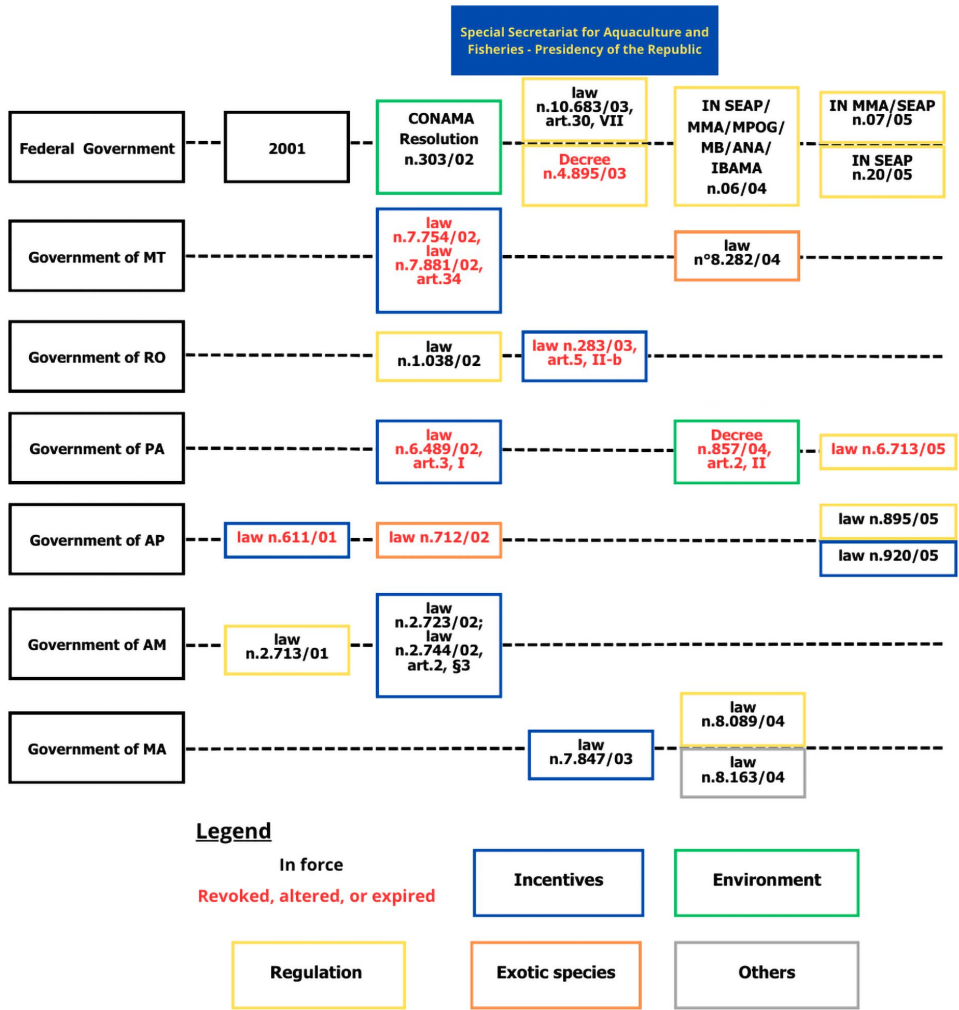


FIGURE 4 – Legislation provision for the Legal Amazon continental aquaculture (2001-2005).  
SOURCE: research results.  
Elaborated by the authors.



Mato Grosso and Rondônia states revised their tax incentive policies due to the same purpose. Amapá State, in its turn, made the cultivation of exotic species easier and this decision did not match Ibama's responsibility, since it was the only governmental authority accountable for this specific issue. Other divergences emerged between

the state and federal levels throughout the analysis, and it opened room for regulatory overlaps and legal uncertainty, mainly between 2006 and 2010, when the Federal Government intensified its efforts by creating the Ministry of Fisheries and Aquaculture (MPA) and by launching Embrapa Fisheries and Aquaculture (Figure 5).

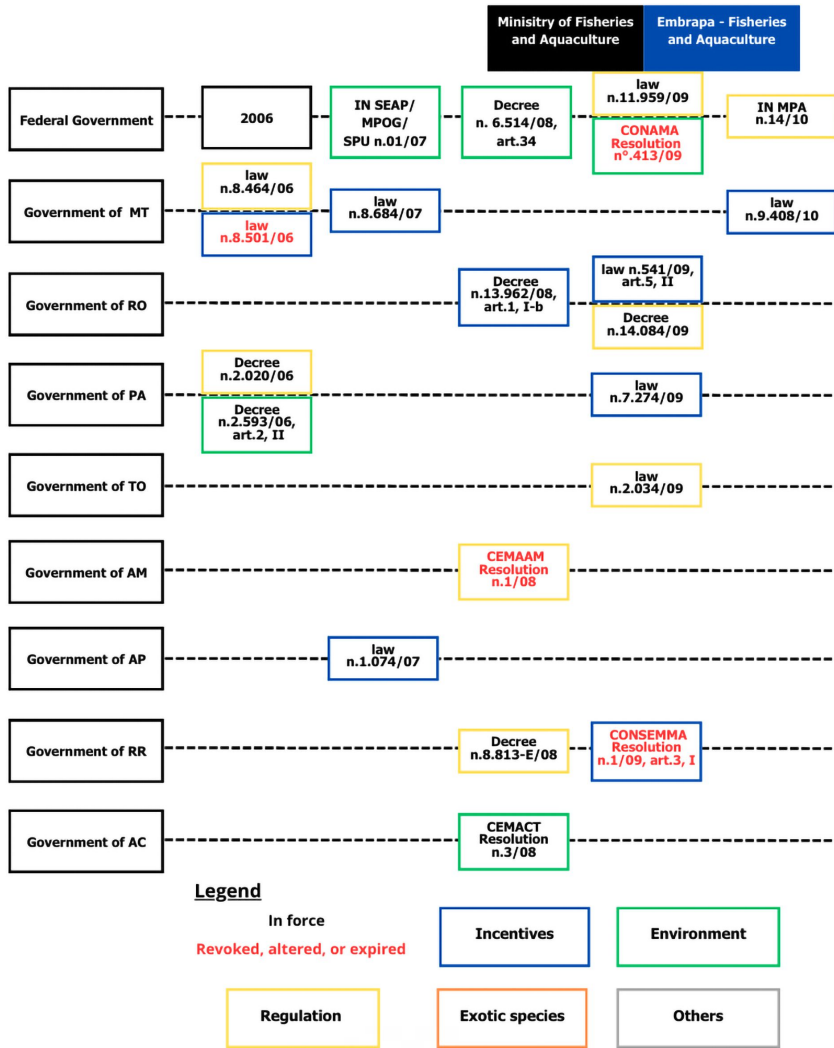


FIGURE 5 – Legislation provision for the Legal Amazon continental aquaculture (2006-2010).

NOTE: SEAP/PR became MPA in 2009.

SOURCE: Research results. Elaborated by the authors.

Furthermore, the Brazilian government implemented environmental policies, whereas the Brazilian states in this territory focused their efforts on promoting aquaculture through incentives. Finally, Acre and Roraima states also adopted these initiatives. These different approaches likely led to legal conflicts involving the Amazonian

aquaculture production. This two-sided approach adopted by the authorities remained in place up to 2014 when Brasília left this stance aside and transferred the full responsibility for aquaculture production sustainable growth to the Federal Units in the region (Figure 6).

The beginning of the conservative cycle in

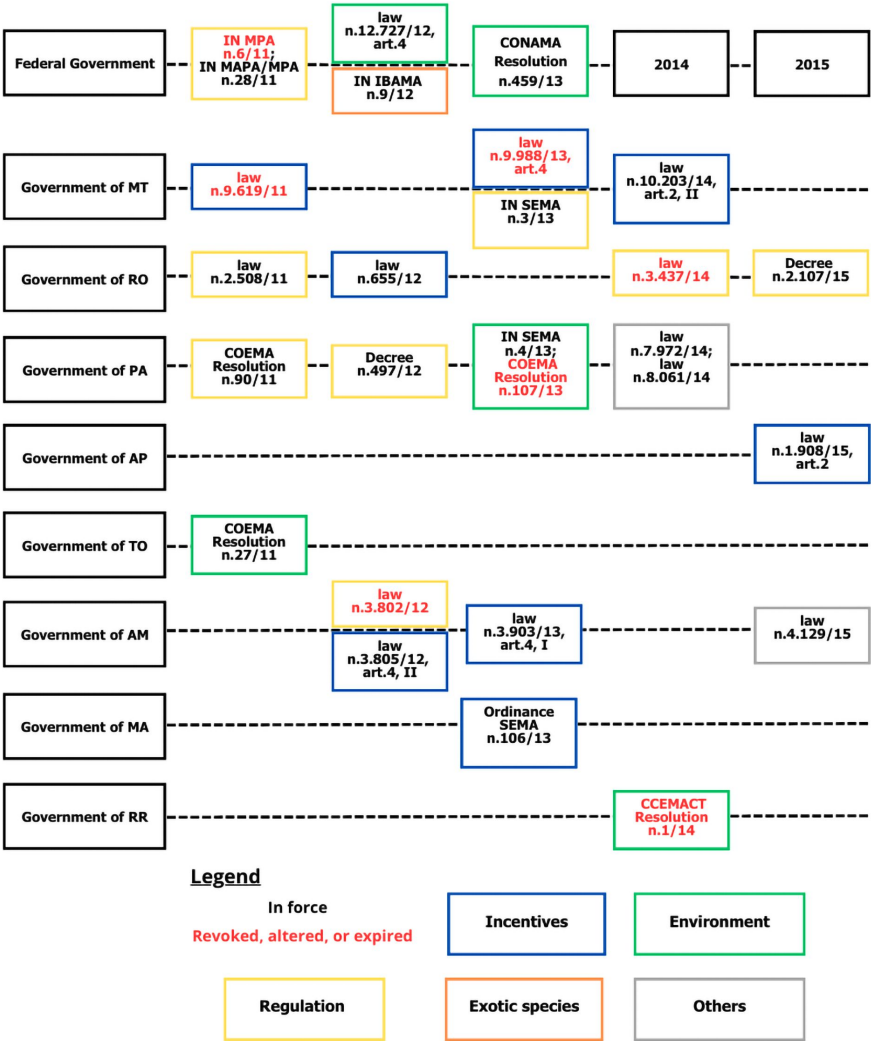


FIGURE 6 – Legislation provision for the Legal Amazon continental aquaculture (2011-2015).

SOURCE: research results. Elaborated by the authors.

the Federal capital matched the end of the continuous aquaculture production expansion, which emerged in the Legal Amazon, in 2003 (Figure 1). From this time on, the states got committed to develop this activity based on new direct-incentive programs, on changes in environmental regula-

tions and legislation, and on creative initiatives such as “State Aquaculture Day and State Fishing Week” (State law n. 10.356/16) in Mato Grosso, which focus on promoting the continental fishing sector (Figures 7 and 8).

In 2020, six years after the last legislation was

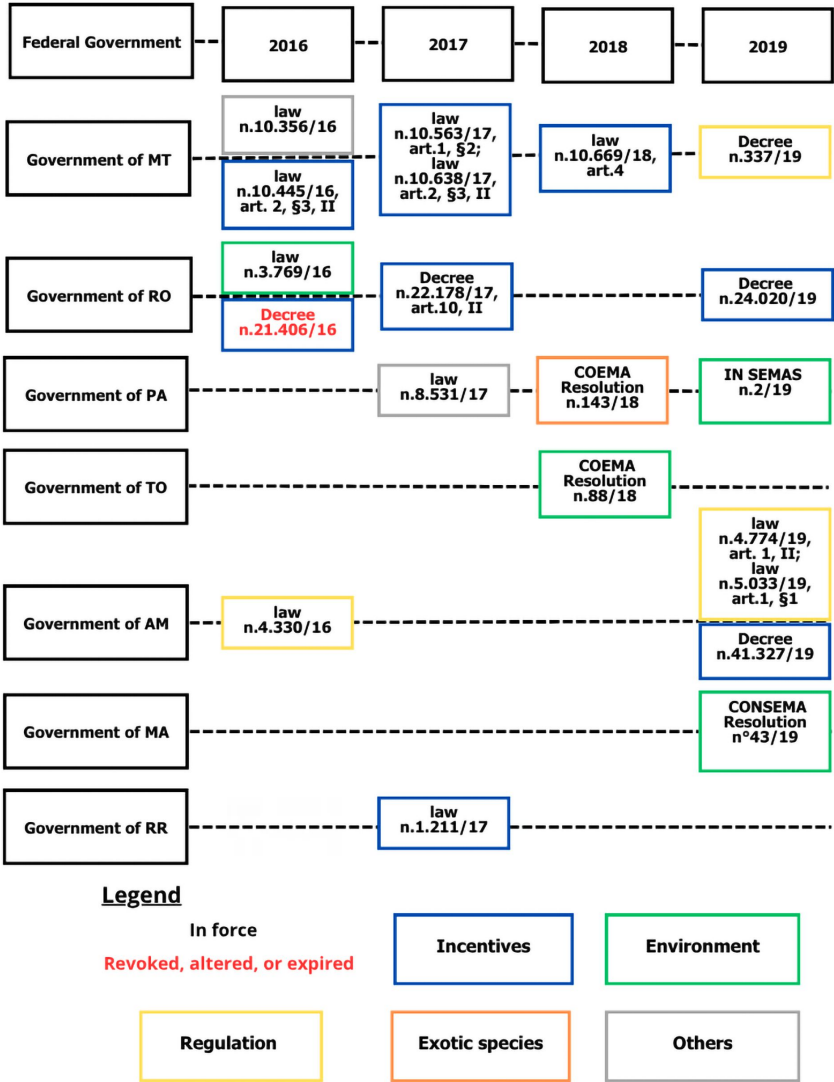
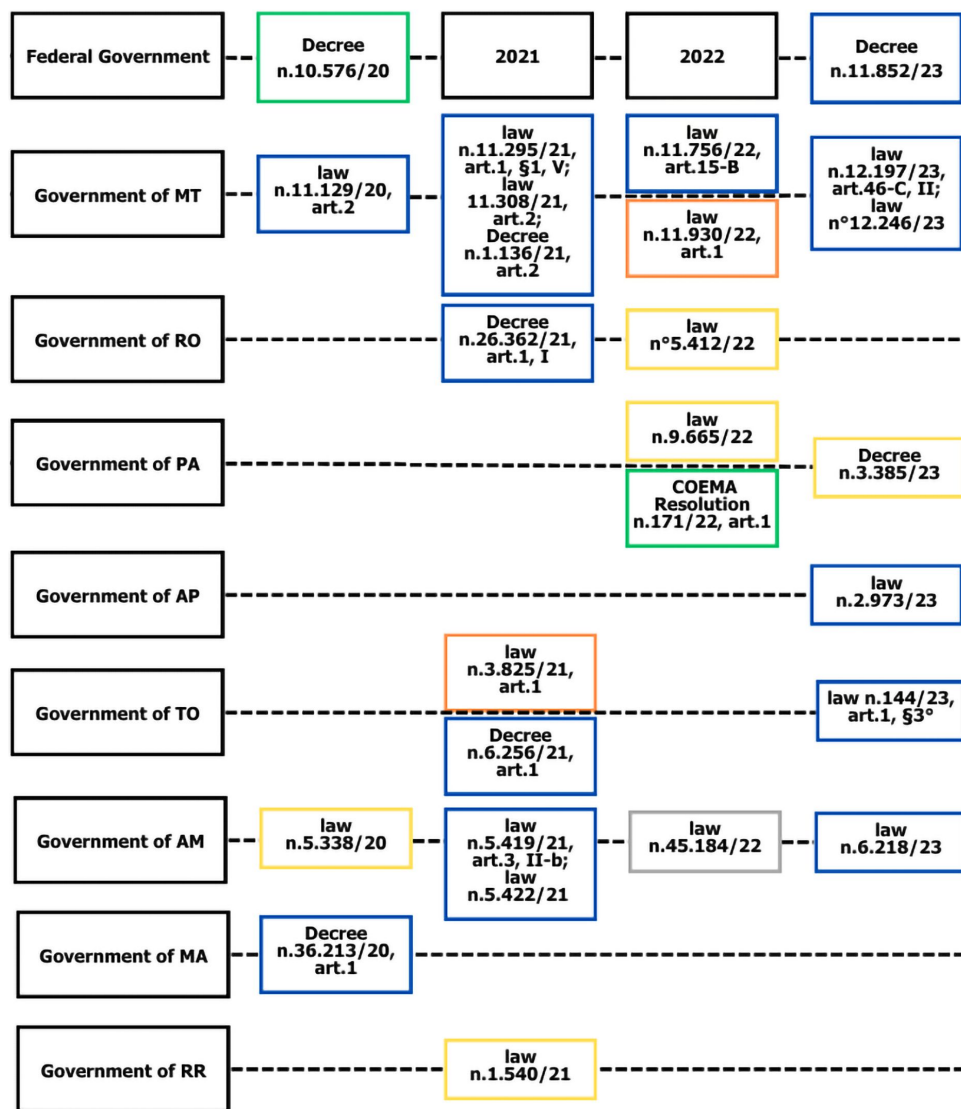


FIGURE 7 – Legislation provision for the Legal Amazon continental aquaculture (2016-2019).  
SOURCE: research results. Elaborated by the authors.



### Legend

In force  
Revoked, altered, or expired

Regulation

Incentives

Exotic species

Environment

Others

FIGURE 8 – Legislation provision for the Legal Amazon continental aquaculture (2020-2023).  
SOURCE: research results.  
Elaborated by the authors.

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enacted, the Federal Government turned its focus to aquaculture by establishing the use of physical spaces in federal waterbodies for this practice (Federal Decree n. 10.576/20). In 2023, when Luís Inácio Lula da Silva returned to the Brazilian Presidency, a new State-action cycle began, marked by the creation of the National Program for Sustainable Aquaculture Development, also known as ProAqui (Federal Decree n. 11.852/23). This initiative seeks to restore productive growth integrated to sustainability, as it was recorded between 2003 and 2014 in the Legal Amazon. This legislation also mentions the circular economy and the bioeconomy as likely pathways for this sector, which highlights the clear potential of the Amazon region (Oliveira *et al.*, 2024b).

#### 4. Complementary Discussions

ProAqui has marked the Federal government's new focus on national aquaculture growth, but it is currently based on sustainability as guiding principle. Only Amazonas (State Law n. 2.713/01) and Mato Grosso states in the Legal Amazon (State law n. 9,408/10 – amendments introduced by State law n. 12.197/23, Art. 46-c, II) had legal bases addressing this topic. Recently, Pará (State law n. 9.665/22 and State Decree n. 9.665/23) and Rondônia states (State law n. 5.412/22) complied with each other. However, the other states, failed to explicitly include this principle in the titles of their legislative texts, and it reflected a worrisome disconnection between the Federal and the inter-state administrative spheres.

Performance discrepancies become clear when timelines are analyzed. Pioneering aquacul-

ture states: Amazonas, Mato Grosso and Rondônia, altogether, approved 29 laws related to “direct incentives” and it points out their leaders’ deep commitment to boost this activity and to justify their production leadership throughout the historical series. On the other hand, Acre State, which was the second-smallest captive fish farmer in the region in 2023, has been presenting successive decline since 2014, since it did not approve any guidelines in this category. Half of these laws were enacted in the last five years in Amazonas State, and it highlight an urgent attempt to resume the growth seen in the first decade of the 21st century.

Balancing economic aspects and natural resources preservation is a basic sustainability premise. Accordingly, Mato Grosso State presents a shortcoming by completely ignoring environmental issues in its institutional aquaculture environment. Pará State, in its turn, has passed seven laws focused on this sector, and it shows an overly protective stance that portrays fish farmers as villains, as primarily responsible for environmental degradation (Costa & Costa, 2022). Furthermore, Pará State has adopted an excessive number of internal legal regulations, and it hinders the approval and implementation of aquaculture projects (Brabo, 2023).

Exhaustive interference was observed in Maranhão State government between 2013 and 2019, namely: State Environmental Council (Consema/MA) changed or revoked (four times) the definition of activities, works and projects that have caused environmental damage. These frequent changes make it difficult to get aquaculture licenses and it renders actions taken by state institutions ineffective, mainly for small landowners who are poorly

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able to navigate bureaucracy (Barbosa & Lima, 2016; Silva *et al.*, 2021; Costa & Costa, 2022). This scenario explains why aquaculture clusters in the Legal Amazon are concentrated in areas housing large rural producers (Oliveira *et al.*, 2024a).

Conflicts are clear in the group of laws related to “Exotic Species”, at political-administrative sphere, although Ibama (Brazilian Institute of Natural Resources) is the only agency responsible for regulating and managing non-native aquatic fauna in captivity, as provided for in Federal Decree n. 10.576/20, Art. 13. On the other hand, authorities in Mato Grosso (State law n. 11.930/22, Art. 1) and Tocantins (Law n. 3.825/21, Art. 1) states authorized panga (*Pangasius hypophthalmus*) farming, which is an Asian species. Such disagreements account for legal uncertainty, which results in endless technical debates and in unnecessary friction among production chain members, besides exposing inefficiency to perform basic institutional functions (Brabo, 2023).

Another analysis’ element lies on the regulation classified as “Other”, whose practical application content is more symbolic than effective. In addition to the “State Aquaculture Day and the State Fishing Week” (State law n. 10.356/16) in Mato Grosso State, other recognitions have taken place at local level in the Legal Amazon. State law n. 8.061/14 and State law n. 8.531/17, for example, declared associations linked to aquaculture activities in Santana do Araguaia City and in Curionópolis City, Pará State, respectively, as of public utility nature. However, fish production in Santana do Araguaia City was suppressed since 2019, whereas there was 83% increase in it, in Curionópolis City, between 2017 and 2023 (IBGE, 2024).

## 5. Conclusion

The present study focused on assessing the association between public policies and variations in continental aquaculture production in the Legal Amazon, between 1988 and 2023. The effectiveness of laws providing for the establish of this practice as alternative livestock farming method in the region was assessed. The current proposition addressed the need for mitigating environmental and social impacts caused by disorderly land use, which is often marked by deforestation and burning for cattle grazing purpose. This agricultural practice, which dates back to the 1960s, remains in place, despite the limitations imposed by the new Forest Code (Federal law n. 12.651/12).

Results pointed out three evolution phases in the Amazonian aquaculture. The first one starts from the enactment of the 1988 Federal Constitution and lasts up to early 21st century. At this time, this activity faced shortage of financial and institutional resources, isolated State actions and Ibama’s creation (Brazilian Institute of Environment and Renewable Natural Resources) guidelines. The second phase emerged after SEAP/PR creation (Federal law n. 10.683/03, Art. 30, VII), and it is featured by match between sectoral growth and public interventionism led by the Federal Government. Finally, federative units held the primary responsibility for strengthening this activity and for presenting modest or lower production results in comparison to the previous period, from 2014 up to the end of the historical series.

Significant changes in the political environment also influenced efforts made to turn continental aquaculture in the Legal Amazon into

a sustainable alternative. Initially, this activity moved between two extremes: fishing resources' full preservation or total exploitation. The Federal Government implemented legal mechanisms to enable aquaculture-controlled expansion in the following phase, although without consistently adopting the sustainability principles. By the end of the historical series, the expression “*ir passar a boiada*” (passing the cattle) illustrates the Federal Government's neoliberal stance, which boosted deforestation and illegal extraction, met private interests and promoted the deliberate weakening of environmental oversight agencies (Freitas *et al.*, 2022).

Findings in the present study confirm the hypothesis that continental aquaculture, alone, is not enough to achieve sustainability (Froehlich *et al.*, 2018), mainly in the complex and conflict-ridden Legal Amazon, where the traditional economic growth model, which is symbolized by extensive cattle ranching, still prevails (Hoelle, 2014; 2017). Reversing this scenario would require exceptional coordination by government officials, but this is something nearly impossible, due to sharp ideological differences. The trend for the coming years shows that these conflicts will go on, and it might result in new legal uncertainties that will increase operational costs, maintain slow production pace and perpetuate past mistakes.

Understanding the effects of public policies on Legal Amazon continental aquaculture requires continued scientific research. Comparative analyses with other Brazilian regions and case studies demonstrating aquaculture practices integration to sustainability are promising pathways. These investigations strengthen the sustainable principles

guiding the current aquaculture agenda, and it led by ProAqui, whose socioeconomic inclusion, biodiversity preservation and regional development are explicitly herein stated.

## Acknowledgement

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