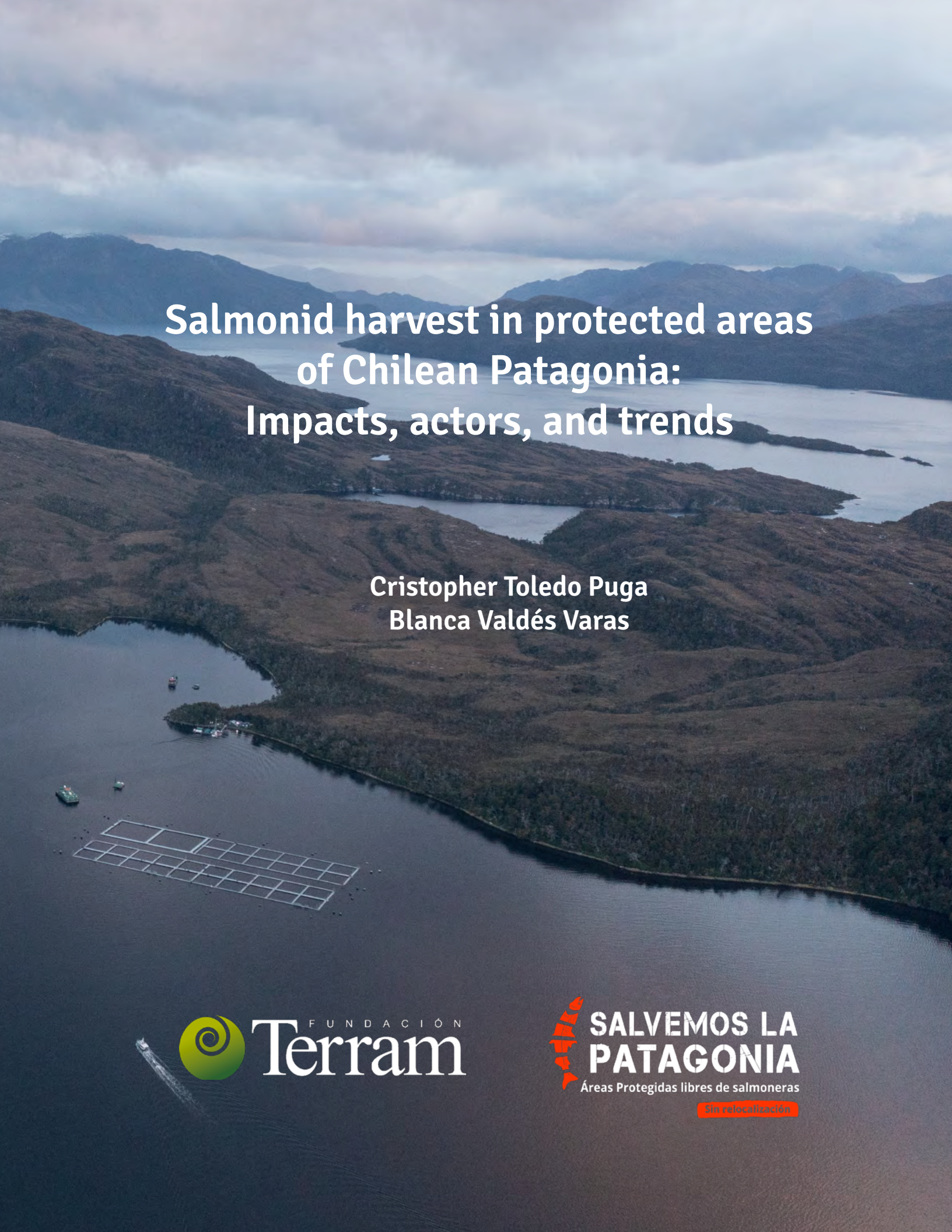

Salmonid harvest in protected areas of Chilean Patagonia: Impacts, actors, and trends

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FUNDACIÓN Terram

SALVEMOS LA PATAGONIA
Áreas Protegidas libres de salmoneras
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Contents

1 Abstract

This report analyzes the evolution of salmonid harvests within protected areas (PAs) in the Aysén and Magallanes regions between 2001 and 2023. Based on official data, it describes the magnitude of harvests, their territorial distribution, and the concentration per owner company in each unit. The results show significant growth in activity within these areas, particularly in the Las Guaitecas and Kawésqar National Reserves, greater than that observed outside them. There is also a differentiated correlation with external events, such as the ISA virus crisis, harmful algal blooms (HABs), and the COVID-19 pandemic: with a positive effect inside the PAs (i.e., increasing harvests) and a negative effect outside them, suggesting that these areas have operated as productive refuges from systemic disturbances. Likewise, there is a high concentration of harvests in a limited number of owner companies, which would increase the vulnerability of the production system to health or environmental events, as well as those associated with climate change. Finally, the study discusses and outlines the socio-environmental implications of the presence of salmon farming in areas legally designated for conservation, highlighting the risks of its coexistence with biodiversity protection objectives. The study seeks to contribute to the understanding of the limits and tensions arising from aquaculture activity in Chilean Patagonia, in a context of intensifying productive pressure on highly environmentally sensitive ecosystems.

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2 Introduction

Global aquaculture has experienced unprecedented growth in recent decades. The latest data from the FAO (2024) reveal that in 2022 aquaculture production reached a historic record of 130.9 million tons in live weight, surpassing capture fisheries for the first time, with an approximate value of US$312.8 billion. Of this total, 94.4 million tons corresponded to aquatic animals (72%) and 36.5 million to algae (28%). Projections indicate additional growth of 17% by 2032, consolidating aquaculture as the fastest-growing food production sector globally.

In this context, Chile has positioned itself as a key player in global aquaculture. In 2024, the country recorded an approximate production of 1.46 million tons in aquaculture, of which 71% corresponded to fish—mainly salmonids—(SERNAPESCA, 2024). The strong export orientation of this industry is evident when we observe that, between 2012 and 2024, on average, 78% of total production was destined for international markets (Toledo, 2025). This performance has generated revenues of over US$6 billion in recent years, driven by historically high prices in global markets (Chilean National Customs Service, 2024), consolidating Chile's position as the world's second largest producer of salmonids, behind only Norway.

Currently, salmon farming is geographically concentrated in Chilean Patagonia, specifically in the regions of Los Lagos, Aysén, and Magallanes, taking advantage of favorable oceanographic conditions, the availability of protected areas such as fjords and southern channels, and the support of public policies promoting the sector.

However, the rapid growth of this industry, along with its economic success, has led to high environmental costs and socio-ecological tensions. Among the main challenges are the impacts on coastal and marine ecosystems, dependence on concessions granted on national public property, limitations on access to transparent information, and, particularly critically, the vulnerability of biodiversity in areas designated for conservation, where this activity has also taken root.

2.1 The problem: salmon farming in protected areas

A particularly serious problem is the presence of salmon farming activities in concessions located within protected areas (PAs) in Chilean Patagonia. These include national parks (NP) and national reserves (NR) in the Aysén and Magallanes regions, territories that are home to unique ecosystems of high value for national and global conservation, characterized by their marine biodiversity, endemism, and ecological fragility.

According to the most recent land registry, at least 408 aquaculture concessions for salmonid farming (mainly rainbow trout, Atlantic salmon, and Pacific salmon or coho) currently operate within the PA under the categories of PN and RN in Aysén and Magallanes, representing approximately 48% of the total concessions granted in these regions (Toledo & Espinoza, 2024). This situation persists despite the conservation-oriented regulatory framework, highlighting significant gaps in institutional governance, limitations in enforcement systems, and unresolved regulatory conflicts. The magnitude of the problem is exacerbated by the fact that most of the concessions located in the aforementioned PAs were granted after their creation, suggesting a decision-making process that did not adequately consider the established conservation objectives.

2.2 Justification and empirical gap

Despite the relevance of the problem, there is a significant empirical gap in the scientific literature regarding the quantification and systematic analysis of salmon farming activity within PAs in Chile, specifically the harvests that take place within them. Existing studies have focused mainly on the environmental, social, and economic impacts of salmon farming or on regulatory aspects, but have not comprehensively addressed the spatial and temporal dimensions of this conflict.

This study aims to fill this gap by quantifying and analyzing annual salmonid harvests in five specific protected areas in Chilean Patagonia—Magdalena Island National Park, Laguna San Rafael National Park, Alberto de Agostini National Park, Las Guaitecas National Reserve, and Kawésqar National Reserve—during the period 2001–2023.

2.3 General objective of the study

Analyze the temporal evolution and spatial distribution of salmonid harvests in concessions located within protected areas of Chilean Patagonia during the period 2001-2023.

2.4 Specific objectives

- Quantify the annual harvest volume of salmonids in concessions located within the five selected APs.
- Determine the proportion that these harvests represent in relation to the regional total for Aysén and Magallanes during the study period.
- Identify temporal patterns, seasonal variations, and trends in salmonid harvests within protected areas.
- Analyze the geographic distribution and concentration of activity (in terms of volume) by region, protected area category, and concession holder.
- Assess the relationship between the expansion of salmon farming and critical events in the sector (ISA virus crisis, FAN, and COVID-19).

2.5 Research question

What is the magnitude, temporal evolution, and spatial distribution of salmonid harvests within protected areas in Chilean Patagonia during the period 2001-2023, and what patterns can be identified in relation to the overall dynamics of the sector?

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3 Conceptual framework

3.1 Evolution of salmon farming in Chile: from expansion to socio-environmental conflict

Salmon farming in Chile represents a paradigmatic case of accelerated production expansion: between 1990 and 2024, salmonid harvests rose from 28,000 tons in 1990 to over 1 million tons in recent years (SERNAPESCA, 2024; Toledo, 2024). It should be noted that harvests correspond to the final stage of the production cycle in marine farming centers, after which the fish are transferred to processing plants, where they are slaughtered and destined for both direct consumption and the manufacture of processed products.

This growth was sustained by a combination of factors: (i) favorable oceanographic conditions in Chilean Patagonia, (ii) permissive regulatory frameworks, (iii) growing international demand, and (iv) public policies promoting the sector. The industry was initially established in the Los Lagos region, specifically in the Chiloé archipelago, and later expanded southward, colonizing the fjords of Aysén and, more recently, Magallanes.

Health crises and vulnerability of the model

This intensive and poorly regulated growth triggered a series of crises that highlighted the vulnerability of the production model. The ISA virus epidemic began in mid-2007 in the Los Lagos region and then spread to the Aysén region until 2010, devastating the sector—drastically reducing production, causing the closure of farming centers, and leading to unemployment—while the industry faced profound economic and social consequences (Tecklin, 2015).

The response to the ISA crisis is analyzed by Bustos-Gallardo (2013) as a "failure of neoliberal environmental governance," as it showed that these were not prepared to address the long-term ecological implications. Instead of solutions based on biological recovery, responses focused on economic and financial restructuring. The measures implemented (supported by regulatory changes) included the creation of "neighborhoods" (known as Salmonid Concession Groups) to coordinate operations and promote geographical expansion into the Aysén and Magallanes regions.

Subsequently, FANs, such as the 2016 episode, caused declines of up to 18% (SERNAPESCA, 2024) in harvests and highlighted the sector's dependence on specific environmental conditions. This and other natural events, such as the El Niño phenomenon, are intensified when they overlap with climate change, making the industrial salmon sector much more vulnerable and generating negative socioeconomic impacts (Chávez et al., 2019; Soto et al., 2019).

More recently, the COVID-19 pandemic, with its global impact, threatened food production, trade, and transportation, among other sectors. Although the consequences of the pandemic, especially on production systems such as aquaculture, have yet to be studied, the study by Soto et al. (2021) suggests that concession areas with higher accumulated biomass present higher levels of risk for both production and the environment. These risks are related to restricted access to farming centers, limited processing capacity, and decreased demand in international markets.

These events—mainly the ISA crisis—forced regulatory changes in the sector and the search for new cultivation areas in the regions of Aysén and Magallanes (Furci, 2008), including areas within protected areas, as a risk diversification strategy. However, it has been shown that the industry continued to engage in practices similar to those that led to the crisis, suggesting that the root causes of the problem have not been addressed (Bustos-Gallardo, 2013).

Socioeconomic contribution

The salmon farming industry has positioned itself as a significant economic driver in southern Chile, particularly in remote coastal areas of the Los Lagos region. In their study, Cárdenas-Retamal et al. (2021) show that the establishment of salmon farming centers contributed to a significant reduction in income inequality, especially in localities close to these facilities, benefiting middle-income households through formal and better-paid jobs.

For their part, Ceballos et al. (2018) conclude that the geographical location of salmon farms plays a decisive role in poverty reduction, with the most notable impacts occurring in communities close to farming centers. However, both studies share important limitations: they focus exclusively on the Los Lagos region and cover a limited period between 1992 and 2002, which restricts the ability to generalize their conclusions to other regions such as Aysén or Magallanes, where salmon farming has become increasingly important over the last decade. This gap highlights the need to expand research to new territories and time horizons, considering the productive, regulatory, and socio-environmental transformations that have marked the sector in the last two decades, added to the fact that the period of analysis of the studies does not include the impacts of the ISA virus crisis and subsequent changes.

In this regard, Bustos et al. (2019) offer a critical and complementary perspective, warning that the industry's growth has not only economic impacts but also sociocultural ones, particularly in terms of local identity-building processes. Their study, focused on the Los Lagos region, shows that salmon farming has led to the territorial and labor displacement of artisanal fishermen, generating resistance to the sector's expansion, while other groups, such as farmers, have tended to adapt to the production cycles imposed by the industry.

Furthermore, the authors argue that the consolidation of salmon farming as the main economic activity in the territories where it operates has displaced other traditional activities, profoundly reconfiguring the relationship between local communities and their environment.

Other research suggests that the relationship between production and employment has begun to decouple (A. Román, 2015; Toledo, 2023) due to the progressive technification of farming centers, which has led to a reduction in the need for direct labor. This trend is confirmed by data provided by the Salmon Council (2023), which reports a 23.5% decrease in the employment of divers in the first half of 2023, attributed to the incorporation of specialized machinery. Added to this problem is a significant information gap: publicly available official statistics on sectoral employment are limited to 2016 (INE, 2016), making it difficult to accurately assess the current social impact. The statistical void forces us to resort to private company data, obtained mainly for tax purposes or through voluntary disclosure (Internal Revenue Service, 2022), which poses serious limitations in terms of representativeness and public access to key information.

3.2 Aquaculture concession system: institutional and economic framework

The development of Chilean salmon farming has been based on a system of aquaculture concessions that grant exclusive rights to use marine space to the concession holders. These concessions, regulated by the General Fisheries and Aquaculture Law (LGPA) (Decree 430), constitute the main asset of the salmon industry (Vega, 2013), and are characterized by being transferable, mortgageable, and subject to legal negotiation (Decree No. 430, Article 69).

This concession system has particular characteristics that distinguish it from other productive sectors: (i) it grants rights over national assets for public use (coastal marine space), (ii) it establishes long terms of validity (25 years, renewable), (iii) it allows the transfer of rights without significant restrictions, and (iv) it generates privately appropriable economic rents from commonly owned resources.

This institutional framework has facilitated the expansion of this sector, but it has also generated distributional and environmental tensions, particularly when concessions are located in areas with significant ecological or landscape values, such as PAs.

Protected areas in Chilean Patagonia: biodiversity and conservation

Chilean Patagonia, which encompasses the regions of Los Lagos, Aysén, and Magallanes, is one of the last pristine ecosystems on the planet, characterized by extraordinary marine and terrestrial biological diversity. Its fjords, channels, and archipelagos are home to—and serve as transit routes for—species of high conservation value, in addition to a biodiversity that promotes high levels of endemism and supports key ecosystem services (Rozzi et al., 2012). This area is one of the few remaining regions in the world that conserves more than half of its natural habitat and is legally protected (Martínez-Harms et al., 2022).

The recognition of areas of ecological importance led to the establishment of multiple categories of protection, including national parks (NP), national reserves (NR), natural monuments (NM), among other conservation figures, aimed at maintaining natural ecosystems operational, acting as a refuge for threatened species, and preserving ecological processes that would be unable to survive in environments with greater anthropic intervention (Dudley, 2008).

Regulatory framework for protection

The recent publication of Law No. 21,600 (2023), which created the Biodiversity and Protected Areas Service (SBAP) and the National System of Protected Areas (SNAP), established a stricter legal regime for the management and protection of these areas, reinforcing the precautionary principle and the duty to conserve biodiversity.

With regard to the highest protection categories, the law stipulates that all forms of commercial exploitation of natural resources are prohibited in national parks. Likewise, when these consist exclusively of marine ecosystems, any type of extractive activity is prohibited, except those expressly authorized for scientific research, education, or small-scale tourism (Law No. 21,600, Article 58). With regard to national reserves, the regulations allow for the development of sustainable use activities, provided that these do not compromise the integrity of the ecosystems subject to conservation (Law No. 21,600, Article 60).

This regulatory framework is complemented by Law No. 19,300, on General Environmental Principles (LBGMA), which incorporates PAs as one of the environmental management instruments by establishing in Article 34 the National System of State Protected Wildlife Areas (SNASPE), whose purpose is to ensure biological diversity, protect nature, and conserve environmental heritage. In turn, the Regulations of the Environmental Impact Assessment System (SEIA) (D.S. No. 40/2012 of the Ministry of the Environment) sets out specific assessment rules for projects intended to be located in or near areas under official protection, imposing stricter requirements for justification and mitigation, remediation, or compensation measures (Articles 10 and 11).

This legal framework is based on Article 19 No. 8 of the Constitution, which enshrines the right to live in an environment free from pollution and the duty of the State to protect nature, providing a constitutional basis for the special protection of these areas.

Finally, the domestic regulatory framework is aligned with Chile's international commitments, in particular the Convention for the Protection of Flora, Fauna, and Natural Scenic Beauty of the Americas (hereinafter "Washington Convention"), approved by Decree 531 of 1967 of the Ministry of Foreign Affairs. This treaty stipulates that the resources existing in the strictest conservation categories, such as national parks, may not be exploited for commercial purposes. In the case of national reserves, it establishes that their purpose is the conservation and use, under official supervision, of natural resources, ensuring that flora and fauna receive all the protection compatible with the aims or objectives that motivated their creation.

Regulatory and environmental conflicts: the case of salmon farming in protected areas

The presence of intensive salmon farming activities within PAs has been documented in two recent studies (Farías et al., 2022; Toledo & Espinoza, 2024), which identify multiple regulatory and environmental conflicts that highlight failures in the institutional governance of the coastal marine territory.

From a legal perspective, the operation of salmon farming concessions in PNs contradicts current regulations, both nationally and internationally. The Washington Convention, ratified by Chile, expressly prohibits commercial exploitation in these areas; however, in practice, concessions were granted, mostly after the creation of the PAs, under the relative opacity surrounding the recognition of the marine portion of the parks. This situation continued until the approval of Law No. 21,600 in 2023, which, after more than a decade of processing, expressly established a ban on granting new concessions in these areas, although without retroactive effect on existing ones.

It should be noted that, in terms of interpretation, the Comptroller General of the Republic (CGR), through Ruling No. 38,429 of 2013, specified that the marine portions of the PAs whose decrees only referred to the terrestrial environment were incorporated into them by virtue of Article 36 of Law No. 19,300. Along the same lines, it ruled, in accordance with the provisions of Article 158 of the LGPA and the Washington Convention, that it was impossible to carry out aquaculture activities within the perimeter of the PNs, reinforcing the intangibility of these areas in the face of extractive activities.

This ruling, by formally recognizing the marine portion belonging to the PAs, reinforces the irregularity of the concessions granted in these areas and constitutes a key precedent for the interpretation and application of regulations on the protection of marine ecosystems. This process highlights regulatory decisions that did not adequately internalize previously established conservation objectives, which has led to persistent conflict in the management of these areas.

On the other hand, the environmental impacts of salmon farming on marine ecosystems have been documented in scientific literature (Buschmann et al., 2009; Niklitschek et al., 2013; Sepúlveda et al., 2013). The main effects include: (i) eutrophication due to excess nutrients, (ii) contamination by antibiotics and other chemicals, (iii) escape of exotic species, (iv) alteration of food chains, (v) degradation of the seabed, and (vi) transmission of diseases to native populations.

A paradigmatic case, the subject of scientific studies since 2003, is the Comau Fjord in Northern Patagonia, renowned for its high biodiversity, which includes rare and endangered species. In 2012, this fjord had 42 aquaculture concessions, of which 33 were for salmonids and 9 for Chilean mussels.

The presence and proliferation of these concessions has contributed to the accumulation of organic waste, eutrophication, and poor management of chemical use, factors that have led to the progressive deterioration of the fjord's biodiversity (Häussermann et al., 2013).

The persistence of these activities in APs and sites of high ecological value highlights significant gaps in coastal and marine territorial governance, including: (i) institutional fragmentation between sectoral and environmental agencies, (ii) limitations in enforcement capacity, (iii) lack of effective mechanisms for intersectoral coordination, and (iv) weak enforcement of environmental regulatory frameworks.

This scenario raises the urgent need to generate robust empirical information that will enable the magnitude of the problem to be assessed and guide decision-making processes regarding this issue.

© José Tomás Yakasovic. Residuos industriales en fondos anóxicos en el Fiordo Comau.

4 Materials and methods

4.1 Data sources

- Information on salmonid stocking and harvesting from the National Fisheries and Aquaculture Service (SERNAPESCA). Data broken down by farming center, including: center code, region, owner, species, year, month, units, and kilograms harvested. Considering the regions of Los Lagos, Aysén, and Magallanes, for the period 2001–2023.
- Statistical Yearbooks on Fisheries and Aquaculture from the National Fisheries and Aquaculture Service: annualized regional series of salmonid harvests for the period 2001-2023.
- Register of concessions for salmon farming located within protected areas (Toledo & Espinoza, 2024): details of aquaculture concessions within PAs.
- National Property Registry of Protected Areas: spatial information on the five protected areas considered in the study, specifically three national parks and two national reserves located in the Aysén and Magallanes regions.
- SUBPESCA map viewer: spatial information on aquaculture concessions for salmon farming.

4.2 Methodology

This research corresponds to a descriptive-analytical longitudinal study that aims to identify the levels of salmonid harvests in concessions located within PAs in Chilean Patagonia, characterizing their evolutionary patterns and concentrations in different regions and concession holders within the PAs during the period 2001-2023.

a) Compilation and integration of databases

Through a request made to SERNAPESCA under the Transparency Law (No. 20,285), harvest data was obtained, broken down by center code, region, owner, species, year, month, units, and kilograms harvested.

To identify concessions located within PAs, the Cadastre of concessions for salmon farming located within protected areas (Toledo & Espinoza, 2024) was used as a basis. Subsequently, this cadastre was updated by reviewing five specific PAs—two parks and three national reserves—as detailed in Table 1. For this update, the concession database available in the SUBPESCA Map Viewer (2025) (consulted in May 2025) was used, considering PAs as continuous units, delimited only by their outer edges.

Table 1. Details of protected areas considered

P.A. Name	Region	Marine Surface (ha)	Year of creation (promulgación)
Parque Nacional Alberto de Agostini	Magallanes	1.115.877	22-01-1965
Parque Nacional Isla Magdalena	Aysén	Sin información oficial	25-05-1983
Parque Nacional Laguna San Rafael	Aysén	347.926	17-06-1959
Reserva Nacional Kawésqar	Magallanes	2.612.810	26-01-2018
Reserva Nacional Las Guaitecas	Aysén	818.481	28-10-1938

Source: Prepared internally based on cartographic information on public assets belonging to the National System of Protected Areas (MBN, 2025).

With the information updated to May 2025 on the boundaries of the PAs and the identification of the concessions located within them—either totally or partially—this mapping was linked to the salmonid harvest database, using the unique code of each farming center as the matching criterion. It is important to note that, given that the delimitation of the PAs and the concession registry correspond to the status in force in 2025, concessions that may have been within a PA in previous years but are not currently in that condition are not included.

Subsequently, a master database was created in Excel combining both sets of data, incorporating: the codes of the centers with their respective owners and Salmonid Concession Groupings (ACS), region, province, municipality, and the sector in which they are located, whether they are within a PA, the name and type of the PA, the year, and the kilograms harvested by each farming center.

b) Quantitative analysis

Based on this integrated database, dynamic tables were created to add up the kilos harvested per cultivation center and year (2001–2023). In addition, filters were applied by region, municipality, AP identification, and owner. The values were converted from kilos to tons in order to analyze harvest patterns and their temporal and spatial concentration.

To identify and focus the analysis on the most relevant concession holders among those located in PAs, we applied a cumulative 80% criterion, in accordance with the Pareto Principle. This approach consisted of ranking concession holders from highest to lowest

productivity—based on total harvest between 2001 and 2023—and then calculating their percentage share of the total produced in each PA. We added up these annual shares until their average for the period reached the 80% threshold. In this way, we selected the small group of concession holders who, together, account for a large part of the harvests (on average), ensuring that the analysis focuses on those with the greatest impact within the PAs.

c) Statistical analysis

To deepen our understanding of trends and relationships between variables and statistically validate the patterns observed, various statistical methods were used, including linear regression models and correlation analysis. These processes included estimating crop growth and evaluating associations between crops and factors such as critical events and active centers. Prior to applying the models, compliance with the fundamental assumptions of the statistical methods used, such as linearity, normality of residuals, homoscedasticity, and absence of autocorrelation, was verified in order to ensure the validity of the results (Gujarati & Porter, 2009).

Once these assumptions had been verified, the coefficients were estimated and the statistical significance of the relationships was evaluated, considering the following levels: *** ($p < 0.001$), ** ($p < 0.01$), * ($p < 0.05$). The estimates were used to quantify the strength and direction of the associations between the variables of interest in salmonid harvesting.

d) Display and verification

Graphs were generated to illustrate annual harvest trends (volume per year), comparing variables such as region, type of AP, and owner. Finally, cross-validation was performed with the aggregated data by year and region contained in the SERNAPESCA yearbooks (2024), ensuring consistency and accuracy in the amounts obtained.

5 Results

5.1 Concessions granted in protected areas

A total of 409 concessions granted for salmon farming were identified within the five PAs considered, as detailed in Tables 1 and 2. It should be noted that, since the purpose of identifying these concessions is to establish the harvests in each one, no distinction was made between those that were totally or partially within the PA.

In terms of distribution, more than 90% of these concessions are concentrated in the Kawésqar and Las Guaitecas National Reserves, with 66 and 314 concessions, covering significant areas of land, 1,371 ha and 2,180 ha, respectively. In contrast, national parks have a smaller presence: Alberto de Agostini with 19 concessions covering approximately 98 ha, Magdalena Island with 8 concessions covering 65 ha, and Laguna San Rafael with only 2 concessions covering 3 ha. This reveals a clear concentration of salmon farming activity within reserves, where usage restrictions are less strict compared to parks.

Table 2. Total concessions granted for salmon farming within protected areas (2025)

Protected Area	Region	N°	Surface (ha)
Parque Nacional Alberto de Agostini	Magallanes	19	97,91
Parque Nacional Isla Magdalena	Aysén	8	64,83
Parque Nacional Laguna San Rafael	Aysén	2	3
Reserva Nacional Kawésqar	Magallanes	66	1.371,45
Reserva Nacional Las Guaitecas	Aysén	314	2.180,1
Total		**409**	**3.717,29**

Source: Prepared internally based on information from the Map Viewer (SUBPESCA, 2025) and cartographic information on public property belonging to the National System of Protected Areas (MBN, 2025).

The notable concentration of concessions in national reserves—particularly Las Guaitecas—not only reflects where most of the concessions granted for salmon farming are located, but also gives us an idea of where harvesting may be most intensive in these PAs.

5.2 Total harvests and harvests in protected areas

Starting in 2001, salmonid harvests began to be recorded in concessions located within PAs, showing a growing share of the total harvests of the salmon farming industry based in the regions of Los Lagos, Aysén, and Magallanes, as shown in Figure 1. When the data is broken down, it can be seen that total harvests, both inside and outside PAs, show different rates of expansion, indicating that the spatial location of concessions has influenced the industry's production dynamics, accelerating its growth in certain areas.

Harvests within the AP—located in Aysén and Magallanes—have grown significantly: from just 61 tons (t) in 2001 to 279.5 thousand t in 2023, representing a relative average of 17% of the total harvests recorded in Los Lagos, Aysén, and Magallanes, and 34% of the latter two. This relative representation peaked at 32.4% in 2021 and averaged 25.2% over the last ten years.

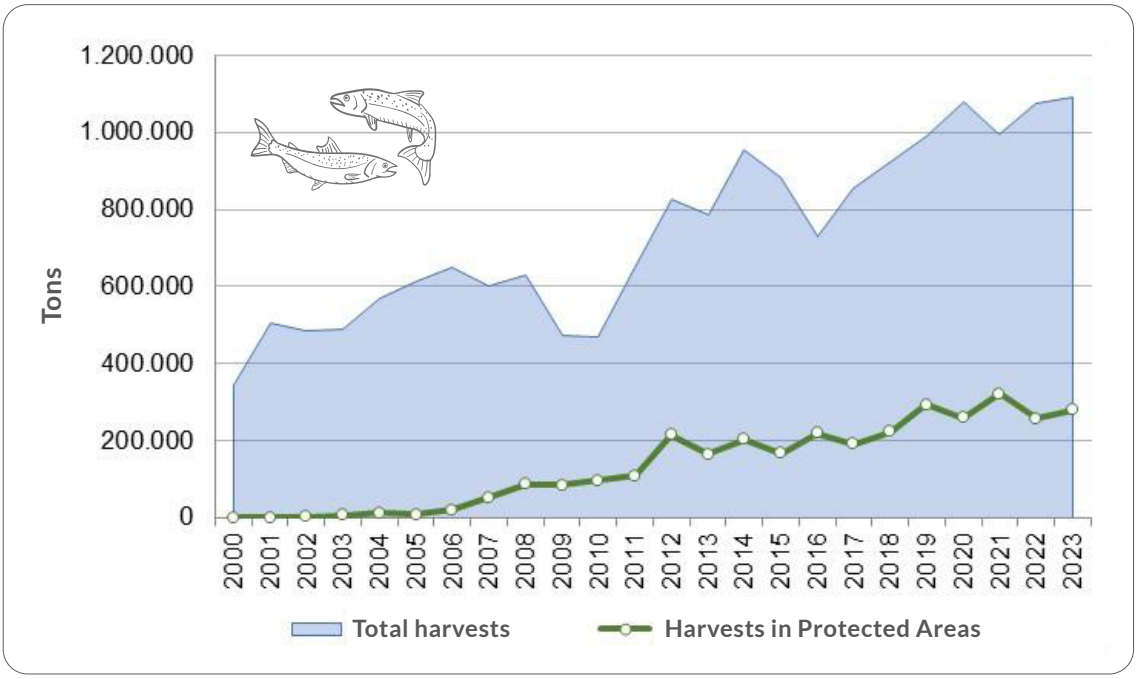
This increase in harvests within AP (according to the estimated log-linear model) corresponds to an average annual growth rate of 29.9% (***), significantly higher than that observed in the industry as a whole, which reached a rate of 3.94% (***) and that recorded in centers outside PAs, which showed an annual growth rate of 7.76% (***). Consequently, growth within PAs significantly exceeds that of other categories, both in individual analyses and in joint comparisons, which would indicate greater productive intensity in these protected areas.

Between 2001 and 2010, this phenomenon gained momentum. Harvests in AP rose from 61 tons to more than 96.7 thousand tons. The biggest jump was observed in 2002, with an increase of more than 1,000% over the previous year. However, in 2005 and 2009, there was a contraction in AP harvests, decreasing by 43% and 3% compared to the previous year, respectively. The decline in 2009 was due to the impact of the ISA virus crisis in the Aysén region. It should be noted that the ISA virus crisis began in mid-2007, with the worst consequences (in social and economic terms) occurring in 2010, reducing overall regional production in Los Lagos and Aysén during that year and the previous one. However, by 2010, harvests in APs had rebounded by 16%, driven mainly by growth in APs in the Aysén region, which showed a 20% increase compared to the previous year. This suggests that these areas may have been less affected or more resilient to health impacts than areas outside the protected zone, as total industry harvests in 2009 and 2010 fell to their lowest levels, reaching −25% and −2% compared to previous years, respectively.

During the following decade (2011–2020), production in AP remained strong and stable: harvests consistently exceeded 100,000 tons, peaking at 292,200 tons in 2019. In 2020, AP harvests declined by 12% to 257,900 tons, contrasting with the growth experienced by total industry harvests, which exceeded one million tons for the first time, as shown in Figure 1.

Finally, the 2021–2023 triennium showed more variable dynamics. The annual average for this period was 285,400 tons. Compared to previous years, 2021 saw a sharp increase of 25% (321,200 tons), followed by a 20% drop in 2022 and a moderate rebound of 9% in 2023, reaching 279,500 tons again. This behavior suggests that, although APs continue to be active production areas, there are variables that affect their performance, causing fluctuations each year.

Figure 1. Total harvests and harvests in protected areas (2000–2023)



Source: Prepared internally based on Statistical Yearbooks on Fishing and Aquaculture (SERNAPESCA, 2024) and information requested via the transparency law.

Note: For reference purposes, total harvests include the regions of Los Lagos, Aysén, and Magallanes, even though AP harvests are located in Aysén and Magallanes.

5.3 Regional harvests

During the period 2001-2023, total industry harvests (inside and outside the AP) were distributed in relative terms as follows: 59% in the Los Lagos region, 35% in Aysén, and 6% in Magallanes. This distribution has been changing in recent years, with Aysén even surpassing Los Lagos, and Magallanes showing remarkable growth. By 2023, the relative distribution reached 40% for Los Lagos, 47% for Aysén, and 12% for Magallanes.

This regional distribution reflects the expansion that the industry has shown in recent years, mainly in Aysén and Magallanes. It also anticipates specific patterns of harvest distribution within the PAs, considering that these are located in regions where the industry has shown expansion.

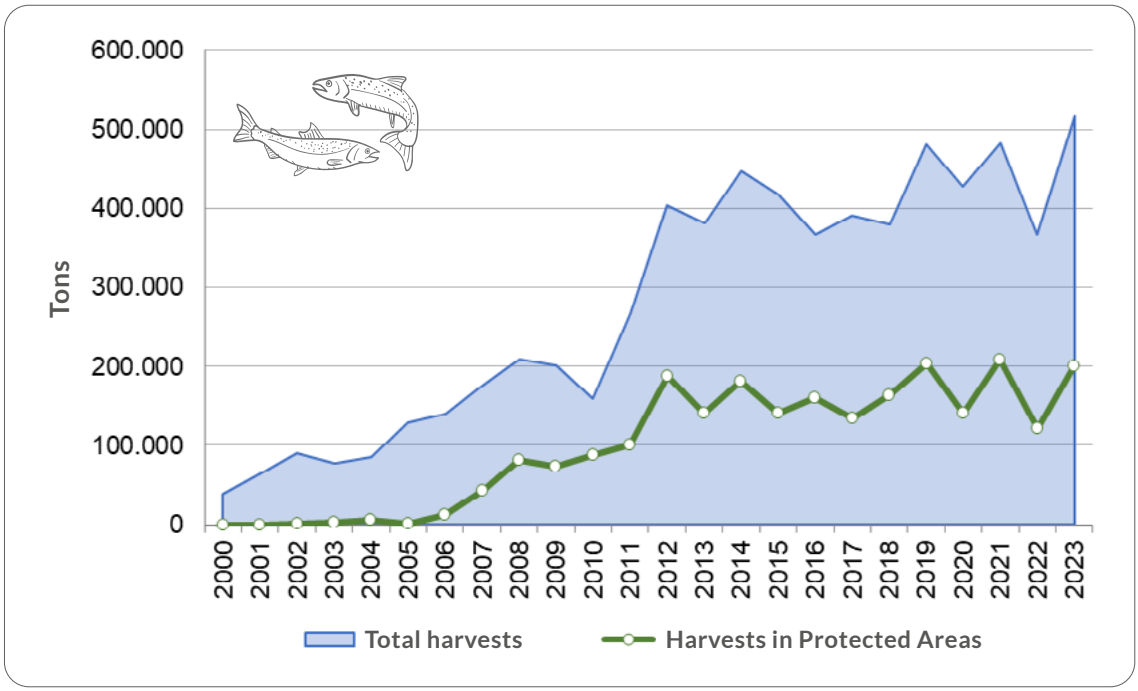
Harvests in the Aysén regio

Since 2001, total salmonid harvests in the Aysén region (inside and outside the PAs) have experienced clear growth, rising from 64,000 tons to 516,000 tons in 2023, showing an average annual growth rate of 9.55% (***), according to the estimated model. Of this total, a portion was generated within PAs: while there was no activity recorded in 2000, in 2001 it began with 61 tons, a figure that climbed to 199,900 tons in 2023, representing an average annual growth rate of 30.53% (***), as illustrated in Figure 2. Harvests outside PA areas, meanwhile, rose from 64,000 tons in 2001 to 316,000 tons in 2023, with an average annual growth rate of 7.02% (***). This distribution shows the systematic incorporation of PA areas into the salmon production model in this region, highlighting the exceptional growth within these areas.

The APs in Aysén have played a significant role in regional production, contributing an average of 30% annually throughout the period 2001-2023 (see Figure 2). This share varied widely, from a low of 0.1% in 2001, when activity was virtually non-existent, to a high of 56% in 2010, coinciding with the most critical stage of the ISA virus crisis (Fundación Terram, 2019; Tecklin, 2015; Toledo, 2024). More recently, between 2019 and 2023, the contribution stabilized between 33% (2020) and 43% (2021).

Harvests within the PAs showed sustained growth from 2006 (12.5 thousand tons) to reach a milestone of 209.2 thousand tons in 2021. Compared to the previous year, 2022 saw a 24% drop to 122.4 thousand tons, followed by a recovery in 2023 to 199.9 thousand tons. This pattern indicates that, despite health impacts such as ISA (mid-2007 to 2010), FAN in 2016, and the COVID-19 health crisis with an impact in 2021 (Salmon Council, 2021), productive employment in PAs not only persisted but continued to grow. To confirm this assertion, a linear model was estimated incorporating ISA, FAN, and COVID-19 events as dichotomous variables in order to evaluate their effect on harvests. The results show that the presence of these events reduced production outside PAs in the Los Lagos and Aysén regions by approximately 103,000 t (***), and when considering only outside PAs, in the Aysén region these fell by approximately 28,000 t (*), while within PAs in Aysén harvests increased by approximately 43,000 t (*). This suggests that PAs acted as a productive refuge, mitigating the negative effects of the events and contributing to the resilience of the salmon farming sector.

Figure 2. Total and AP harvests in the Aysén region, 2000-2023



Source: Prepared internally based on Statistical Yearbooks on Fisheries and Aquaculture (SERNAPESCA, 2024) and information requested via the transparency law.

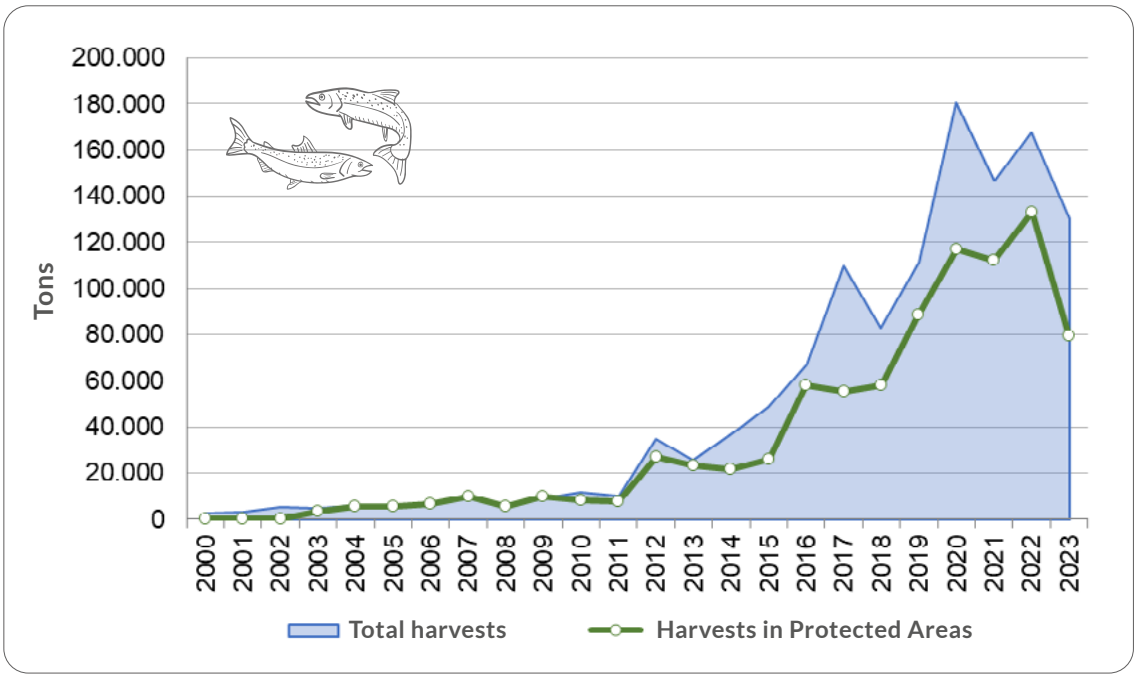
Cosechas en la región de Magallanes

Although the Magallanes region has significantly lower harvest volumes compared to Los Lagos and Aysén, the salmon industry in this territory has experienced sustained growth over the last two decades, rising from 3,200 tons in 2001 to 130,100 tons in 2023. This increase translates into average annual rates of 22.23% (***) for the total and 24.04% (***) in concessions located within AP, consolidating an expansion (see graph 3) and projecting future growth (Soto et al., 2019). This development is later than in other regions, but equally sustained, driven by favorable geographical conditions, supported by state policies, and accelerated after the health crisis caused by the ISA virus, which most severely affected Los Lagos and Aysén.

The first harvests within the PA were recorded in 2002 (267 t), and quickly accounted for 79% of regional production in 2003. During the period 2003-2011, harvests in AP remained stable at around 6,800 tons per year, representing on average 90% of Magallanes' total production during that period. From 2012 onwards, production in AP intensified, rising from 26,800 tons that year to a peak of 133,200 tons in 2022. In 2023, there was a 40% contraction, leaving the figure at 79,700 tons, although it still represents a majority share of the regional total in recent years (over 60%).

This pattern shows that concessions within APs have been decisive for regional production, representing a relative average of 76% over the entire period (2002-2023) and exceeding this value in several years, especially during periods of intense expansion. The high percentage share of harvests in AP and the growth observed underscores the centrality of these areas in salmon farming in Magallanes, shedding light on the growing incorporation of the farming model within areas that have been officially declared as conservation zones.

Figure 3. Total and AP harvests in the Magallanes region, 2000-2023



Source: Prepared internally based on Statistical Yearbooks on Fishing and Aquaculture (SERNAPESCA, 2024) and information requested via the transparency law.

5.4 Harvests per protected area

When analyzing harvests per PA unit, the first thing that is established is the existence of a significant positive correlation between the number of active centers and the harvests recorded in all units, indicating that a greater number of active centers is associated with higher harvests, as expected. In addition, significant differences were observed in the median harvests between units and categories of parks and national reserves.

In Alberto de Agostini National Park, all 19 authorized concessions are active, with harvests ranging from 267 tons to 28,003 tons, and an annual average of 11,138 tons. In Magdalena Island National Park, of eight concessions, seven recorded harvests between 2 tons and 6,106 tons, with an average of 1,997 tons. Laguna San Rafael National Park showed the two concessions granted with harvests ranging from 467 tons to 7,384 tons, with an average of 4,605 tons (see Table 3).

In contrast, RNs present a completely different dynamic. In Kawésqar, of 66 existing concessions, 60 were active and harvests ranged from 1,454 tons to 130,111 tons, with an annual average of 41,052 tons. In Las Guaitecas, the picture is even more uneven: of 314 authorized concessions, only 221 recorded harvests, ranging from a minimum of 61 tons to 200,496 tons, resulting in an annual average of 100,497 tons (see Table 3). This significantly uneven distribution confirms that the majority of production in PA is concentrated in the reserves.

Table 3. Details of active cultivation centers and harvests by protected area

Protected Area	Number of concessions granted	Active centers (recorded harvests)	Cosechas en toneladas:		
			Minimum (year)	Maximum (year)	Average (period)
Parque Nacional Alberto de Agostini	19	19	267 (2002)	28.003 (2017)	11.138 (2002-2023)
Parque Nacional Isla Magdalena	8	7	2 (2022)	6.106 (2023)	1.997 (2002-2023)
Parque Nacional Laguna San Rafael	2	2	467 (2010)	7.384 (2021)	4.605 (2007-2023)
Reserva Nacional Kawésqar	66	60	1.454 (2011)	130.111 (2022)	41.052 (2009-2023)
Reserva Nacional Las Guaitecas	314	221	61 (2001)	200.496 (2021)	100.497 (2001-2023)
Total	**409**	**309**			

Source: Prepared internally based on information from the Map Viewer (SUBPESCA, 2025), cartographic information on public property belonging to the National System of Protected Areas (MBN, 2025), and information requested via the Transparency Law.

Note: Harvest averages per center were calculated considering only the years in which production was recorded, i.e., excluding periods of inactivity, in order to estimate the effective productivity of the centers that operated.

Considering the harvests and the magnitude of the records accumulated between 2001 and 2023, three units are identified that account for the highest production in the period, in descending order: Las Guaitecas National Reserve, Kawésqar National Reserve, and Alberto de Agostini National Park, which will be analyzed below.

Harvests in Las Guaitecas National Reserve

When analyzing the PAs with the highest concentration of harvests during the period considered, we find that the Las Guaitecas National Reserve, created in 1938 in the Aysén region, ranks first. Therefore, all concessions granted and production recorded in this area occurred after its creation. Starting in 2001, activity skyrocketed in just two years, growing from 61 tons (2001) to 511 tons (2002) and reaching 5,800 tons in 2004. This early acceleration reflects the rapid expansion of salmon farming in this PA (see Figure 4).

Between 2005 and 2010, there were significant fluctuations: levels fell to 1,100 tons in 2005, but then recovered, exceeding 40,000 tons in 2007 and doubling this amount in 2008, reaching 87,900 tons in 2010. Since then, the trend has remained upward, albeit with variations: in 2012, a first peak of 181.5 thousand tons was reached, followed by moderate declines in 2013 (−26%) and 2015 (−20%) compared to the previous year. The period 2015–2023 is characterized by continuous growth, with a new peak of 200.5 thousand tons in 2021, although in 2022 there is a 39% drop, and in 2023 there is new growth of 52% compared to the previous year.

This behavior shows a growth trend in production. The harvest trajectory confirms that Las Guaitecas has been completely taken over by salmon farming. The sustained increase in harvest volumes, both in terms of time and magnitude, shows an alarming consolidation of the intensive production model within an ecosystem formally designated for conservation.

Harvests in Kawésqar National Reserve

The Kawésqar National Reserve was created in 2018 in the Magallanes region, meaning that part of the harvests took place before this area was declared protected. It can be seen (see Figure 4) that this unit has undergone a production process that has intensified in recent years. Although initially (2000–2008) there were no harvests, this dynamic changed dramatically from 2009 onwards when harvesting began.

During the period 2009–2015, salmon harvests in the Kawésqar National Reserve began to consolidate their position as a significant component of the regional total, exceeding 4,000 tons in some years (see Annex 1). Of particular note is 2014, when 12,200 tons were harvested, marking a turning point in the occupation of the protected area. This period shows the progressive integration of the reserve into the regional production model, with variable harvests.

In the period 2016–2019, production in Kawésqar became more robust and increased: it rose from 35,100 tons in 2016 to 67,300 tons in 2019, consolidating itself above an average of 40,000 tons per year. In 2019, this area accounted for 60% of regional production, one year after being declared a National Reserve.

From 2020 onwards, production in the reserve consistently exceeded 100,000 tons per year, peaking in 2022 at 130,100 tons and representing 78% of the regional total (the highest in the period). In 2023, there was a drop to 70,900 tons compared to the previous year. During this period, Kawésqar's share of the regional total fluctuated between 55% and 78%, consolidating it as a key area within the regional production system.

This pattern of evolution—a decade of consolidation followed by rapid expansion—suggests that the Kawésqar National Reserve has gone from being marginal to becoming a strategic production center within the salmon farming industry in Magallanes. Thus, there is evidence of growing production pressure following the creation of the protected area.

Harvests in Alberto de Agostini National Park

Production in this national park located in the Magallanes region and created in 1965 has been constant since 2002, although significantly lower compared to other PAs (see Figure 4). However, this area, together with the Kawésqar National Reserve, provides a significant portion of the harvests in the Magallanes region, accounting for more than 90% in several years for this region.

Since its inception in 2002 with 267 t, production grew rapidly, reaching 5,600 t in 2004. It then remained at around 5,000 to 9,000 t until 2011. This initial consolidation phase shows increasing use of concessions within the park, although without reaching relatively high levels, exceeding those recorded in the Kawésqar National Park during these years and in some subsequent years (see Annex 1). The relative stability recorded reflects that, although the industry began to operate in the park, it had not yet entered into stages of intensive exploitation.

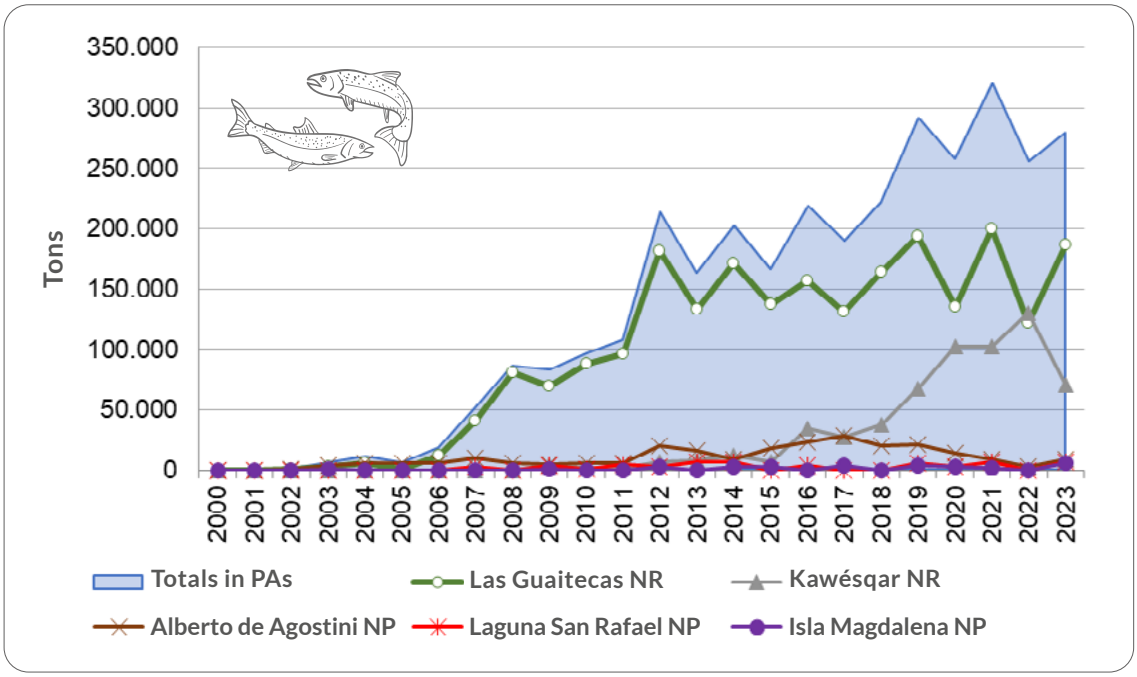
© Eduardo Hernández. Cabo Froward, mirando hacia el Parque Nacional Alberto de Agostini.

From 2012 to 2020, there was a notable increase: production exceeded 14,000 tons, reaching a peak in 2017 with 28,000 tons. During this period, the annual average was close to 19,000 tons, reflecting a phase of growth and consolidation in production. This stage represents a clear expansion of salmon farming activity within the park.

From 2021 onwards, harvests begin to decline, falling to a low of 3,000 tons in 2022, before recovering slightly to 8,800 tons in 2023. This decline continues a trend of adjustment or contraction after reaching a peak in the previous period, which is also occurring at the regional level. Although they do not return to previous levels, these values remain above the initial volume of the first phase, indicating that operations in the park continue, albeit on a smaller scale than at their peak.

This pattern suggests that this park plays a strategic role within the industry in Magallanes, with phases of intensification followed by adjustment. The consolidation of production within the park raises questions regarding the development of this intensive activity and conservation, given that its regulation should restrict commercial activities within its perimeter.

Figure 4. Harvests by protected area (2000–2023)



Source: Prepared internally based on information requested via the transparency law.

5.5 Harvests per owner

There is a clear correlation between the number of concessions granted/active and the volume of crops produced by each holder within the PAs. By applying a cumulative concentration criterion of 80%—based on the Pareto Principle—it is possible to identify those companies that together account for most of the production in each PA. This approach allows the analysis to focus on a small number of key players with the greatest productive impact in the protected areas analyzed.

Harvests per owner in Las Guaitecas National Reserve

Among the selected licensees, which together account for more than 80% of annual production in the Las Guaitecas NR, are the companies Multi X S. A., Salmones Blumar S.A., Australis Mar S.A., Exportadora Los Fiordos Ltda., Cultivos Yadran S.A., Empresas Aquachile S.A., and Mowi Chile S.A. Together, these companies account for a total production of 1.9 million tons during the period 2001-2023, with an annual average of 83,200 tons, representing a cumulative average of approximately 87% of the total harvested within this unit (see Table 4).

It should be noted that the distribution of production among these companies began to diversify in 2007. Prior to that year, production was concentrated among one or two players. For example, in 2001, the entire harvest was divided between Exportadora Los Fiordos Ltda. and Empresas Aquachile S.A., with shares of 25% and 75%, respectively. Currently, both companies are linked to the same business group (Agrosuper), so we will consider them as a single company. In the following years (2002–2005), a single company controlled 100% of production: Exportadora Los Fiordos Ltda. in 2002 and Mowi Chile S.A. between 2003 and 2005. This initial concentration gave way, from the middle of the decade onwards, to greater participation by new players who, together, now form the dominant productive core.

Table 4. Landowners with the largest harvests in the Las Guaitecas National Reserve

Company	Period	Total production (tons)	Annual average (tons)	Average annual share of total (%)
Multi X S.A.	2006-2023	537.696	29.887	22 %
Salmones Blumar S.A.	2007-2023	386.673	22.745	17 %
Australis Mar S.A.	2007-2023	312.839	18.402	14 %
Exportadora Los Fiordos Ltda.	2001-2023	214.082	11.267	15 %
Cultivos Yadran S.A.	2007-2023	166.030	11.069	8 %
Empresas Aquachile S.A.	2001-2023	154.865	8.151	12%
Mowi Chile S.A.	2003-2023	140.085	7.783	25 %
Total		**1.912.543**	**83.154**	**87 %**

Source: Prepared internally based on information requested via the Transparency Act.

Note: Averages were calculated considering only the years in which production was recorded, i.e., excluding periods of inactivity, in order to estimate effective productivity.

Harvests per holder in the Kawésqar National Reserve

Among the companies that account for approximately 80% of annual production in the Kawésqar National Reserve are: Aquachile Magallanes SPA, Australis Mar S.A., Multiexport Patagonia S.A., and Cermaq Chile S.A. These companies account for a total production of approximately 546,700 tons during the period 2009-2023, which together maintain an annual average of 36,500 tons and represent around 93% of the cumulative annual average harvested in the reserve (see Table 5). This confirms that a small group of actors largely dominates production activity within the area. In the early years, production was low, but from 2014-2016 the volume generated by these licensees began to climb, consolidating their position as the main harvesters in Kawésqar and beyond.

As in the Las Guaitecas NR, the early years of production in the Kawésqar NR (2009–2015) were dominated by a single license holder, Aquachile Magallanes SPA, which accounted for the entire harvest during that period. Starting in 2016, production began to diversify, mainly incorporating the licensees listed in Table 5.

Table 5. Landowners with the largest harvests in the Kawesqar National Reserve

Company	Period	Total production (tons)	Annual average (tons)	Average annual share of total (%)
Aquachile Magallanes SPA.	2009-2023	227.169	15.145	66 %
Australis Mar S.A.	2016-2023	213.541	26.693	35 %
Multiexport Patagonia S.A.	2019-2023	65.304	13.061	14 %
Cermaq Chile S.A.	2018-2023	40.666	10.167	14 %
Total		**546.681**	**36.445**	**93 %**

Source: Prepared internally based on information requested via the Transparency Act.

Note: Averages were calculated considering only the years in which production was recorded, i.e., excluding periods of inactivity, in order to estimate effective productivity.

Harvests per owner in national parks

In the case of national parks, the concentration of harvests by a few owners is even greater. In Alberto de Agostini National Park, production is entirely in the hands of Nova Austral S.A., the only company with concessions granted within the park according to AP concession records (Toledo & Espinoza, 2024). Between 2002 and 2023, it accumulated a total of 245,000 tons in harvests and reached an annual average of 11,100 tons.

For its part, in the Laguna San Rafael National Park, Cooke Aquaculture Chile S.A. is the only company with concessions granted and accounts for all reported production. During the period 2007-2023—with years where no harvests were recorded—(see Annex 1) it reached a cumulative total of 55,300 tons with an average of 4,600 tons harvested.

Finally, in Magdalena Island National Park, although there are multiple concession holders, AquaChile and its subsidiaries account for around 94% of average annual production. Consequently, harvests within this unit are practically dominated by this company. During the period 2002-2023—with some years without harvests—(see Annex 1), it reached a cumulative total of 25,700 tons and an average of 1,800 tons of harvests.

Table 6. Landowners with the largest harvests in national parks

Protected areas	Period	Company	Total production (tons)	Annual average (tons)	Average annual share of total (%)
Alberto de Agostini NP	2002-2023	Nova Austral S.A.	245.038	11.138	100%
Laguna San Rafael NP	2007-2023	Cooke Aquaculture Chile S.A.	55.257	4.605	100%
Isla Magdalena NP	2002-2023	AquaChile	25.647	1.832	84%

Source: Prepared internally based on information requested via the Transparency Act.

Note: Averages were calculated considering only the years in which production was recorded, i.e., excluding periods of inactivity, in order to estimate effective productivity.

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6 Discussion

The results of this study reveal a fundamental paradox in the management of PAs in Chilean Patagonia: the average annual growth rate of 29.9% in harvests within PAs between 2001 and 2023 contrasts with a significantly lower rate of 3.94% for the industry as a whole, suggesting a deliberate strategy of colonizing protected areas for industrial salmon production.

This dynamic takes on particular relevance when considering that a significantly larger share of AP production is concentrated in RN, where current legislation (Law 21,600) allows for "sustainable use" under certain conditions. However, the volumes recorded—with maximums of 200,500 tons in RN Las Guaitecas (2021) and 130,100 tons in Kawésqar National Park (2022)—raise questions and tensions about the limits of what can be considered "sustainable" in this type of ecosystem and the need to assess the compatibility of salmon farming with the conservation objectives of national parks (Farías et al., 2022).

A particularly revealing finding is the differentiated behavior of harvests in AP during periods of critical events that have affected the sector. While the ISA virus epidemic (2007-2010) devastated production in Los Lagos and later in Aysén, harvests in AP in the latter region experienced a 20% rebound in 2010, reaching 88,300 tons. Similarly, during the 2016 FANs, which caused widespread declines of 18% in the sector, harvests in Aysén's PAs grew by 14%. The results of a joint analysis of these events, together with that of COVID-19, which impacted the industry in 2021 (Salmon Council, 2021), show a positive correlation in harvests within PAs and a negative correlation outside them. This pattern suggests that PAs functioned as "productive refuges" during the crisis, possibly due to more favorable environmental conditions. This differential resilience highlights not only the strategic importance of these areas for the industry, but also the vulnerability of protected ecosystems to intensified production pressures during periods of external crisis.

At the same time, there is a concentration of ownership in AP. In Las Guaitecas, six companies control 87% of production, and in Kawésqar, four companies account for 93%. In national parks, the companies Nova Austral S.A. (Alberto de Agostini National Park), Cooke Chile S.A. (Laguna San Rafael National Park), and AquaChile (Magdalena Island National Park) operate under conditions of virtual monopoly. This concentration not only raises questions about the distribution of economic benefits derived from the use of national public goods, but also suggests a private appropriation of "conservation rents"—the additional benefits derived from operating in pristine ecosystems with fewer cumulative environmental externalities.

Although this study focused on production quantification (harvests), the volumes recorded suggest significant environmental pressures. Previous studies in similar ecosystems (Häussermann et al., 2013) document processes of eutrophication, accumulation of organic waste, and alteration of food chains in fjords with intensive salmon farming activity. The production levels identified—particularly in Las Guaitecas National Park, with production reaching 200,000 tons—suggest that these protected ecosystems could be operating near or above their environmental load thresholds, which needs to be evaluated in depth.

The recent creation of the SBAP with the enactment of Law No. 21,600 represents significant regulatory progress, but its effectiveness will depend on the institutional capacity to remove concessions from APs. This implies the need to adjust the current production model, which requires public policies that recognize the real environmental costs of salmon farming in PAs, internalize these externalities through differentiated economic instruments for the sector, and promote the gradual withdrawal of concessions from these areas. This is even more relevant in a context where the industry continues to push for growth, without giving importance to the impact it generates. Currently, there is no system in which this sector can produce large quantities of fish without affecting the ecosystem. For this reason, regulations must be created to contain this growth and reduce and compensate for the environmental impact it generates (Alvarez et al., 2022).

7 Conclusions

This study documents for the first time the actual scale of salmon farming activity in protected areas of Chilean Patagonia, revealing that of the current 409 concessions for salmon farming granted in these areas (as of May 2025), 309 are active (with recorded harvests), generating 3.2 million tons between 2001 and 2023, representing on average 17% of the industry's total and 34% of the total in Aysén and Magallanes. At the regional level, protected areas represent, in relative terms, an average of 30% of total production in Aysén and 76% in Magallanes during the period analyzed.

The results confirm a serious and persistent regulatory conflict: on average, 20% of production in protected areas occurs in national parks, where commercial activity is explicitly prohibited by Law No. 21,600 and, prior to that, by the Washington Convention approved by Chile in 1967. Even more concerning: all concessions were granted after the creation of national parks, revealing systemic failures in institutional governance and territorial decision-making.

This study confirms that salmon farming within protected areas is not marginal, but rather a central component of the industry over the last two decades. Harvests are growing at a significantly higher rate than outside these areas, showing positive correlations in the face of health and environmental crises.

In this context, protected areas have not only served as drivers of salmon farming expansion, but also as buffers against external crises. However, this productive role contradicts the legal and ecological mandate of these areas, creating an urgent need to review regulatory frameworks, strengthen environmental governance and oversight, and evaluate land-use alternatives that ensure conservation prevails over productive interests in protected areas.

The results of this study demonstrate that the current model of territorial development is not compatible with these global conservation objectives. The transition to a paradigm that considers conservation as a key element is not only an environmental necessity, but also a historic opportunity to position Chile as a world leader in conservation with territorial development in line with this reality.

The findings of this study open up multiple priority lines of research: (i) analysis of specific environmental impacts in PAs, (ii) socioeconomic studies on the distribution of benefits and costs in local communities, (iii) modeling of climate change scenarios and their interaction with productive pressures, and (iv) comprehensive economic evaluation that includes assessment of ecosystem services.

8 References

Alvarez, R., Araos, F., Diestre, F., Riquelme, W., Brañas, F., Torrijos, C., Cursach, J., & Stock, M. (2022). Are salmon aquaculture sustainable? Framing tensions over salmon farms in Patagonia. Desenvolvimento e Meio Ambiente (Vol. 59, pp. 23–45). Universidade Federal do Parana. https://doi.org/10.5380/DMA.V59I0.74054

Buschmann, A. H., Cabello, F., Young, K., Carvajal, J., Varela, D. A., & Henríquez, L. (2009). Salmon aquaculture and coastal ecosystem health in Chile: Analysis of regulations, environmental impacts and bioremediation systems. Ocean and Coastal Management (Vol. 52, Issue 5, pp. 243–249). https://doi.org/10.1016/j.ocecoaman.2009.03.002

Bustos, B., Délano, J., & Prieto, M. (2019). "Chilote tipo salmon". The relationship between nature commodification and identity production processes. The case of the salmon industry in Los Lagos Region, Chile. Estudios Atacamenos, 63, 383–402. https://doi.org/10.22199/issn.0718-1043-2019-0026

Bustos-Gallardo, B. (2013). The ISA crisis in Los Lagos Chile: A failure of neoliberal environmental governance? Geoforum, 48, 196–206. https://doi.org/10.1016/j.geoforum.2013.04.025

Cárdenas-Retamal, R., Dresdner-Cid, J., & Ceballos-Concha, A. (2021). Impact assessment of salmon farming on income distribution in remote coastal areas: The Chilean case. Food Policy, 101. https://doi.org/10.1016/j.foodpol.2021.102078

Ceballos, A., Dresdner-Cid, J. D., & Quiroga-Suazo, M. Á. (2018). Does the location of salmon farms contribute to the reduction of poverty in remote coastal areas? An impact assessment using a Chilean case study. Food Policy, 75, 68–79. https://doi.org/10.1016/j.foodpol.2018.01.009

Chávez, C., Dresdner, J., Figueroa, Y., & Quiroga, M. (2019). Main issues and challenges for sustainable development of salmon farming in Chile: a socio-economic perspective. Reviews in Aquaculture, 11(2), 403–421. https://doi.org/10.1111/raq.12338

Consejo del Salmón. (2021). Reporte de empleo de la Salmonicultura. In Reporte. Consejo del Salmón. https://www.consejodelsalmon.cl/wp-content/uploads/2022/02/020222-Reporte-empleo-CDS-octubre-diciembre-2021.pdf

Consejo del Salmón. (2023). Reporte de monitoreo empleo Consejo del Salmón A.G. https://www.consejodelsalmon.cl/wp-content/uploads/2023/10/230925-Reporte-empleo-CDS-ene-jun-2023.pdf

Dudley, N. (Editor). (2008). Directrices para la aplicación de las categorías de gestión de áreas protegidas. Gland, Suiza: UICN. 96pp. (In Spanish).

FAO. (2024). El estado mundial de la pesca y la acuicultura 2024. La transformación azul en acción. Roma. https://doi.org/10.4060/cd0683es

Farías, A., Ramírez, C., Martínez-Harms, M. J., & Tecklin, D. (2022). Caracterización de las concesiones acuícolas ubicadas en la porción marina de Áreas Silvestres Protegidas (pp. 1–66). Programa Austral Patagonia, Facultad de Ciencias Económicas y Administrativas (FACEA), Universidad Austral de Chile.

Fundación Terram. (2019). Antecedentes económicos de la industria salmonera en Chile (pp. 1–12). https://www.terram.cl/descargar/recursos_naturales/salmonicultura/cartilla/Antecedentes-economicos-de-la-industria-salmonera-en-Chile.pdf

Furci, G. (2008). ISA: Impulsando el Salto Austral. Análisis de Políticas Públicas. Fundación Terram.

Gujarati, D., & Porter, D. (2009). Basic Econometrics (5th ed.). McGraw-Hill/Irwin.

Häussermann, V., Försterra, G., Melzer, R. R., & Meyer, R. (2013). Gradual changes of benthic biodiversity in Comau Fjord, Chilean Patagonia-lateral observations over a decade of taxonomic research. SPIXIANA, 36(2), 161–171. www.pfeil-verlag.de

INE. (2016). Encuesta Estructural de la Industria del Salmón. Reseña Metodológica (pp. 1–43). https://regiones.ine.cl/los-lagos/estadisticas-regionales/economia/economia-regional/estructura-de-la-industria-del-salmon

Martínez-Harms, M. J., Armesto, J. J., Castilla, J. C., Astorga, A., Aylwin, J., Buschmann, A. H., Castro, V., Daneri, G., Fernández, M., Fuentes-Castillo, T., Gelcich, S., González, H. E., Hucke-Gaete, R., Marquet, P. A., Morello, F., Nahuelhual, L., Pliscoff, P., Reid, B., Rozzi, R., … Tecklin, D. (2022). A systematic evidence map of conservation knowledge in Chilean Patagonia. Conservation Science and Practice (Vol. 4, Issue 1). Blackwell Publishing Inc. https://doi.org/10.1111/csp2.575

MBN. (2025). Catastro de Bienes Nacionales. Reporte. https://catastro.mbienes.gob.cl/

Niklitschek, E. J., Soto, D., Lafon, A., Molinet, C., & Toledo, P. (2013). Southward expansion of the Chilean salmon industry in the Patagonian Fjords: Main environmental challenges. Reviews in Aquaculture, 5(3), 172–195. https://doi.org/10.1111/raq.12012

Román, A. (2015). Revolución salmonera paradojas y transformaciones territoriales en Chiloé (Á. Román, J. R. Barton, B. Bustos, & A. Salazar, Eds.; Primera). RIL editores-Instituto de Estudios Urbanos y Territoriales UC. https://estudiosurbanos.uc.cl/libro/revolucion-salmonera-paradojas-y-transformaciones-territoriales-en-chiloe/

Rozzi, R., Armesto, J. J., Gutiérrez, J. R., Massardo, F., Likens, G. E., Anderson, C. B., Poole, A., Moses, K. P., Hargrove, E., Mansilla, A. O., Kennedy, J. H., Willson, M., Jax, K., Jones, C. G., Callicott, J. B., & Arroyo, M. T. K. (2012). Integrating ecology and environmental ethics: Earth stewardship in the Southern end of the Americas. BioScience (Vol. 62, Issue 3, pp. 226–236). https://doi.org/10.1525/bio.2012.62.3.4

Sepúlveda, M., Arismendi, I., Soto, D., Jara, F., & Farias, F. (2013). Escaped farmed salmon and trout in Chile: Incidence, impacts, and the need for an ecosystem view. Aquaculture Environment Interactions (Vol. 4, Issue 3, pp. 273–283). https://doi.org/10.3354/aei00089

SERNAPESCA. (2024). Anuarios Estadísticos de Pesca y Acuicultura. http://www.sernapesca.cl/informacion-utilidad/anuarios-estadisticos-de-pesca-y-acuicultura

Servicio de Impuestos Internos. (2022). Estadísticas de Empresas. https://www.sii.cl/sobre_el_sii/estadisticas_de_empresas.html

Servicio Nacional de Aduanas de Chile. (2024). Documentos Únicos de Salida (DUS); exportaciones a título definitivo ajustadas con sus documentos modificatorios. Estadísticas COMEX. https://www.aduana.cl/aduana/site/edic/base/port/comex.html

Soto, D., Chávez, C., León-Muñoz, J., Luengo, C., & Soria-Galvarro, Y. (2021). Chilean salmon farming vulnerability to external stressors: The COVID 19 as a case to test and build resilience. Marine Policy, 128. https://doi.org/10.1016/j.marpol.2021.104486

Soto, D., León-Muñoz, J., Dresdner, J., Luengo, C., Tapia, F. J., & Garreaud, R. (2019). Salmon farming vulnerability to climate change in southern Chile: understanding the biophysical, socioeconomic and governance links. Reviews in Aquaculture, 11(2), 354–374. https://doi.org/10.1111/raq.12336

SUBPESCA. (2025). Visualizador de Mapas. http://mapas.subpesca.cl/ideviewer/

Tecklin, D. (2015). La apropiación de la costa chilena: la ecología política de los derechos privados en torno al mayor recurso público del país. In Editorial Universitaria (Ed.), Ecología Política en Chile: Naturaleza, propiedad, conocimiento y poder (pp. 121–142).

Toledo, C. (2023). Empleo directo generado por la industria salmonera en las regiones de Los Lagos, Aysén y Magallanes (2005-2021). Reporte (pp. 1–18). Fundación Terram. https://www.terram.cl/descargar/recursos_naturales/salmonicultura/Informe-empleo-industria-salmonera-2005-2021.pdf

Toledo, C. (2024). Análisis de la evolución de cosechas de salmónidos en Chile (1990-2023) (pp. 1–11). Fundación Terram. https://www.terram.cl/descargar/Cosechas-salmones-1990-2023.pdf

Toledo, C. (2025). Exportaciones de la industria salmonera en Chile (2012-2024). Reporte. Fundación Terram. https://www.terram.cl/descargar/Exportaciones-de-la-industria-salmonera-en-Chile-2012-2024.pdf

Toledo, C., & Espinoza, D. (2024). Catastro de concesiones para el cultivo de salmones ubicadas al interior de las áreas protegidas. Reporte. Salvemos la Patagonia. https://www.salvemoslapatagonia.cl/web/wp-content/uploads/2024/10/Catastro-de-concesiones-para-el-cultivo-de-salmones-ubicadas-al-interior-de-Areas-Protegidas.pdf

Vega, D. (2013). Uso de las Concesiones Acuícolas de Mar en la Industria Salmonera en Chile. Sustainability, Agri, Food and Environmental Reasearch, 1(2), 1–35. https://portalrevistas.uct.cl/index.php/safer/article/view/770

Appendix

Appendix 1. Details of annual harvests by protected area, in tons (2001-2023)

Year	National Reserves:		National Parks:		
	Las Guaitecas	Kawésqar	Alberto de Agostini	Laguna San Rafael	Isla Magdalena
2001	61	0	0	0	0
2002	511	0	267	0	121
2003	2.393	0	3.484	0	537
2004	5.840	0	5.669	0	0
2005	1.115	0	5.492	0	0
2006	12.455	0	6.339	0	0
2007	40.362	0	9.717	2.448	82
2008	80.924	0	5.435	0	5
2009	69.731	4.183	5.352	3.789	337
2010	87.846	2.013	6.326	467	0
2011	96.317	1.454	6.083	4.401	0
2012	181.472	6.733	20.058	2.691	3.100
2013	133.618	7.661	15.745	6.880	0
2014	171.017	12.178	9.354	6.649	3.320
2015	137.355	7.344	18.456	0	3.051
2016	156.904	35.139	22.938	3.674	0
2017	131.603	27.534	28.003	0	3.429
2018	163.722	37.950	19.879	0	0
2019	193.468	67.250	21.101	6.322	4.098
2020	135.291	102.610	14.313	3.307	2.406
2021	200.496	102.691	9.224	7.384	1.358
2022	122.435	130.111	3.048	0	2
2023	186.499	70.929	8.754	7.244	6.106

Source: Prepared internally based on information requested via the Transparency Act.


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SALMON FARMING CONCESSIONS GRANTED WITHIN PROTECTED AREAS

AYSÉN REGION

Isla Magdalena National Park
8 Marine concessions

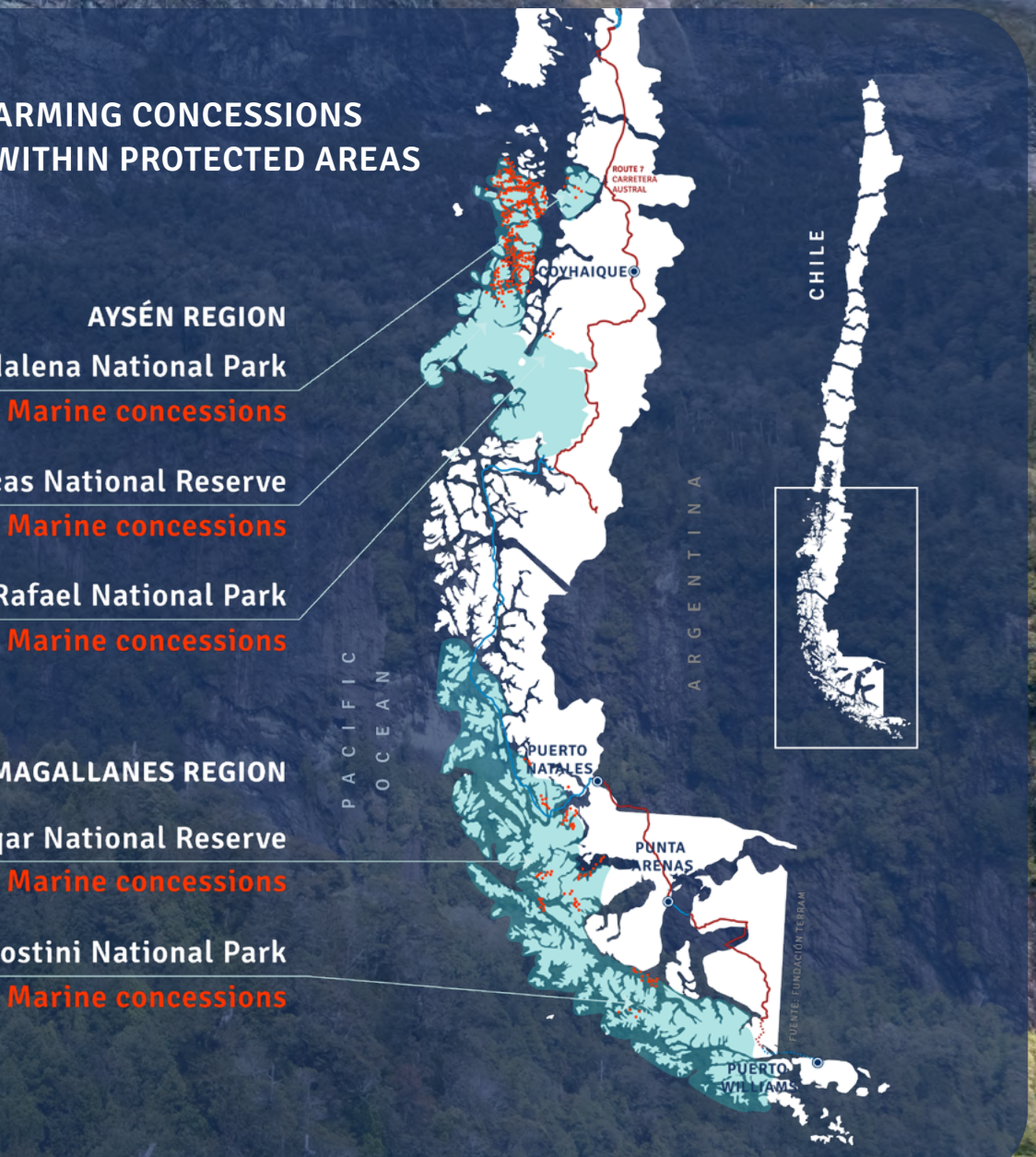
Las Guaitecas National Reserve
313 Marine concessions

Laguna San Rafael National Park
2 Marine concessions

MAGALLANES REGION

Kawésqar National Reserve
66 Marine concessions

Alberto de Agostini National Park
19 Marine concessions

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