CHILEAN AQUACULTURE MARKET REPORT UPDATE 2023

Prepared by ACUIESTUDIOS SPA

Support
Embajada de Noruega
Santiago
Innovasjon Norge

AQUACULTURE PROFILE – NORWEGIAN EMBASSY IN CHILE

Prepared by

ACUIESTUDIOS SPA

June 2023

Index

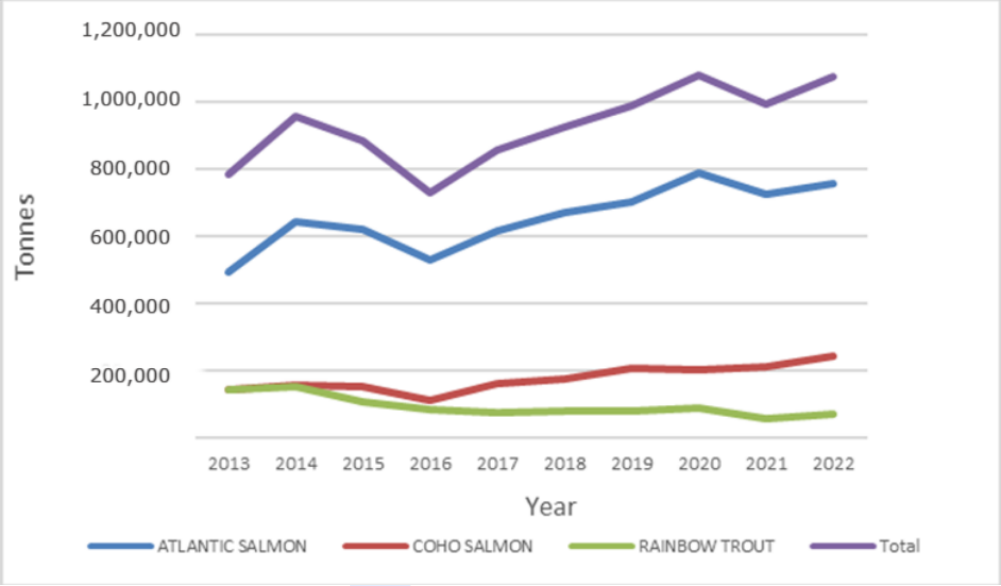
1. SECTOR OVERVIEW

Aquaculture in Chile is mainly based on salmon and Chilean mussel farming, and to a lesser extent, on seaweed farming (pelillo), northern oyster and red abalone.[1]

Chile is the second largest producer of salmon and Chilean mussel in the world, after Norway and China respectively, accounting for 31% of the world salmon harvest and 22% of Chilean mussel production, according to FAO (Food and Agriculture Organization) figures for 2021.

In geographical terms, Chilean aquaculture is mainly performed in the southern austral area, covering the Los Lagos, Aysén and Magallanes regions, which together accounted for 99% of the total harvest in 2022, with the Los Lagos region standing out with a 22% increase compared to 2021. In the northern part of the country, aquaculture is developed on a smaller scale, and is concentrated in the Atacama and Coquimbo regions, with production of oysters, and to a lesser extent pelillo and red abalone.

Regarding salmonids, the growth registered during the 2013 - 2022 period is remarkable; the annual growth rate was of 3.5%, supported by Atlantic salmon farming, which registers an average annual rate of 5% for the same period, explaining 71% of the salmonid harvest for the last year of the series (Figure 1).



Source: SERNAPESCA

Figure 1: Evolution of salmonid Chilean harvests for the 2013-2022 period, by resource

[1] Atlantic salmon (Salmo salar), Pacific salmon (Oncorhynchus kisutch), chorito or Chilean mussel (Mytilus chilensis), northern oyster (Argopecten purpuratus), pelillo (Gracilaria sp), red abalone (Haliotis rufescens).

In terms of regional contribution, the Los Lagos region is the most relevant in terms of salmonids, with an average contribution of 44% for the last five years, compared to 43% in the Aysen region. Although the Magallanes region ranks third in importance, this region stands out for its continuous growth, especially in the case of Atlantic salmon farming, for which the species recorded an annual growth rate of 24% from the 24,000 tons harvested in 2013 (Figures 2 and 3).

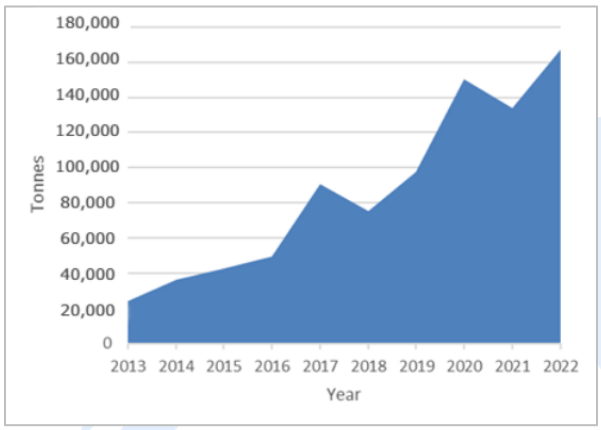


FIGURE 2 Salmonid resources harvest 2013 - 2022 of the Magallanes and Chilean Antarctic Region

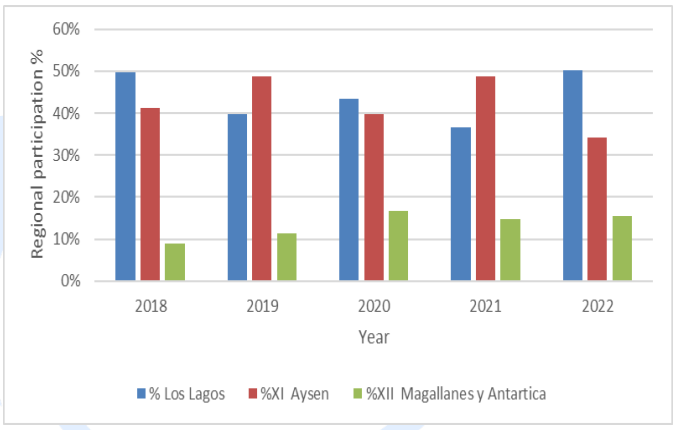


FIGURE 3 Regional participation in salmonid harvest 2013 - 2022.

Source: SERNAPESCA

Information contained in the Chilean National Aquaculture Registry[2] indicates that there are 3,675 farming facilities in Chile, of which 278 are fish farms and 67 are hatcheries. Of the total number of farming centers, 1776 correspond to the salmonid group, followed by mollusks with 1,417 centers and algae with 768, the regional distribution is detailed in Annex 1 a.

In 2022, aquaculture production reached 1.5 million tons, fish accounted for 71%, mollusks 29% and algae 1%.

The main resources corresponded to Atlantic salmon, Chilean mussel and coho salmon, contributing 50%, 28% and 16%, respectively, which accounted for 94% of the total harvested (Annex 1 b).

Fishing and aquaculture in Chile are focused mainly on exports, with products that are processed nationally by 696 establishments, accounting for a total of 1026 processing lines, 65% of which are dedicated to the processing of products for human consumption, of which 347 are processed in the southern regions linked to aquaculture (Annex 1 c).

Exports from the aquaculture subsector reached US$7,175 million in 2022, which represents 81% of total exports from the fishing and aquaculture sector and 14% of the country's total non-mining exports[3], a figure that represents a growth of 28% over the last 5 years.

[2] Chilean National Aquaculture Registry (RNA for its acronym in Spanish): national list of holders of aquaculture concessions and authorizations licensed to execute farming activities, which is administered by the Chilean National Fisheries and Aquaculture Service.

[3] Total Chilean exports for the year 2022 reached US$ 97,491 million, non-copper exports US$ 52,388 million.

A total of US$ 5,099 million originates from exports of Atlantic salmon[4], US$ 1208 million from coho salmon, trout and Chilean mussel exports are lower in the ranking, with US$375 and US$259 million respectively.

The salmon farming activity in Chile is strongly linked to foreign capitals; the main examples in this area are companies like MOWI of Norwegian capitals, AUSTRALIS SEAFOOD of Chinese capitals, CERMAQ of Japanese capitals and VENTISQUEROS of German capitals. It is estimated that around 30% of the national production of Atlantic salmon originates from the operation of these companies[5], being the Chilean capital companies AQUACHILE[6], MULTIEXPORT, BLUMAR, CAMANCHACA and MARINE FARMS (COOKE Aquaculture) the most important ones in Atlantic salmon production. (Table 1)

Table 1: Harvest by company salmonid resources year 2021

COMPANY (HOLDING)	HARVEST (IN TONNES)
EMPRESAS AQUACHILE S.A.	200,660
CERMAQ CHILE S.A.	102,962
MULTIEXPORT FOODS S.A.	98,403
AUSTRALIS MAR S.A.	83,877
MOWI CHILE S.A.	74,005
BLUMAR S.A.	69,839
SALMONES AUSTRAL S.A.	45,571
MARINE FARM S.A.	43,201
SALMONES CAMANCHACA S.A.	42,148
SALMONES DE CHILE S.A.	42,148
PRODUCTOS DEL MAR VENTISQUERO	35,862
SALMONES AYSEN S.A.	31,248
SALMONES ANTARTICA S.A.	31,030
EMPRESAS YADRAN	26,732
COOKE AQUACULTURE CHILE S.A.	25,078
CALETA BAY S.A.	15,158
OTHERS	26,853
TOTAL	995,135

Source: Sernapesca's 2021 Annual Report on Antimicrobial Usage

As for coho salmon, the main producers are AQUACHILE, CERMAQ and SALMONES AYSEN[7], with SALMONES ANTARTICA, a Japanese-owned company, leading trout production.

In terms of exporters, in 2020 [8] a total of 24 companies exported salmon products, out of which 6 companies accounted for 51% of the total value. The main exporters are AQUACHILE S.A, AUSTRALIS MAR S.A and MULTIEXPORT, the first having 13% of the value, the second 9.2% and the third 9% (Table 2).

[4] Salmo salar.
[5] According to the MOWI 2019 annual report, among the top 10 Chilean companies producing Atlantic salmon are CERMAQ (Japan), MOWI (Norway), AUSTRALIS SEAFOOD (China) and VENTISQUEROS (Germany
[6] New Aquachile is the result of the merger of Los Fiordos, Aquachile, Salmones Magallanes and Friosur.
[7] It should be noted that Salmones Aysen is only dedicated to the farming of coho salmon.
[8] Information on exporters is only available for 2020.

Table 2: Major salmon and trout exporting companies from Chile, 2018 – 2020 (USD)

COMPANY	VALUE 2018	VALUE 2019	VALUE 2020
Empresas Aquachile S.A.	509.504.801	648.368.671	551.021.192
Australis Mar S.A.	313.700.516	364.375.459	392.597.670
Salmones Multiexport S.A.	441.553.429	458.939.963	382.077.977
Cermaq Chile S.A.	545.763.444	477.343.929	310.574.364
Salmones Camanchaca S.A.	314.812.727	288.223.215	278.163.427
Mowi Chile S.A.	359.833.558	373.947.741	254.080.518
Others	2.828.200.525	2.714.061.022	2.448.314.852
Total	5.313.369.000	5.325.260.000	4.616.830.000

Canadian investments are represented in the area through the company COOKE AQUACULTURE located in the Cupquelan fjord in the Aysén Region; they are dedicated to the production of Atlantic salmon and coho salmon[9].

In the case of Chilean mussel farming, the presence of Spanish investors through the companies CULTIVOS TORALLA, F Y S Chile S.A., BLUE SHELL S.A., and PESQUERA SAN JOSE S.A. stand out among producers and exporters of Chilean mussel. Chilean companies that diversified from extractive fishing to mussel aquaculture, such as PESQUERA SAN JOSE S.A., PESQUERA CAMANCHACA S.A., and LANDES (Landes Mussels S.A.), have an important local presence.

There is information on employment for the two main farming activities, i.e. salmon farming and Chilean mussel farming, the figures estimate around 96,000 jobs between direct and indirect employment[10], jobs that are generated in the southern regions of the country, between the Los Lagos, Aysén and Magallanes regions, 80% of which are explained by the salmon activity.

The development and consolidation of aquaculture in Chile has had to face a series of challenges in order to establish itself, currently becoming one of the main suppliers of salmon and Chilean mussel worldwide.

In terms of growth, given the current regulations, it is unlikely that salmon production will increase strongly in the Los Lagos and Aysén regions. However, given the incorporation of new centers in the Magallanes and Chilean Antarctic region, it is estimated that national production should increase by around 100,000 tons by 2030.

The success seen by aquaculture is mainly due to the quality and purity of the waters in the southern part of the country, the capacity of the industry's stakeholders, access to qualified labor, good port and logistical infrastructure for operations, good quality of professional and technical services to support the processes, and the sector's capacity to adapt.

Despite successful figures, the subsector has certain weaknesses that require permanent attention, such as the treatment of sanitary risks, treatment of massive mortalities due to pests, mainly Harmful Algal Blooms (HAB), fish escapes, concentration of destination markets, little diversification of resources, and conflicts over space with other usage interests, namely native peoples and protected marine areas, as well as questionings risen by citizens in general.

Moreover, there have been great efforts from the private sector to innovate, which is why there are research centers that correspond fundamentally to technical institutions associated with companies in the sector. This is the case of

[9] www.cookeaqua.cl

[10] Estimations from IFOP, 2020, and FIPA, 2016-56

Cargill Chile, AquaInnovo (associated with AquaChile) and Biomar, among others. Some particular cases are the Technological Institute of Salmon (INTESAL) and the Technological Institute of mytiliculture (INTEMIT), which correspond to research centers sponsored by salmon guilds (SalmonChile) and mytiliculture (AMIChile and others), respectively. Similarly, from a public standpoint, there is the Interdisciplinary Center for Aquaculture Research (INCAR), financed by funds from the Chilean government, linked to the Universidad de Concepción, as well as a collaborating center of OMSA; Center for antimicrobial Stewardship in Aquaculture, of the Faculty of Veterinary and Livestock Sciences of the Universidad de Chile. It is also necessary to consider that Chilean universities and their institutes actively participate in research programs in the area of aquaculture.

2. REGULATION FRAMEWORK

The regulations governing the subsector have evolved greatly over the last 10 years, significantly strengthening the consideration of environmental and health impacts aimed at generating changes in production models in order to make them more sustainable. This approach establishes greater requirements, and legislative discussions are currently underway to address the regime for granting and duration of concessions, environmental aspects such as sediment treatment, environmental impact assessments and monitoring of environmental conditions, as well as biodiversity and conservation, such as restrictions for centers located near protected areas and the incorporation of exotic species in centers located near these areas. The above points to a complex scenario regarding growth projections for salmon farming in particular, and includes opportunities for the provision of monitoring, environmental assessment and impact mitigation services, among others.

2.1 Sector Institutional framework

The sector institutional framework is represented by the following agencies:

a) Ministry of Economy, Development and Tourism.
The Ministry of Economy, Development and Tourism is the ministry through which policies regarding fishing and aquaculture are planned, determined and coordinated.

The Ministry is the hierarchical superior of the Undersecretariat of Fishing and Aquaculture and of the National Fishing and Aquaculture Service.

b) Undersecretariat for Fisheries and Aquaculture (SUBPESCA for its acronym in Spanish)

SUBPESCA is a public agency under the Ministry whose mission is to regulate and manage the fishing and aquaculture activity, through policies, standards and management measures, dependent on technical reports based on scientific research.

In this function, it is responsible for recommending to the Minister public policies and sector regulations, as well as rules for protection, administration and rational use of resources.

It is the public regulatory authority at the sector level.

c) National Fisheries and Aquaculture Service (SERNAPESCA for its acronym in Spanish)

SERNAPESCA is a public agency under the Ministry of Economy, Development and Tourism in charge of sanitary control and management. It has about 1,126 employees nationwide, distributed among the 16 regions of the country. The LGPA establishes that SERNAPESCA shall oversee compliance with and ensure the due application of the legal and regulatory standards on fishing and aquaculture, and its officials are certifying officers of the complaints made.

Thus, SERNAPESCA is the public regulatory authority at the sector level.

In order to exercise this role, the LGPA empowers SERNAPESCA officials to exercise a series of prerogatives, including the power to register and inspect facilities, centers and all types of vehicles. It is important to note that SERNAPESCA is responsible for controlling the safety and sanitary quality of resources and elements used in aquaculture, which means that it can issue general resolutions that allow it to make this control effective.

Lastly, SERNAPESCA is mandated by the LGPA to file complaints before the courts and/or competent authorities to hear proceedings for violations of fishing regulations.

d) Sector institutional support bodies

i. Fishing and Aquaculture Research Fund (FIPA for its acronym in Spanish)
FIPA is a public fund administered by a public-private Council and is administratively dependent on the Ministry. It is mainly comprised of contributions granted by the Budget Law and advances from the payment of the annual aquaculture patent.

FIPA is intended to finance aquaculture research projects, necessary for the adoption of measures for the administration of fisheries and aquaculture activities in biological, economic and social aspects.

ii. Technical Scientific Committees

The LGPA establishes the existence of 3 Technical Scientific Committees for Aquaculture, as advisory and consultative bodies on scientific matters relevant to the management of aquaculture activities, environmental, sanitary and land use planning issues.

The LGPA establishes that the Committees shall be consulted on:

- The methodology for classifying farms and concession clusters, according to their biosecurity level.
- Proposals for the establishment of sanitary macrozones.
- The evaluation of aquaculture sanitary programs.
- Others established in the law.

iii. National Aquaculture Commission

The National Aquaculture Commission is a public-private advisory body to the Sector Authority whose main functions are:

- Advise on the formulation and evaluation of the actions, measures and programs required to implement the National Aquaculture Policy.
- Give its opinion regarding environmental and sanitary regulations for aquaculture.
- Give its opinion regarding the zoning of the coastal border in relation to aquaculture activities.
- Give its opinion on international issues with relevance to the sector.
- Give its opinion on amendments to the General Law of Fishing and Aquaculture in relation to aquaculture

e) Other relevant agencies

Beyond the role played by environmental institutions, it is important to highlight the role of the Ministry of National Defense and the SFFAA, which are the public bodies responsible for the administration of the

coastal border, and in this role, they are recognized in the LGPA in the process of spatial planning and allocation of aquaculture titles.

2.2 Access to the activity

2.2.1 Spatial planning: where can aquaculture be performed?

The General Law of Fishing and Aquaculture (hereinafter LGPA or Law) provides that aquaculture concessions can only be granted in areas called Preferential Areas for Aquaculture, and said determination implies:

a) Issuance of an administrative act
b) Sector technical report
c) Consultation with other public agencies with interests in the area (e.g., with aptitude for its production and environmental protection).

This implies spatial arrangement of aquaculture activities in areas not excluding other economic activities, and therefore, implies a public and private participatory zoning in its establishment.

These areas are preferably located in the sea, which does not prevent the existence of aquaculture activities located in lakes and rivers that respond to concessions granted prior to the current regulations.

2.2.2 Allocation of title of use for aquaculture: the concession

The assignment of exclusive rights of use and enjoyment for the exercise of aquaculture activities is translated into the granting of an aquaculture concession. As of Chilean Law No. 20,434 - dated April 8, 2020 -, any new aquaculture concession granted has a maximum term of 25 years, renewable in accordance with the conditions established in Articles 69 and 84, and following the LGPA. In the case of aquaculture concessions granted before that date, the Law provides that they will be indefinite, unless a cause for expiration has been verified.

Regarding the procedure, and in accordance with Article 80 of the LGPA and S.D. No. 290, of 1993, of the Ministry of Economy, Development and Reconstruction, regulations for aquaculture concessions, the aquaculture concession is granted through a resolution of the Undersecretariat for the Armed Forces (hereinafter "SFFAA"), whose technical project and schedule of activities is approved by resolution of the SUBPESCA after verification by SERNAPESCA that there are no natural banks of hydrobiological resources, including natural algae meadows, in said place.

Once an aquaculture concession has been obtained by its holder, and before being able to make use of it, the holder shall publish an extract of the granting resolution in the Official Gazette and request the material delivery of the concession to the Maritime Authority within three months, proving the payment of the aquaculture patent established by the LGPA.

Concessions are valid for an indefinite term or 25 years as explained above, but may be subject to renewal and expiration as explained below:

a) Renewal of concessions.

As seen above, the aquaculture concessions granted as from Law No. 20,434 were established within a 25-year term, renewable in case they do not incur in the causes that the LGPA itself established, namely:

- That half of the INFA's have been negative or anaerobic.
- That the holder of the concession is not up to date in the payment of the fine imposed for having been sanctioned for unfair or anti-union practices.

- That the concession holder accumulates three judicially executed sanctions for unfair or anti-union practices in three continuous productive cycles, referring to events that occurred in the cultivation center that is the object of the renewal.

b) Expiration of the Concession

According to the LGPA, aquaculture concessions may be terminated by:

- Voluntary relinquishment by its holder of all or part of it, which shall be made by public deed. The SFFAA shall issue a resolution establishing the new extension of the concession, which shall be registered – in conjunction with the aforementioned public deed - in the Registry.
- If the holder incurs in a cause for the expiration of the concession.

In general terms, the expiration constitutes an abnormal way of extinction of administrative acts due to the non-compliance by the interested party of the obligations imposed by them, which operates automatically and as a matter of law, and therefore cannot be amended or saved by the passage of time, nor by the subsequent conduct of the holder.

The LGPA establishes 14 grounds for aquaculture concessions, some of which are related to the use of the concession within a certain period of time or for a certain purpose, others derived from the breach of obligations that the LGPA, due to their importance, have been qualified as hypothesis of expiration, and others directly related to the repeated configuration within a certain period of time of infractions typified in the LGPA.

Among the main causes for the expiration of a concession the following can be mentioned: the exploitation of the concession for a purpose other than that for which it was granted; failure to pay the aquaculture yearly fee; failure to start operations in the cultivation center within one year from the material delivery of the concession or authorization; paralyzing activities for more than two consecutive years; and having been sanctioned 3 times, within a period of 4 years from the date of the commission of the first infraction, for the delivery of incomplete or false information. To date, almost all of the administrative processes initiated for the declaration of the expiration of an aquaculture concession are due to the cause of not starting operations or paralyzing operations in the terms indicated above.

The LGPA provides that the expiration shall be declared by resolution of the SFFAA, which shall be notified to the holder of the aquaculture concession by registered letter, who shall have a period of 30 days, counted from the date of dispatch of the letter, to complain about the resolution before the Ministry of National Defense, which shall decide after a technical report from the same SFFAA.

2.2.3 Legal regime for aquaculture concession

The LGPA provides that aquaculture concessions are transferable and susceptible to any legal transaction, including encumbrances expressly regulated in the regulations. For these purposes, the regulation created a Public Registry of Aquaculture Concessions - free of charge and available for consultation on the SUBPESCA's electronic domain page - in which the following shall be registered:

a) Aquaculture concessions.
b) Transfers, leases and any act that implies cession of rights over the aquaculture concessions or their expiration, or that enables the exercise of the aquaculture activity in them.
c) Mortgages, pledges without displacement, encumbrances and prohibitions that affect the concession.

The registration of such acts in the aforementioned Registry constitutes an enabling solemnity for the acquirer or transferee to use the concession, and makes such acts enforceable against third parties and the Authority. In addition, the LGPA provides that the obligations and infringements are the responsibility of whoever has the concession registered in their name, whether as owner or holding another title that enables them to do so.

2.2.4 Closure of access to the activity: temporary moratorium and relocation of concessions

Law No. 20,434 created the figure of relocation of aquaculture concessions, by virtue of which aquaculture concession holders may relinquish an aquaculture concession subject to the condition that a new aquaculture concession located in a new sector within the same region is granted.

This law had several amendments contained in Law No. 20,583 - dated April 2, 2012 - and Law No. 20,825 - dated April 7, 2015 - which established that the figure of relocation of salmonid concessions located in the X, XI and XII Regions, allowing that these could be relocated within the same region, meeting the following requirements:

a) Maintain the group of hydrobiological species and area of the authorized concession (no increase in species or surface area).
b) Renounce the original concession subject to the condition that the replacement concession be granted.
c) The request for the replacement concession had to be located within AAA, comply with the coastal border zoning established by the LGPA and be subject to the requirements established in article 79 of the LGPA (requirements applicable to aquaculture concession requests).
d) Submit the replacement concession to the SEIA.
e) It could not overlap with areas of management and exploitation of benthic resources; marine parks and reserves; national parks; coastal marine areas of native peoples; areas where there is a natural bank or fishing ground, and sectors of tourist interest defined in the respective zoning, with SUBPESCA being responsible for determining, through a Technical Report, the existence or not of fishing grounds in the requested sector.

To apply this figure, the LGPA provided the suspension of the entry of applications for concessions in the X and XI regions for various periods ending no later than April 8, 2020, and required the denial of applications in process, except those with a technical project approved by SUBPESCA and those that corresponded to relocation requests.

2.3 Conditions and obligations for the development of the activity

2.3.1 Concession operation obligation

The LGPA requires all holders of an aquaculture concession to comply with obligations that allow them to maintain the validity of their concession, which are to start operations within one year from the material delivery of the concession and not stop operations for more than two consecutive years. Failure to comply with these obligations generates the expiration of the aquaculture concession, and therefore, the loss of the title that enables the exercise of the activity.

In this regard, the LGPA has set a standard for such operation, which is that the operation assumes that the activity of the center is equal to or higher than the minimum levels of operation constituted by a percentage in relation to the maximum annual production. The law also states that there is an operation when the plant shall comply with the break period or shutdown by resolution of the authority.

On this matter, there have been several interpretations issued by the Authority and the Comptroller General of the Republic on how to count the periods that have meant a lack of legal certainty on a permanent and general criterion. Notwithstanding the above, Law No. 20,434 provided that the periods of inactivity between January 1, 2006 and December 31, 2011 are not counted for the purposes of the application of the cause of expiration contemplated in Article 142 letter e) of the LGPA.

Without prejudice to establishing the obligation to operate within the terms indicated above, the LGPA grants the right to request from the SFFAA an extension of the period of stoppage for the equivalent of twice the time of operation that preceded the stoppage, with a maximum of four years. For such purposes, the regulations shall consider included in

the operation the period of 6 months that elapses between a harvest and the next planting, as well as the period that corresponds to a period of break or stoppage by resolution of the authority.

2.3.2 Submission of information

The LGPA states that all persons performing aquaculture activities shall report:

a) The structures used in the farming.

b) Supply.

c) Stocks.

d) Harvests.

e) The sanitary situation of the facility.

f) The origin and destination of the specimens.

Delivery of this information shall be made in a complete, reliable and timely manner, as provided for in the respective regulations.

2.3.3 Patent payment and distribution

The law establishes the obligation of the holders of aquaculture concessions to pay a yearly aquaculture fee. Although the amount of such patent was established at 2 Monthly Tax Units (hereinafter UTM)[11], several legal amendments have increased the value of the patent in the case of those concessions that operate on exotic fish (i.e. salmonid concessions), establishing in Law No. 20,583 that in the case of such concessions and as of 2017, the value of the patent would be 20 UTM per hectare.

The LGPA provides that if the concession is not used in the previous 54 months and the application of the expiration cause for lack of operation is not applicable, an additional 10 UTM per hectare shall be paid for each year of non-use. Notwithstanding the foregoing, such additional payment shall not be verified if the concession:

a) Is subject to mandatory break in accordance with a sanitary management plan of the respective grouping of concessions[12].

b) Is located in a sector affected by an environmental event, natural disaster or force majeure.

c) It is located in a sector declared in sanitary emergency by the Authority.

d) The authority has ordered a mandatory suspension of operations.

The distribution of the resources from the fishing yearly fee are distributed as follows:

a) 10 UTM per hectare are paid into the general funds of the Nation (Public Treasury).

b) 5 UTM per hectare are paid to the Chilean National Fund for Regional Development of the region corresponding to the aquaculture concession or authorization.

[11] The Monthly Tax Unit is a unit of money that corresponds to an equivalent amount in Chilean pesos used for the collection of internal taxes and considers the inflationary factor. The value as of May 2023 is close to $63,000 (sixty-three thousand Chilean pesos), i.e. USD 79.3

[12] This cause should not be applicable at present because the Comptroller General of the Republic ruled in October 2018 that the mandatory sanitary breaks provided for in a sanitary management plan do not prevent the configuration of a cause for expiration, so the centers shall operate.

c) 5 UTM per hectare are paid to the municipalities of the communes where the aquaculture concessions or authorizations are located. In the event that a concession or authorization is located in the territory of two or more communes, the respective municipalities shall determine, among them, the proportion in which they shall receive the municipal benefit product of the corresponding patent, dividing its amount pro rata to the surface area covered by the concession or authorization in each commune.

The payment of these amounts shall be made in the month of August of each year at the General Treasury of the Republic. Notwithstanding this, the LGPA considers a tax benefit for those holders who make early contributions to the Fisheries Research Fund, which translates into a credit against the payment of the patent equivalent to the value of what should have been paid increased by a factor defined by the LGPA.

2.3.4 Environmental

Environmental monitoring of the cultivation center

According to the environmental regulations for aquaculture, the holders shall prepare an environmental report (INFA for its acronym in Spanish) of the farming center in a determined period that shows whether or not the center is operating at levels compatible with the capacity of the water body.

According to the regulation, in fish fattening farms, INFA sampling shall be performed two months before harvesting begins, as shown in Figure N°4.

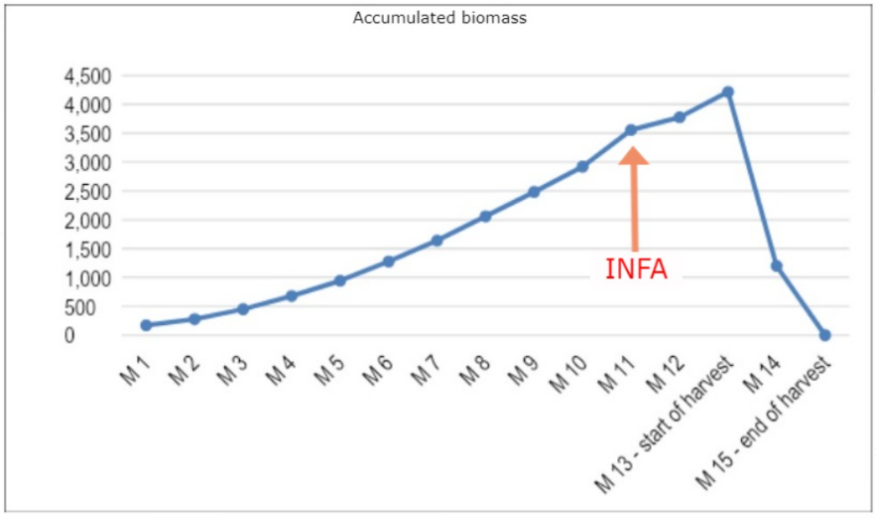


Figure N°4. Example of accumulated biomass of a salmon production cycle and elaboration time of the INFA. Source: own elaboration.

The result of an INFA is dichotomous: aerobic or anaerobic. Therefore, an aerobic result indicates that the farming center is operating at levels compatible with the capacity of the water body, and, on the contrary, an anaerobic result indicates that this condition is not met. In the latter case, the regulation provides a forced mitigation measure, since it indicates that the entry of fish into the farming centers is prohibited until the results of the INFA proving that the center is operating at levels compatible with the capacity of the water body are available, i.e., a fish farming center cannot operate again until it has the result of an aerobic INFA.

In practice, this has determined that the sector environmental regulations recognize the existence of three types of INFAs, which are fundamentally differentiated according to the opportunity in which they are executed. This is in accordance with the following:

a) **Environmental information (INFA):** report of the environmental background of a cultivation center in a given period. It corresponds to the one performed two months before the beginning of the harvest in the case of fish fattening farms.

b) **INFA prior to the entry of specimens or Pre INFA:** refers to the INFA that shall be performed in a farming center in which its last INFA has shown an aerobic condition, the center has not operated and five or more years have elapsed since the date of the last harvest of specimens, understood as the date on which the total depopulation of the respective farming center takes place.

c) **Post anaerobic INFA:** refers to the INFA that is performed in a farming center after obtaining an INFA that shows an anaerobic condition, and whose objective is to demonstrate that the aerobic condition of the operation site has been reestablished.

Based on the above, it is important to note that a farming center can elaborate as many post-anaerobic INFAs as it deems appropriate to determine the opportunity in which the bottom or water column conditions have been restored, as appropriate, without this leading to the conclusion that a farming center is more or less anaerobic because it has performed more or less post-anaerobic INFAs.

However, one of the major legal changes made in this area in 2010 was to establish that SERNAPESCA shall prepare, at the cost and expense of the companies, the environmental reports. For this purpose, SERNAPESCA performs a public bidding process, and the execution of field sampling is a task that can be entrusted to independent analysis entities, registered and supervised by SERNAPESCA. This is an important milestone in the regulation, since before the legal amendment, each company selected the sampling entity that would perform the INFA and, therefore, there was a commercial relationship and direct dependence between both parties, which did not provide a total guarantee of the veracity of the results.

Marine Mammal Monitoring

In 2020 and considering that the Marine Mammal Protection Act of the United States established the prohibition of importing fishery/aquaculture resources from countries that report incidental or direct mortalities on marine mammals, derived from fishing or aquaculture processes, without evaluating the effect of this on the population of the resource, SUBPESCA modified the environmental regulations in order to incorporate measures to mitigate this interaction.

Thus, all salmonid farming centers are obligated to: have anti-sea wolf nets as perimeter protection, in order to avoid or minimize the entanglement of marine mammals in the fish nets and the escape of specimens being farmed as a result of these organisms breaking the fish nets; have a plan of action in place to prevent interaction with marine mammals in order to avoid the death of these species, and to periodically report incidents to SERNAPESCA in order to have an official record of such incidents.

Certification of farming structures

Companies are required to have farming and anchoring modules that present safety conditions appropriate to the geographical and oceanographic characteristics of the site, to prevent the escape of fish, according to the methodology and technical specifications set by SUBPESCA.

Pursuant to the above, in 2020, SUBPESCA fixed the referred methodology and technical specifications. Thus, the companies shall:

- Have an engineering study that includes a calculation memory specifying the conditions for which the farming gear and modules were designed. This study shall specify the base information used, referring to the bathymetric, geographic, meteorological and oceanographic characteristics of the site.

- Perform a biannual verification of the good condition of the modules, having to perform maintenance if necessary for the reestablishment of the safety conditions.
- Annually certify the good condition of the modules, through an independent entity, registered and supervised by SERNAPESCA.

Online monitoring of environmental parameters

In 2021, SUBPESCA published a regulation that stipulated that ACS holders shall install monitoring stations for various meteorological (temperature, atmospheric pressure, wind, radiation and precipitation) and oceanographic (temperature, salinity, depth, currents, fluorescence, turbidity, oxygen and pH) parameters, so that SUBPESCA can monitor and control online the environmental conditions of the clusters for correct decision making.

Treatment and disposal of waste from aquaculture activities

In 2021, SUBPESCA issued a specific regulation for companies to adopt the necessary measures to handle, store, transport and dispose waste - organic, inorganic, hazardous, non-hazardous, among others - generated by the development of the activity, in such a way as to keep the farming center and its surroundings clean. For the latter, the possibility is established for a company to associate with other company(ies) so that they can comply, jointly and in a coordinated manner, with the requirement to keep the beaches and surrounding beach areas clean of aquaculture waste.

Likewise, the companies are obliged to have a traceability system for the main elements that are likely to become waste, in order to facilitate the control of the obligations by SERNAPESCA, since it is possible to detect the company that generates the waste. This system shall be made of a long-lasting material, resistant to UV radiation, indelible, inviolable and not susceptible to alteration, copying or adulteration

Law No. 21,410

In the year 2022, an amendment to the LGPA was published, its main objective was to incorporate new requirements to companies to avoid or reduce the deposit of inorganic and organic waste at the bottom of the farming center.

Thus, in the case of inorganic waste, the law imposes on the companies the duty to take all measures to avoid its deposit at the bottom, performing the necessary cleaning works - within a maximum period of 6 months - in the case of detecting its presence at the bottom.

In the case of organic waste, the law stipulates that companies shall take all measures to avoid or reduce its deposit on the seabed, for which they shall have a recovery plan and a seabed investigation plan. The purpose of the recovery plan is to establish the use of physical, chemical or biological mechanisms to improve the conditions of the sedimentation area and accelerate the incorporation of organic matter into the environment. The purpose of the research plan is to study and develop methods and technologies for the recovery of the seabed.

It should be noted that the law shall come into force as from January 2024 and it was stipulated that in the meantime SUBPESCA shall issue a regulation that will establish the obligations that the companies shall adopt in order to comply with what was previously indicated.

As of the date of submission of this report, SUBPESCA has not yet published these regulations. However, a couple of weeks ago, SUBPESCA released the technical proposal and gave a deadline for the companies to send their observations.

In this respect, one of the main concerns expressed by the companies regarding this technical proposal is the consequences that the fact of presenting an anaerobic condition will have in the future. This, because in addition to the cessation of operations currently provided for in the regulation, 3 new restrictions will be added, namely:

a) The company shall decrease the production of the farming center by a percentage to be determined by SUBPESCA based on the number of INFA's or Post anaerobic INFA's with anaerobic results, among others.
b) The company may only reestablish its production levels to the extent that it demonstrates to SUBPESCA that it has implemented operational measures that guarantee that the center has significantly decreased the contribution of organic wastes in the sedimentation area of the concession and that this is authorized by SUBPESCA.
c) The company may not request an increase in the biomass of the farming center above what is authorized in its Environmental Qualification Resolution.

Law No. 21,532

In the year 2023, an amendment to the LGPA was published, its main objective was to incorporate new requirements to companies to prevent the occurrence of salmon escapes from farming centers.

Thus, if it is found that a company has not complied with the calculation memory for the installation of the farming and anchoring structures, the following effects are established:

(a) If the center has not yet planted, a prohibition on planting is established until compliance is verified through a certifier at the owner's expense.

b) If the center has fish in the water, it is given a maximum period of 2 months - counted from the non-compliance - to remove all specimens unless it proves compliance through a certifier at the owner's cost.

The law also provides that SERNAPESCA is obliged to publish, at the end of the production cycle, information on the amount and type of antibiotics and antiparasitics used and the respective biomass, mortality and harvest. This information shall be disaggregated by company and farming center. Likewise, SERNAPESCA shall publish the amount of escaped specimens when an event occurs.

Lastly, the law regulates the accidental capture of salmonid species - not associated with escape events from a farming center - by artisanal ship-owners registered in the regions where these species are subject to farming, obliging them to report this situation to SERNAPESCA and to submit to the requirements defined in a regulation. It also states that until the regulation which regulates the accidental capture of salmon species by artisanal ship-owners is issued, they shall be authorized to fish salmon accidentally.

It should be noted that as of the date of submission of this report, SUBPESCA has not yet published the aforementioned regulation.

Draft bill that creates the Biodiversity and Wildlife Protected Areas Service

The general idea of this project is to create a new Administration Body - called the Biodiversity and Wildlife Protected Areas Service (SBAP for its acronym in Spanish) - which will be in charge of the conservation of biological diversity and the protection of the country's natural heritage, through the preservation, restoration and sustainable use of genes, species and ecosystems.

Among the functions that this Service will be in charge of will be the administration of the National System of Protected Wildlife Areas, which will comprise 6 categories of protection, namely:

(a) Virgin Region Reserve

b) National Park

c) Natural Monument

d) National Reserve

e) Multiple Use Conservation Area

f) Indigenous Peoples Conservation Area

According to the project, the categories have different protection objectives, ranging from strict preservation - the development of any economic activity will be prohibited, for example - to conservation - the development of sustainable economic activities will be allowed. Thus, for example, a National Park is defined as an area whose objective is preservation, while a National Reserve and a Multiple Use Conservation Area are defined as conservation areas.

One of the major discussions that have arisen during the discussion of this bill in Congress has to do with the possibility of developing salmon farming within protected areas, regardless of the category in question and its object of protection.

The above definition is transcendental for the future development of the activity considering that currently in Chile there are 431 salmon farming centers located inside different protected areas in the Los Lagos (11), Aysén (339) and Magallanes (81) regions, according to the following detail:

REGION/ PROTECTED AREA	PRODUCTION CENTER No.
LOS LAGOS	**11**
COMAU-SAN IGNACIO DE HUINAY FJORD MPA-MU*	5
PUMALÍN NATIONAL PARK	3
LLANQUIHUE FOREST RESERVE**	3
AYSÉN	**339**
PITI PALENA-AÑIHUÉ MPA-MU	8
ISLA MAGDALENA NATIONAL PARK	4
SAN RAFAEL LAGOON NATIONAL PARK	4
LAS GUAITECAS FOREST RESERVE	315
QUITRALCO ESTUARY NATURE SANCTUARY	8
MAGALLANES	**81**
ALBERTO DE AGOSTINI NATIONAL PARK	19
KAWESQAR NATIONAL RESERVE	62
TOTAL	**431**

* Corresponds to the future category of Multiple Use Conservation Area.

** Corresponds to the future category of National Reserve.

Source: SUBPESCA

2.3.5 Sanitary

The health crisis caused by the infectious salmon anemia (ISA) virus forced the Chilean government to redefine the production, health and environmental model for salmon farming, which is currently based on the following fundamental pillars:

i. **Importation of eggs:** it is only possible to import salmon eggs into Chile from countries whose Competent Authority has undergone a sanitary evaluation by SERNAPESCA, for which the Import Risk Analysis (IRA) methodology recommended by the World Organization for Animal Health (OMSA) is used and is complemented with at least one on-site verification visit during the development of the IRA.

Only once the assessment has been performed and approved by SERNAPESCA can egg producers in the country of origin export to Chile subject to the sanitary certification conditions established by current regulations.

Currently, Iceland is the only country authorized to import Atlantic salmon eggs to Chile.

ii. **List of High Risk Diseases (HRD):** HRD are classified in List 1, List 2 and List 3, by groups of hydrobiological species, considering their virulence, prevalence, level of dissemination or economic impact for the country or the circumstance of being in the OMSA list of diseases that are mandatory to notify.

List 1: HRD that have not been previously detected in Chile.

List 2: HRD that have not been detected in Chile and have a high prevalence, distribution, morbidity and/or mortality in a population of farming species.

List 3: HRD that have been detected in Chile causing variable mortalities and whose epidemiology may or may not be completely described.

Annex 2 show the list of diseases of the salmonid group in force in Chile.

iii. **Groupings of salmonid concessions (ACS):** understood as the set of aquaculture concessions that are located within the AAA in a sector that presents safety, epidemiological, oceanographic, operational or geographical characteristics that justify their coordinated sanitary management by group of hydrobiological species.

They originated in 2009, when SERNAPESCA established the sanitary management areas or "neighborhoods" as one of the measures to face the sanitary crisis. Then, in 2010, with Law No. 20,434, published in the Official Gazette on April 8, 2010, they were incorporated into the LGPA under the name of ACS, although currently they are still commonly known as "neighborhoods".

Thus, in accordance with the LGPA, the ACS are set by resolution of SUBPESCA and currently there are a total of 83 ACS in the Los Lagos (24), Aysén (37) and Magallanes (22) regions.

iv. **Sanitary and environmental distances:** measure established to avoid the transmission of infectious diseases between farming centers. In the case of salmon farming centers, these shall have a minimum distance between them of 1.5 nautical miles, and there shall be a minimum distance of 3 nautical miles between the vertices of the bordering aquaculture concessions of each of the ACS, understanding as such, those located in the peripheral area of the grouping.

v. **Coordinated sanitary breaks:** coordinated sanitary measure applicable to the ACS set by SUBPESCA, which consists of a period of time during which the farming centers that are members of the respective group shall cease operations and remove all specimens from the center, prohibiting the entry and maintenance of hydrobiological species.

In accordance with the LGPA and the RESA, these are set by resolution of SERNAPESCA and shall have an extension of 3 months, as a general rule.

vi. **Production cycle:** corresponds to the period of time for a hydrobiological species in a farming setting to reach the degree of development necessary to continue with the following production stage(s). In the

case of fish fatting, it is the period between the entry or seeding of a generation of specimens until their total harvest or the total depopulation of the farming center.

vii. **Production period:** corresponds to the period of time between the end date of a coordinated sanitary break and the beginning of the next coordinated sanitary break of a group of concessions. In accordance with RESA, said period may not exceed 24 months, except in the case of the Magallanes and Chilean Antarctica region, where the period shall not exceed 33 months.

This means that in practice there are mostly 21+3 and 24+3 productive regimes in the Los Lagos and Aysén regions, and 33+3 in the Magallanes region.

It should be noted that according to Article 58 G of RESA, a maximum of 1 production cycle of Atlantic salmon or 2 production cycles of rainbow trout or coho salmon can be carried out within a production period. All this can be seen in an example in Annex 3.

viii. **Sanitary surveillance of farming specimens:** sanitary measure aimed at timely detecting the presence of an infectious disease in order to activate control measures that allow its rapid control. The owners of farming centers shall comply with the sanitary measures set forth in the RESA and, in particular, with the obligations contained in the Specific Sanitary Surveillance and Control Programs for the diseases infectious salmon anemia, Piscirickettsiosis and Caligidosis.

ix. **Control of production for sanitary purposes**: during the sanitary crisis, it was found that the sanitary and environmental conditions of the farming centers and what the companies plan to produce are important to the correct development of this activity. This is because the more concentrated the fish are (overcrowded in cages) and the more fish there are in an area, the more risky the scenario is for the outbreak and spread of diseases and the deterioration of environmental conditions of the farming site.

The need then arose for the Chilean government to control the number of fish in farming for sanitary purposes by determining a farming density per group. This measure consists of SUBPESCA determining the maximum number of specimens to be placed in the farming cages in order to avoid the overcrowding of fish that generates an environment conducive to the appearance of diseases, and lastly a carrying capacity per grouping is determined, as it indirectly regulates the maximum biomass that can be produced by the farming centers that are members of an ACS.

Currently, the sanitary regulations consider two regimes: farming density and Percentage Reduction of Individual Seeding (PRSi).

Density of farming regime

This control measure began to be applied in 2014 in the ACSs of the Los Lagos and Aysén regions, and as of 2015 in the Magallanes region.

The farming density which all companies that make up an ACS shall submit to is determined by an evaluation of three elements: the sanitary and environmental performance of the previous productive period and the amount of fish that the companies project for the following productive period.

Health performance is measured in relation to the number of fish that died during the previous production period, i.e., the higher the percentage of mortality, the worse the performance of the group and vice versa.

Environmental performance is measured according to the results of the environmental assessment (INFA) that every farming center must perform, therefore, it is estimated that the higher the percentage of unfavorable environmental results (INFA), the worse the performance of the ACS and vice versa.

The productive element is measured according to the planting projections declared by the companies, i.e., it is estimated that the higher the percentage of growth for the following period, the worse the performance of the group and vice versa.

Thus, the ACS farming density varies depending on the biosecurity classification obtained and the farming species involved, as shown below:

- Atlantic salmon: its maximum density is 17 kg/m^3 and its minimum is 4 kg/m^3.

- Rainbow trout and coho salmon: its maximum density is 12 kg/m^3 and its minimum is 3 kg/m^3.

Thus, for example, the higher the percentage of mortality and unfavorable environmental results (INFA) and the higher the percentage of growth, the lower the farming density for the next period. The lower the farming density - fewer fish per cage - the more expensive it is to operate because more cages are required to produce the same, which is a disincentive for companies to project growth that is not supported by good health and environmental performance.

The following is an example of this:

	ACS A	
	CENTER 1	
Biosafety ACS classification	High	Low 4
Maximum density permitted	17 kg/m^3	4 kg/m^3
Target species	Atlantic salmon	
Specimen number target production	1,200,000	1,200,000
Maximum fish/cage number	75,000	40,000
Number of cages to install	**16**	**30**

Source: own elaboration

Of the PRSi regime

It was incorporated into the sanitary regulation of 2016 as a result of an analysis that at that date had been performed by SUBPESCA regarding the implementation of the farming density per ACS measure.

Essentially, it corresponds to an alternative and voluntary measure to the farming density by ACS wherein a holder of one or more concessions may choose to produce the maximum farming density allowed - 17 Kg/m^3 in the case of Atlantic salmon and 12 Kg/m^3 in the case of rainbow trout and coho salmon species - to the extent that it reduces its production in the following productive period, by a percentage determined by SUBPESCA. That is to say, through this regime it is allowed to operate with the best density, but with fewer fish in total in the company's centers where this measure was applied.

It is determined according to the sanitary performance obtained by the company in the previous productive period, considering the three following elements: mortality, sanitary management of caligidosis and the antibiotic consumption indicator.

Mortality is determined in the same way as the sanitary performance of the ACS is calculated for the farming density. Therefore, the higher the mortality percentage of a company, the worse its sanitary performance is assumed to be.

The sanitary management of caligidosis is measured in relation to the frequency of pharmacological treatments by immersion performed in a farming center per productive period. Thus, the higher the average number of net cages treated, the worse the holder's sanitary management of the disease is assumed to be.

The antibiotic consumption indicator (ICA for its acronym in Spanish) is determined based on the amount of pharmacological product used to produce one kilogram of harvested biomass. Therefore, the higher the ICA, the worse the holder's sanitary performance is assumed to be.

Thus, the PRSi determines that:

- The maximum percentage growth rate is set at 9%

- The maximum percentage of reduction is set at 16%

- Growth with mortalities higher than 14% are not allowed, regardless of the amount of antibiotic used or the percentage of cages treated against caligus.

- When the ICA is higher than 600 gr/ton, the company can only reduce its production by a percentage to be defined by SUBPESCA.

Thus, the percentage of reduction or growth is applied to the company's immediately previous production, and, therefore, it shall be the maximum amount of fish that SUBPESCA shall propose to the company so that it can operate with the maximum density allowed in subsidy of the farming density of the ACS.

The following is an example of the above:

	COMPANY A	
PPJT ≤ 50%	X	
PPJT > 50%		X
% mortality	8%	30%
ICA	100 gr/ton	450 gr/ton
PRSi	+9%	-16%
Target Species	Atlantic salmon	
Maximum density permitted	17 kg/m^3	
Previous production (number of fish)	2,500,000	2,500,000
Authorized fish number production	**2,725,000**	**2,100,000**

Source: own elaboration

3. BEST PRACTICES AND INNOVATION

The information presented herein was obtained through the review of press media and specialized literature, sustainability reports and annual reports from companies and governmental agencies involved in the matter.

3.1 Innovation from the public sector

As stated in the production section, one of the pending topics in Chile's aquaculture development model is the diversification of cultivated species. In Chile, until 2022, the resources supply reached a total of 22 cultivated resources; nevertheless 94% of the aquaculture activity harvest is accounted for by 3 resources. Given the importance of this topic, the Chilean State, through promotion and innovation instruments provided by the Corporación de Fomento y La Producción (www.corfo.cl), such as technology programs, has enabled significant improvements regarding diversification, sustainability, national technological development and productive chains.

In this regard, the Government launched three technological programs[13], one on aquaculture fish diversification aimed at native species, such as: red conger eel, amberjacks and corvina (*Cilus gilberti*); another one on oceanic aquaculture lead by the Consorcio SpA and Ecosea Farming; and the third one, the Centro Tecnológico de Innovación Acuícola, AquaPacífico, that supports the aquaculture industry development in the country's northern macrozone, which operates in the Coquimbo region.

The Programa de Diversificación de la Acuicultura Chilena (PDACH) has generated specialized and local capacities through the use of technologies developed in Chile for sustainable production, adjusting ground-based cultivation technologies based on the recirculation and reuse of water, thus achieving the productive cycles' closure, and this in turn results in high density and highly productive cultivation systems without the use of antibiotics.

In the case of the Programa de Congrio (*Genypterus chilensis*), awarded in 2016 and executed from 2017 on, it is implemented in the Coquimbo region and constitutes a link with communities from the coastal border, through the formation of an Small Scale Aquaculture (APE) model, and red conger eel repopulation activities with artisanal fisherfolk groups from communes of the coastal cities of Tongoy and Los Vilos. This initiative had its first harvest in 2020 (4t), which was aimed at the development of different testing formats in restaurants and supermarkets.

Likewise, again in the Coquimbo region, and also in the Tarapacá region, the Programa de Corvina[14] (*Cilus gilberti*) was awarded in 2015 and executed from 2020 on, and it aims to validate the sustainable cultivation technology and enhance the technological development, incorporating the country´s northern macrozone to the national aquaculture and diversifying its productive matrix.

Furthermore, the Programa Seriola (*Seriola lalandi*)[15] started in 2015, implemented by Acuinor[16], executed in the Atacama region in the north of Chile, aims to the productive scaling and enhancing of this resource's export capacity[17].

Despite these efforts, to date the production of these new species is still marginal in relation to traditional resources.

[13] https://www.corfo.cl/sites/cpp/movil/pte-programas-tecnologicos-estrategicos
[14] https://fch.cl/iniciativa/programa-corvina/
[15] Also known as Vidriola/palometa/Dorado, and designated in international markets as *Patagonian Hiramasa.* http://acuinor.cl/patagonian-hiramasa-es
[16] http://www.acuinor.cl/es/acuinor
[17] https://www.aqua.cl/2020/07/10/experiencia-pionera-desafios-del-cultivo-de-seriola-en-el-desierto-de-atacama/#

Regarding oceanic aquaculture initiatives, the 'Programa Tecnológico Estratégico para el Desarrollo de la Acuicultura Oceánica'[18] started in 2019 and it is currently in the stage of validating the technologies that will enable the development of fish cultivation in high energy and 'offshore' areas, involving in this program producers and providers of operations, logistics, feeding, marine engineering, robotics, satellite communications and high tech supplies.

In terms of the technological center AquaPacífico[19], it is an aquaculture innovation center that deals with the Chilean north-center zone concerns, it originated at the end of 2016 with the support of the Corporación de Fomento de la Producción – CORFO, and later from the Agencia Nacional de Investigación y Desarrollo (ANID). It is constituted as an alliance between the Universidad Católica del Norte (UCN) and Fundación Chile (FCH), with special aim in the promotion of small-scale aquaculture (APE), with the participation of artisanal fisherfolk associations and small and medium-sized companies.

On the same matter, and in the scope of mollusks, the regional strategic program (PER for its acronym in Spanish), 'Mejillón de Chile'[20], is functioning since 2017. This initiative is being implemented by the Los Lagos region's CORFO and aims at strengthening the Chilean mussel (*mytilius chilensis*) production, promoting the productive chaining, and establishing the development of the industry by adding innovation and added value.

3.2 'Green' initiatives

Within the framework of joining sustainable and eco-friendly production standards, the national aquaculture of salmonids industry has undertaken diverse courses of action regarding the establishment of better practices for a sustainable activity, mainly under the scope of obtaining different certifications and the addition of more eco-friendly initiatives within the processes.

In this regard, it is worth mentioning that there are great efforts for advancing sustainable production certifications. The Aquaculture Stewardship Council [21](ASC), Global Gap [22] and Best Aquaculture Practices (BAP)[23] certifications have an important presence among Chilean producers.

In terms of eco-friendly commitment and best practices, the industry has executed optimization actions for the use of water (hydric efficiency in process plants, recirculation of water in fish farms), beach and environment cleaning efforts, encouragement of rational and efficient use of energy, conversion to renewable energies, control and registry of the amount and type of energy used in the activity, measurement and management of emissions and carbon footprint[24], noise and smells emissions, waste management (circular economy and recycling of decommissioned consumables) [25]

[18] https://acuiculturaoceanica.cl/
[19] http://www.aquapacifico.cl/
[20] www.mejillondechile.cl
[21] https://asc-aqua.org/
[22] https://www.globalgap.org/es/for-producers/globalg.a.p./integrated-farm-assurance-ifa/aquaculture/
[23] https://www.bapcertification.org/
[24] May, 2023, companies Caleta bay Mar Spa, caleta bay Agua Dulce SpA, productos del mar Ventisqueros S.A., Salmones Blumar S.A and Novaustral S.A have agreed to the Huella de Chile certification, in its carbon footprint measurement mode, a stage previous to the establishment of the greenhouse gases emission decrease commitment. www.huelladechile.cl Program from the Chilean Environment Ministry to promote the calculation, report and management of greenhouse gases (GEI for its acronym in Spanish) in organizations at a public and private level. In this same regard, Salmones Camanchaca S.A has performed greenhouse gases measurements annually during the 2017-2021 period, with the objective of greatly advancing the carbon neutrality for the year 2025.
[25] Ecofibras https://ecofibras.cl; Good Wood https://goodwoodchile.cl/;www.eco-logica.cl; www.bureo.co; www.greenspot.cl

, and advancements in terms of possessing sustainable and recyclable packages. Likewise, initiatives regarding the use of Artificial Intelligence (AI) for monitoring heath, feeding and growth of fish have been implemented.

In this respect, to date 29 companies linked to the salmonid industry[26] of the Los Lagos and Aysén regions, assumed in October of 2021 the commitment to advance concrete and verifiable solutions to reduce environmental gaps within the sector, related specifically to carbon footprint and generation of residues, through the Acuerdo de Producción Limpia (APL), signed between the Chilean Government and the Asociación Gremial SalmonChile (Chilean professional union) through the Agencia de Sustentabilidad y Cambio Climático[27] .[28]

The main objective of the APL is to optimize practices from the salmonid aquaculture sector and its value chain, specifically to what is related to circular economy and climate change, in order to improve the sector's sustainability and make contributions, at a sector level, to the commitments undertaken by the country in this matter.

In the Chilean salmonid industry, the use of renewable energy is low, and the use of fossil fuels is high, which shows that there is much space to increase its usage. No company has enough renewable energy to operate with; they only use it for emergency purposes. Nevertheless, in the past few years there has been major improvements in these matters.

To diversify the energy matrix and encourage the shift from hydrocarbons to renewable energies

It is important to note that the Chilean government has created a fund for the development of green Hydrogen (H2V) and its derivatives for US$ 1,000 million, which will begin to operate in 2024. This initiative aims to support the development of local demand of H2V, and to generate national production capabilities in order to make the country an exporter of this energy.

The Universidad Austral de Chile, through the INVENT research center, is currently researching lines associated to the use of hydrogen as an energy source for the propulsion systems and assistants of ships for services in aquaculture that possess a hybrid energy generation system (diesel/hydrogen).

Actually, the shift from fossil fuels to the cleanest energy of liquefied gas has taken place by using high efficiency equipment for its better harnessing. The industry has developed projects in steam, electric generation and Gasoline Sea motors conversion production lines. The last two have been accompanied by nautical development for sea centers. Regarding savings and efficiency, successful cases were reached with average savings of over 30%, and in the case of liquefied gas conversion of equipment that operate with diesel or fuel oil, the decrease of particulate material to the environment was reduced by 46% and 84% respectively, meanwhile the drop of sulphur oxides was between 93% and 99%.

On the other hand, one of the opportunities that should be enhanced in the upcoming years in Chile is the development of tidal energy, meaning that is which obtained from the movement of oceans' waves, tides, currents, salinity or temperature differences. According to the Marien Energy Research and Innovation Center (MERIC), Chile has excellent conditions for the development of these types of energies, taking into account, besides its natural conditions, the supply chains and disposition of ports along its territory, and also the fact that Chile is aligned with the European Union's decarbonization goals.

[26] https://accion.ascc.cl/empresas-y-elementos-adheridos?acuerdo_id=95; mainly harvest centers, process plants and fish farms, including a plant that manufactures feeding and pharmaceutical products.
[27] https://www.ascc.cl/
[28] https://www.salmonchile.cl/blog/empresas-avanzan-en-implementacion-de-cumplimientos-del-acuerdo-de-produccion-limpia-de-la-salmonicultura/

Moreover, when the off shore cultivation tendency becomes necessary for the national aquaculture of salmonids' growth, maritime energies are going to take up an even more important role. Thus, this industry will need to take the maximum advantage of the renewable maritime energies, including wind, to provision the great demand of energy it will have in open sea, especially for the implementation of its different processes and the feeding of fish.

It is important to note that the zones with the most aquaculture production match the places in Chile that have one of the most powerful resources in maritime energy. For example, Aysén y Magallanes are one of the points with the most tidal energy occurrence, whereas in southern Chiloé, the off shore wind is privileged (See https://www.mundoacuicola.cl/new/preven-uso-de-energia-marina-para-el-futuro-de-la-acuicultura/).

In 2020, Skretting Chile, a company oriented to nutritional solutions for the aquaculture of salmonids, signed an electric supply agreement with the company Starkraft, an international company leader in clean generation and the biggest renewable energy generator in Europe, which will progressively secure the clean renewable energy supply that will be validated through international I-REC (International Renewable Energy Certificates) certifications. These certifications guarantee that 100% of the energy supplied is generated through natural renewable resources, which greatly impacts the CO2 reduction for operation in the next few years. Thus, Skretting Chile will drop the electric energy related emissions to zero.

In 2021, the company Blumar Seafoods and its subsidiaries PacificBlu, St. Andrews and Frío Pacífico, announced that they would use 100% clean energy, originated from renewable sources, such as wind, geothermal or hydraulic, in their production processes.

To do so they signed a power purchase agreement (PPA) with the Chilean company Enel Generación, after a bidding process implemented by the consultant company MatchEnergía. The contract will be extended for 4 years, for an estimated total annual generation of 72 GWh. This milestone implies that the companies will obtain a I-REC certification and green seal, which among other benefits will translate into energy traceability, origin certification and ownership, environmental and social impact minimization, sustainability management with a model aligned with the Sustainable Development Goals (SDG), specifically the goal number 13 "Climate Action".

Recently, ASMAR, a public company dedicated to naval construction, launched a last generation lithium battery prototype that reduces energy consumption and emissions for shipping lines and aquaculture. This equipment consists of an energy loading and storing system by means of lithium batteries, using each unit or pontoon's generation capacities. For its installation in ships, it considers a model with a plug and play system that allows real time monitoring of the performance of the generators, batteries and energy consumption. All of this allows a lesser use of diesel generators, thus reducing connectivity ships' carbon footprint, isolated facilities and cultivation centers, and also reducing generators´ maintenance costs.

The Chilean Army already operates this system in lighthouses in the Magallanes Region, with auspicious results in energy availability and decrease in low-cost emissions, reaching up to a 70% direct energy generation reduction, besides savings in fuel, generators equipment maintenance and an important durability extension.

Recently the development of wind energy projects has started, which have been installed in pontoons, where space is reduced, for which probably the development of independent platforms is needed for the ship's crew to be able to avoid cohabitating the diesel- or gas-powered generator.

Regarding the photovoltaic alternative, the main obstacle faced is the lack of space, and it will probably require operating in floating panels, which is a complication particularly to those concessions with little surfaces. This might be an interesting alternative for development in Chile, such as floating solar systems that allow the combination of hybrid systems solutions with batteries and diesel or gas.

In terms of innovations to face productive best practices challenges, there is currently in execution an initiative of feasibility study performed in the Aysén region by the Mowi Chile company alongside the Universidad Austral de Chile, which studies the possibility of generating energy from green hydrogen with applications in salmonid aquaculture, which would gradually allow to stop using diesel generators on harvest centers. It is worth mentioning that the development and use of green hydrogen is part of the energy policy of the Chilean government.[29]

Moreover, possibilities of fossil fuels substitution have been identified for wellboats, incorporating hydrogen cells and electric batteries, which would reduce by approximately 20% the use of diesel. It is also expected that there will be developments that allow satisfying the demand with carbon neutral fuels. The production of e-diesel poses a challenge for national producers.

In this same regard of contributing to the reduction of the carbon footprint, the substitution of diesel petroleum by liquified gas emerges as an option for the generation of energy in pontoons, verifying that generators based on liquified gas present a cleaner combustion than diesel, with less pollutant emissions.

3.3 Financing mechanisms for a sustainable aquaculture

In terms of incentives for eco-friendly practices and their financing, recent initiatives have been documented within the national industry in regards to access to green credits through "loans linked to sustainability"[30]. This loan method is linked to the achievement of sustainability performance objectives, constituting incentives to improve business models through the subscription to commitments in this matter.

To date, there is the existence of experiences from the companies Salmones Blumar S.A, Productos del Mar Ventisqueros and Salmones Camanchaca S.A., which in 2021 took out credits with environmental goals, establishing within the acquired commitments the reduction of carbon footprint in different productive processes, increase the use of renewable energy sources, efficient management of residues generated by production, reduction of the use of antibiotics in the harvest of salmons, increase efforts in harvest centers to obtain the ASC certification, accidents rate and decrease of sea ingredients used in diets per each kilo of produced salmon.

In the same way, in 2020 the first green bond was documented from an aquaculture salmonid company. The beneficiary of this emission was the Norwegian company MOWI; this modality is contingent upon investment on tools for sustainable production[31].

4. GREAT CHALLENGES AND TRENDS OF THE NATIONAL (CHILEAN) SALMON FARMING INDUSTRY

a) SANITARY SCOPE

A permanent challenge faced by aquaculture production, in particular Chilean aquaculture of salmonids, is maintaining an appropriate sanitary status within facilities. In the case of Chile, the greatest challenges are probably related to

[29] https://energia.gob.cl/energia2050
[30] Sustainability Linked Loan
[31] Posteriormente suscribieron las empresas noruegas Grieg Seafood y Salmar. https://www.salmonexpert.cl/aquasur-camanchaca-consejo-del-salmn/bonos-verdes-y-cultivo-en-tierra-surgen-como-tendencias-verdes-en-salmonicultura/1187788

infectious diseases' prophylaxis – such as vaccine development, use of preventive systems and the use of functional diets to improve fish's immune response -, and thus, their control.

For example, unlike the northern hemisphere – where the main diseases are viral – in Chile the control of Piscirickettsiosis (SRS), a disease responsible for the greatest proportional use of antibiotics in the Chilean salmonid industry, is still a major challenge.

Thus, it is key for the development of this activity that, in the Piscirickettsiosis control, as in the fight against emerging diseases such as Tenacibaculosis and Caligidosis, eco-friendly means are employed, or technologies that avoid the insertion of chemical agents into the sea, this should translate in antimicrobial and antiparasitic use reduction in the aquaculture of salmonids.

b) CLIMATE CHANGE

The increasingly more intense effects of climate change, such as lack of rain, higher water temperatures, change in the patterns associated to predominant winds and the oceans' acidification, will negatively impact Chilean aquaculture and, consequently, it is to be expected that increasingly larger Harmful Algal Bloom (HABs) events appear. This requires the creation of predictive models based on effective monitoring, which allow predictions of, for example, phenomena associated to environmental conditions that favor the apparition of Harmful Algal Bloom. It is also necessary to have appropriate contingency plans, and above all, having regulations that allow the required flexibility to address this kind of contingencies that at times cause massive fish mortality rates. These requirements will probably be demanded from both the mussel industry and the aquaculture of salmonids.

Carbon footprint reduction is a continuous challenge that the Chilean aquaculture industry production chain will face and moreover, the markets will also demand. Thus, the dramatic reduction of greenhouse gas emissions (GHG) and the development of innovative and efficient power solutions such as the addition of renewable power sources in the industry's energy matrix and the efficient power use are identified as relevant challenges for the industry.

c) SOCIAL LICENSE AND ENVIRONMENTAL SUSTAINABILITY

A great challenge present in the Chilean industry is to continue strengthening the creation of trust and collaboration among producers, goods and services providers and, above all, the government, through sector institutionality (Undersecretariat of Fishing and Aquaculture, Chilean National Fishing and Aquaculture Service, Superintendence of Environment). Likewise, it is fundamental to strengthen the alliances with research institutions, which necessarily requires greater R&D investment.

Aquaculture activities are conducted in a complex setting, in which environmental, technical and biological factors create a situational framework that places pressure on the processes, sometimes triggering unwanted events that jeopardize, impact and infringe upon the reputation of the companies. These events occur in situations that affect the communities and the setting in which the activity is developed, and that are particular to them, such as fish escapes, massive mortality rates, pollution, etc., and upon happening, the community's perception of the activity is severely deteriorated.

In this sense, the social license has become an important factor for the development of aquaculture, as it represents the activity's legitimacy earned through the acceptance, approval, and recognition by interest groups, particularly local actors, facilitating the development of related projects and activities.

The Chilean society's greater environmental sensitivity and awareness causes that these matters must be paid particular attention by the producer companies and service providers, who must be proactive in the building of the social license, maintaining fluent and continuous communication and involvement in endeavors of the local communities and local and central authorities.

The industry has advanced in the improvement of its processes and addition of new technologies required for the field's sustainability, without affecting the ecosystem. This allows the improvement of the industry's image within an important part of the communities. Nevertheless, there are still pending topics that require advances such as non-consumed food and feces retention mechanisms, or in bioremediation technologies for the sediment below cultivation facilities.

An important aspect to continue strengthening relates to the international certifications that are present in the industry, but require a greater subscription from the salmonid sector, as in the case of the ASC certification, one of the world's most prestigious in aquaculture industry.

One of the greatest challenges for the Chilean industry is to continue adding better environmental care practices and, in that sense, a paradigm shift is necessary from a reactive one to a preventive one. For example, beyond having proper recollection and beach cleaning systems, the arrival of residues to the shoreline should be avoided in the first place, having more robust systems to avoid the escape of fish and provide infrastructure that ensures an efficient handling of massive mortality rate events.

Circular economy is without a doubt a practice that requires more development, there being an important number of companies that show progress in this matter. In the future, it will be fundamental to advance the different links of the productive and logistics chain. For example, in this regard R&D is fundamental in recyclable packaging, net and unused structures recycling, just to mention a few.

d) PRODUCTIVE SYSTEM INNOVATION

In a global context where its tendency is to increasingly reduce the space for the salmonid industry, it is fundamental to continue progressing on engineering research, high-tech and logistics development to use zones and areas increasingly more exposed and separated from the shoreline (off-shore aquaculture), considering new net cages designs, food supply systems and greater automatization and remote work, which will necessarily require a cultural change.

The development of closed floating system units (ships with cages and water recirculation) and ground based closed systems also constitute challenges and are increasingly projected, because they would allow the development of different productive stages – for example the pre-fattening and fattening – in said facilities. In fact, currently there are ground based stockpiles with tanks and recirculation systems. This technology is firmly settling in, which improves sanitary handling, is more eco-friendly and optimizes costs.

One of the most complex and important challenges for the Chilean industry is the aquaculture production concessions and the necessity to reorganize the location of cultivation facilities, on one hand, to make production more efficient (when and where to produce) and, on the other, the necessity of safeguarding the spaces defined as marine protected areas. In this regard, the government has noted that it will not allow new concessions or relocations within protected areas.

e) MARKETS

Global population growth includes a greater demand for healthy food; thus, the demand for aquaculture industry products will also rise. The Chilean aquaculture industry has understood this opportunity and has been gradually adapting to this challenge, adding new technologies, R&D and better environmental practices.

The Chilean salmonid aquaculture industry must continue the search to create greater trust with international consumers, through the recognition of the Chilean product's quality abroad, the commercial opening to other countries in the world, the changes in alimentary tendencies and the rise of countries' per capita income, among others.

f) RELATIONSHIP WITH COMMUNITIES

Another important challenge within the national aquaculture industry is the establishment of strong links with communities in different territories, a relationship based on trust and transparency and the access to information that accounts for the compliance of the companies' sanitary and environmental compromises. In this regard, it is important to continue prevention and trash removal on beaches, the maintenance of sea bed cleaning and keeping the production levels in balance with the environment, among others.

Furthermore, the creation of specialized human capital will continue to be a permanent challenge that must be addressed both by the Chilean academy and the very industry.

Thus, it is key to incorporate more capacities for the strengthening of social capital, which would build trust, a sense of community, transparency and collaboration between the aquaculture industry and national and local authorities, political actors and, above all, local communities.

g) New standard in process

In matters of new legislation, there are new standards in process that establish new conditions for the activity exercise, in work, production and environmental spheres, in accordance with the following:

BULLETIN No.13194-21 No.9.404-12 MESSAGE FROM THE PRESIDENT OF THE REPUBLIC BY WHICH THE BIODIVERSITY AND PROTECTED WILDLIFE AREAS SERVICE IS CREATED.

This projects' general idea is to create a new government agency - called Biodiversity and Protected Wildlife Areas Service (SBAP for its acronym in Spanish) - which would be in charge of the biological diversity conservation and the country's natural heritage protection, through the preservation, restoration and sustainable usage of genes, species and ecosystems.

Among the functions that this Service will be in charge of, one is managing the Protected Wildlife Areas National System, which will comprise 6 production categories, namely:

- Virgin Region Reserve
- National Park
- Natural Monument
- National Reserve
- Conservation Area of Multiple Uses
- Indigenous Community Conservation Area

In agreement with the project, the categories have different protection objectives, from strict preservation - for example, the ban of any economic activity - up to conservation - sustainable economic activities would be permitted. Thus, for example, a National Park is defined as an area whose objective is preservation, meanwhile, a National Reserve and a Conservation Area of Multiple Uses, are defined as conservation areas.

One of the big discussions that have been raised in Congress during the process of this bill has to do with the possibility of the development of the aquaculture of salmonids within protected areas, regardless of its category and its protection objective.

BULLETIN 12634-12 BILL THAT ESTABLISHES ENVIRONMENTAL AND CLIMATE CHANGE ADAPTABILITY STANDARDS FOR AQUACULTURE ACTIVITY (RECAST WITH BILL BULLETIN 12.605-21)

In aquaculture matters, the bill modifies the mandatory distances between production centers and protected areas, and also prohibiting the concession of salmonids on ancestral indigenous communities' territories, and the renewal of concessions in the Magallanes Region. It also establishes 10 year duration for concessions, which are renewable for

the same amount of time, unless there are 2 Negative Infas or expiration grounds. If there is 1 Negative Infa, the validity of the RCA will be reviewed.

The bill toughens the expiration grounds from environmental and/or sanitary non-compliance infractions and removes the possibility of using land portions comprised of national and forestry reserves to complement maritime aquaculture activities.

BULLETIN No.13194-21 BILL WHOSE OBJECTIVE IS TO ESTABLISH THE AQUACULTURE AND FISHING COMPANY'S OBLIGATION TO REMOVE FROM THE OPERATIONS PLANT EVERY RESIDUE COMPRISED OF PLASTIC AND OTHER POLYMERS DISCARDED BY THEIR INDUSTRIAL ACTIVITY.

This bill aims to establish the company's obligation to remove residues comprised of plastic and other polymers derived from industry process from territorial sea up to the end of the continental platform, as an upgrade in matters of social responsibility that industries should have. The obligation falls on those national or international companies that practice fishing and aquaculture activities from the fifth mile closest to the shoreline towards the Pacific Ocean, who shall

1. Remove the residues generated by human industrial processes on the sea from the territorial sea up to the end of the continental platform.

2. Practice residue extraction and extend it until the end of the continental platform.

BULLETIN No.14.667-21 BILL THAT AIMS TO MODIFY THE FISHING AND AQUACULTURE GENERAL LAW IN THE MATTER OF ECONOMIC AND SOCIAL SUSTAINABILITY FOR THE FISHING AND AQUACULTURE ACTIVITY AND FOR THE DEVELOPMENT OF SUSTAINABLE ALIMENTARY VALUE CHAINS, AMONG OTHER MATTERS.

This bill aims to add to the LGPA objectives the economic and social sustainability of the fishing and aquaculture industry. Also, it adds among the elements and principles to consider when taking measures, interpreting and applying the LGPA:

- the principle of Alimentary Safety and Alimentary Value Chain, as the State shall secure the population's food supply, satisfying the present and future generations' alimentary needs

- a principle that demands considering different realities and interest of macrozones, with particular attention on special territories and extreme and isolated zones, encouraging decision making on a regional level;

- and one that forces to minimize, within the realms of possibility, the economic and social impact which the policies and measures taken have on the fishing and aquaculture industry workers - including those of the extractive and processing industry, as those of artisanal fishing - as well as other involved industries in the value chain.

Lastly, it adds to the LGPA definitions that help visualize the on-board and industry related processing plant personnel as fishing industry workers, extractive fishing industry workers, processing industry workers and aquaculture industry workers.

5. SUB-SECTOR IDENTIFICATION

5.1. Equipment, Technologies and Services for Salmon Farming

Salmon farming is a productive activity that involves a complex and diverse system of support activities that play a valuable role in the different stages of the industry's value chain in the freshwater, seawater, processing and

commercialization phases, constituting a network of suppliers which in turn create a productive cluster with great local impact.[32]

Regarding the current supply of services, it is possible to group them into nutrition, animal health, genetics, specialized engineering, logistics, center management and environmental management, of which 50% of production costs are explained by the supply of feed, with a second relevant cost being that of pharmaceuticals and genetics. In this last section, it is worth highlighting the relevance of the pharmaceutical aspect due to the need of efficiently treating bacterial diseases, as is the case of SRS.

As for the main players in the industry, in the provision of feed, Cargill Chile (formerly EWOS) of North American capitals, Biomar Chile of Danish capitals, Salmofood (acquired in 2012 by the Peruvian company Alicorp) and Skretting Chile of Danish capitals stand out. In addition to the above, there are two salmon producing companies that produce their own feed, namely Salmones Antártica and Aquachile.

In the area of health and genetics, there are two types of suppliers, local and those linked to multinationals. Local suppliers include ADL Diagnostic Chile, a diagnostic, biotechnology and genetics laboratory, Plancton Andino, an environmental consulting and laboratory company, and Veterquimica, a pharmaceutical laboratory. Other laboratories and companies in the area of animal health and genetics with a global presence in the local market include Aquapharma Chile, which develops and offers disease prevention and control systems, a company with presence in Norway, Canada, Chile, Australia, the United States and Europe; Europharma, a veterinary products company of Norwegian capital; DSM nutritional products; Pharmaqarma Chile, a veterinary products company of Norwegian capital; DSM nutritional products; Pharmaqarma Chile, a veterinary products company of Norwegian capital; DSM nutritional products; Pharmaq Chile, a subsidiary of Pharmaq Norway; ELANCO (of North American capitals); FAV, a company belonging to the Abbott Group of North American capitals; Virbac Centrovet, a multinational of French origin; Intervet, veterinary pharmaceutical division of Merck laboratory of German origin; Hendrix Genetics, of Dutch capitals and the Blue Genomics Chile consortium, of Norwegian capitals.

It is possible to recognize in the ISA virus event of 2007, a turning point in terms of requirements for new suppliers, a phenomenon that generated a new production model, with new regulations and new standards, which have required to be accompanied by new services. This is especially true for biosecurity, logistics and veterinary services, related to the development of new diagnostic systems, development of pharmaceutical products, mainly aimed at the control of caligidosis and the development of new vaccines against endemic diseases (BKD, SRS) and for emerging diseases such as tenacibaculum and amoeba (gill disease), among others. These areas offer a niche for new solution providers.

In relation to services, the development of functional diets is contemplated, not only associated to better growth, but also to generate better capacities for disease resistance, a situation that is also seen as an opportunity for new developments.

On the other hand, higher costs faced by domestic producers compared to their Norwegian competitors[33], makes it necessary to generate improvements in those aspects related to production efficiency through the application of technology in the different stages of the value chain, either process automation in fattening centers, such as automatic feeding and incorporation of artificial intelligence, and in processing plants the incorporation of robotics to improve the standards of the final product, filleting and packaging or other solutions to increase productivity and reduce costs. Automation and centralization of remote feeding tasks and technology for this purpose are areas of interest to be explored by new suppliers.

[32] FIPA 2017-17

[33] This situation could be explained by higher food expenses, use of antibiotics, higher labor intensity, higher transportation costs due to the geographical complexities associated with the expansion of the production frontier towards regions XI and XII.

In the development of new diets, several initiatives have arisen to replace animal protein with vegetable protein, some of these companies have incorporated canola oil of national origin and imported from Canada[34]. The need for new inputs in terms of fish feed remains unsatisfied, and there are some developments that are worth noting, like protein based on insects and other innovations.

Despite having a wide range of laboratories, the sanitary situation of the national salmon industry[35] highlights the important challenge of improving the supply of therapeutic tools, both for freshwater and marine diseases, particularly in relation to prevalent and emerging diseases, in order to have more options for treatment and prevention.

The development of new products is also key for the control of caligidosis, as there are a series of products that have been developed against this parasite which have been decreasing their effectiveness rapidly, as a result of the generation of resistance to the active principles, making them obsolete. Also the appearance of new treatments in the market with non-pharmacological methods such as systems for the treatment of caligidosis, have an important growth potential, even more so considering eventual restrictions that the authority can establish to the realization of baths under the system of tarpaulins, currently of greater use, due to the environmental risks of this current modality.

The treatment of this parasite is clearly an opportunity for new suppliers, both in the development of new active ingredients and in the incorporation of non-therapeutic and mechanical treatments against caligus, as well as the incorporation of a greater number of vessels that can perform the treatments on board, particularly considering the greater environmental restrictions that are expected to be applied to salmon farming.

In terms of logistics, one of the services in greatest demand is the transfer of smolt and live fish[36], performed by the wellboat fleet in the southern area of Chile, which is made up of around 22 companies with 59 vessels registered with SERNAPESCA[37], a large number of which are organized under the Asociación de Armadores de Transporte Marítimo Sur Austral (ARMASUR AG).[38]

Additionally, 23 FISH boats are registered.

In this regard, one area of growth will be the production of smolt in the Magallanes region, which today is mainly supplied by the Los Lagos and Araucanía regions, with important risks from a sanitary and product quality standpoint.

Eggs are currently imported from Iceland and in 2021 the figure reached 159,000 eggs, and in 2022 no salmonid eggs were imported.

The wellboat service is constantly evolving and there is an important niche for suppliers to develop new capacities, namely, larger scale, environmentally friendly technology, techniques to protect against the spread of FAN by displacement of the fleet, vessels prepared for adverse weather conditions, improvements in loading and unloading systems, and demand for on-board therapeutic treatments.

In addition to the above, it is necessary to face some productive challenges that have arisen with the new norm and the new standards, such as the treatment of mortalities, both in normal conditions and in the event of massive mortalities, where the issue of their management and final disposal constitutes a bottleneck of complex resolution, as well as improving the capacity of the mortalities treatment equipment (silos, crushing, suction and silo storage).

The development of technology for real time monitoring of environmental conditions, work for bottom recovery, technology for the development of farming in exposed areas (offshore), thus expanding the production frontier, and

[34] Source: National Customs Service

[35] Sernapesca,Salmon farming sanitary report in marine centers, 2023

[36] Smolts to fattening centers and live fish to processing plants.

[37] http://www.sernapesca.cl/sites/default/files/naves_prestadoras_de_servicios_de_acuicultura_20200213.pdf

[38] www.armasur.cl

technology and solutions for interaction with marine mammals should also be considered as a pending gap to be solved.

5.2 Equipment, Technologies and Services for Mussel Farming[39]

The farming of Chilean mussels is comprised of an industrial network of 620 companies that manage a total of 1,115 aquaculture concessions, dedicated to seed collection and fattening, 89% of which are medium and small companies[40], which account for between 40% and 50% of production, with the differential being attributable to large companies that use their production to supply meat to their own processing plants.

The value chain of the Chilean mussel industry includes activities of seed collection[41], fattening, processing and marketing for final destination to the external market or, to a lesser extent, for domestic consumption.[42]

A wide range of companies operate in its various stages, supplying various goods and services, non-specific companies for some services such as maritime and land transport, boats and engines; and others more specialized and of low sophistication such as suppliers of seeds in bulk or in collectors, provided by artisanal fishermen or small-scale producers.[43]

The Chilean mussel industry presents development asymmetries between small and medium-sized producers with respect to large-scale producers. This is mainly related to the quality of the raw material, measured according to the standardization of the caliber of intermediate products (seeds) and final products (raw material to plant), the percentage of accompanying fauna and yields, characteristics that can be managed through the provision of adequate mechanization of the processes.

In this sense, there are local companies that provide machinery for the different tasks that occur in the planting and harvesting stage, namely, calibrating or sieving machine, sowing machine, harvesting machine and davits and winches to support the maneuvering on board the work rafts. In this area, ACEROS TECSUR is mentioned as a reference supplier.[44]

Regarding the demand for these technologies, it should be noted that 90% of the producers are small and medium-sized, of which an estimated 50% have mechanization; therefore, it is desirable to advance in the medium term in a greater coverage, constituting an opportunity for new suppliers.

The industry also demands environmental services related to the Bivalve Mollusc Sanitary Program (PSMB[45] for its acronym in Spanish), control and monitoring of heavy metals, and the collection and management of information to efficiently determine the carrying capacity of the bays in which the activity is performed. In relation to PSMB, the current supply adequately meets the needs of producers[46], with a total of 14 laboratories registered with SERNAPESCA, 4 of which are present in the Los Lagos region, namely LAMAR ASOCIADOS LTDA, PLANCTON ANDINO Spa, UACH CERAM and UCHILE, Marine Toxins Laboratory.

---

[39] Chilean mussel

[40] http://www.mejillondechile.cl/industria/

[41] Mytiliculture in Chile is developed from the environmental supply of seeds in the so-called natural catchment areas, which correspond to sectors during the summer - autumn months, when there is a high amount of larvae in the water column.

[42] "Análisis cadena de valor de la industria del chorito desde el ámbito de la innovación tecnológica, investigación, emprendimiento y gestión del conocimiento", Pizarro, L.;2008

[43] The collection of Chilean mussel seed is regulated through the granting of permits of little importance that until now were renewed annually, a situation that was modified by Law 21.183 of 2019, which states that the granting of these permits shall be for a duration of 10 years.

[44] www.acerostecsur.cl

[45] Bivalve Mollusks Sanitary Program

[46] http://www.sernapesca.cl/sites/default/files/entidades_de_analisis_20200303v2.pdf

There are also other inputs, such as buoys and floats, with WENCO, AUSTRAL PLASTIC and POLYCHEM as suppliers, and cotton ropes and beams, the latter supplied by the national company TIPY TOWN; it is estimated that the current supply covers requirements.

Finally, in the processing plant stage, there are a series of non-specific activities related to the provision of inputs, processing equipment and technologies, sanitary, containers, packaging, load maintenance, certification, diagnostics, and laboratories, in accordance with the standards required by the destination markets, similar to the requirements of the salmon farming industry and seafood products in general.

This activity has not been exempt from problems since its extensive farming condition makes it very vulnerable to environmental fluctuations, such as what happened in 2010 with the shortage of natural feed and the lack of seed in 2012 and 2013 and also the Harmful Algal Blooms (HAB) in 2016.

In this framework, and in particular in gaps within the technological field, there are spaces in which there are shortcomings and needs for improvement in the provision of services for mytilidae aquaculture, that is, technologies for the professionalization of productive activities and the management of companies, essentially micro SMEs and small producers, for seed collection and fattening work, for caliber control, for the safety of fattening centers, for the automation of processes in processing plants, for the development of new products, for the determination of biomass in water, for the study of diseases and epidemiology, environmentally friendly technologies, information and communication technologies and the need to incorporate environmental monitoring of the environment and of natural banks, of carrying capacity and yields by zones.

Equipment for remote and low-cost monitoring of environmental variables constitutes an opportunity in this industry for monitoring phytoplankton, temperature, salinity and eventually detection of marine toxin-producing algae species.

5.3. Other farming

According to official information for the year 2022[47], a total of 22 resources were harvested, however 98% of the production was explained by the harvesting of salmonids and Chilean mussel, the remaining 2% being mainly explained by pelillo seaweed, red abalone and northern oyster. These figures indicate that in terms of volume, the activity in Chile is still very much concentrated and far from achieving diversification.

Regardless of the smaller scale of farming of other resources, these activities present opportunities for service providers, as follows:

For pelillo seaweed, diagnostic studies flag as gaps the insurance of the production process, to have technology for drying that allows to meet the required moisture standards, as well as to have a product free of impurities.

Similarly, the quality of the algae has reached a critical state in terms of its genetic variability. This puts at risk the species' capacity to adapt to climate change, uses of the coastal border, pollution, introduction of pathogens and other pests[48], which is why applied research in this area is identified as an opportunity to be explored.

Regarding abalones, it is necessary to advance in solutions to address the uncertainty in the access to a stable natural source of feed that sustains farming throughout the year, a situation that occurs due to the seasonality presented by the natural meadows of algae and the variability of the quality of it.

On the other hand, the aging genetic pool of this resource has also been reported as a gap for the development of abalone aquaculture.

[47] SERNAPESCA statistics.

[48] http://chileesmar.cl/articulos-cientificos/el-pelillo-gracilaria-chilensis-alga-de-importancia-economica-en-chile-en-posible-peligro-de-extincion/

As for the northern oyster activity, it offers opportunities for new service providers to solve the lack of information on the environmental factors that condition seed collection.

5.4 Other subsectors that present secondary or incipient opportunities to Norwegian suppliers.

In the area of fishing and aquaculture, a number of areas are identified in which opportunities are perceived, some of which are cross-cutting in scope for both subsectors, as follows:

1. Seaweed and human consumption. The low consumption of seafood products in Chile, the need to improve the diet of the population, and the idea of adding greater value to the supply of raw materials from artisanal fishing, are factors that have made it necessary to implement a national policy to increase human consumption, with algae as an outstanding alternative for its availability and nutritional richness; therefore, the development of new foods based on this resource is an opportunity to be explored.

2. Technology for processing plants. Fish processing plants face the challenges of modernity and new production and environmental standards, where waste treatment and operation based on clean energy generation are issues to be addressed.

3. Desalination plants to provide drinking water to rural fishing coves. One of the barriers for incorporating small-scale fishing into productive diversification models is access to drinking water, a situation that is being addressed by installing desalination plants in rural coves, which have had very good results. 467 fishing coves in Chile are subject to state support for financing these initiatives through the Institute for the Development of Artisanal Fishing and Small-Scale Aquaculture (INDESPA for its acronym in Spanish)[49], a development investment program.

4. A total of 82 types of aquaculture waste have been identified[50], and a pending task is to generate the capacity for their adequate treatment and use, within the framework of what has been called the Circular Economy.

6. KEY CONTACTS ON PRIVATE AND PUBLIC SECTOR

Government Contacts	Private sector contacts
Fisheries and Aquaculture Undersecretary Fisheries and Aquaculture Undersecretariat Contact: Sr. Julio Salas Gutierrez E-mail: oirs@subpesca.cl www.subpesca.cl	Asociación de la Industria del Salmón de Chile A.G. Contact: President Mr. Arturo Clement. E-mail: aclement@salmonchile.cl www.salmonchile.cl
Fisheries and Aquaculture National Director Fisheries and Aquaculture National Service Contact: Sra. Soledad Tapia Almonacid E-mail: informaciones@sernapesca.cl	Asociación de Mitilicultores de Chile A.G. Contact: Mrs. Yohana González. Chief Executive Officer (CEO) E-mail: gerente@amichile.com www.amichile.com

[49] https://www.subpesca.cl/sitioprensa/614/w3-propertyvalue-61677.html
[50] Fipa 2016-69

www.sernapesca.cl	
Aquaculture Division Head Fisheries and Aquaculture Undersecretariat Contact: Benjamin Eyzaguirre Delreal E-mail: oirs@subpesca.cl Internet: http://www.subpesca.cl	Asociación de Salmonicultores de Magallanes A.G. Contact: Mr. Carlos Odebret. Chief Executive Officer (CEO) E-mail: contacto@salmonicultoresmagallanes.cl
Aquaculture deputy director Fisheries and Aquaculture National Service Contact:	Asociación Gremial de Procesadores y Productores de Algas Marinas, COPRAM A.G. Contact: Mr. René Pientini. President. E-mail: copram.ag@gmail.com www.copram.cl
National Institute of Sustainable Development of Artisanal Fishing and small-scale Fishing (INDESPA). Contact: Sr. Leonardo Llanos	Asociación de Armadores de Transporte Marítimo Sur Austral. ARMASUR AG Contact: Mr. Manuel Bagnara. Chief Executive Officer (CEO) www.armasur.cl
Programa Estratégico Regional Industria de la Mitilicultura. Programa CORFO. Contact: Gerente General. Sr. Javier Aros Durán www.mejillondechile.cl	Aquachile Contact: Mr. Sady Delgado. Chief Executive Officer (CEO) E-mail: sady.delgado@aquachile.com www.aquachile.com
Interdisciplinary Center for Aquaculture Research (INCAR) Contact: Sr. Renato Quiñones. Director E.mail: rquinone@udec.cl www.incar.cl	Australis Seafoods S.A. Contact: Mr. Andrés Lyon.Chief Executive Officer (CEO) www. http://www.australis-seafoods.com

	CERMAQ Contact: Mr. Pedro Courard. Chief Executive Officer (CEO) E-mail: pedro.courard@cermaq.com www.cermaq.com
	Consejo del Salmon Contact: Mrs. Loreto Seguel E-mail: loreto.seguel@consejodelsalmon.cl www.consejodelsalmon.cl
	Mowi Contact: Mr. Fernando Villarroel. Chief Executive Officer (CEO) E-mail: Fernando.villarroel@mowi.cl www.mowi.com
	NOVA AUSTRAL Contact: Mr. Javier Herrera. Production Manager. E-mail: Javier.herrera@novaustral.cl www.nova-austral.cl
	Salmones Antartica Contact: Mr. Claudio Lara www.salmonesantartica.cl
	Salmones Aysen Contact: Mr. Pablo Baraona. Chief Executive Officer (CEO) E-mail: pablobaraona@proexport.cl www.salmonesaysen.cl
	Salmones Blumar

	Contact: Mr. Gerardo Balbontin. Chief Executive Officer (CEO) E-mail: Gerardo.balbontin@blumar.com www.blumar.com
	Salmones Camanchaca Contact: Mr. Ricardo Garcia www.camanchaca.cl
	Salmones Multiexport Contact: Mr. Cristian Swett www.multiexportfoods.com
	Ventisqueros Contact: Mr. Jose Luis Vial Chief Executive Officer (CEO) www.ventisqueros.cl
	Cultivos Toralla Contact: Mr. Sergio Leiro. Chief Executive Officer (CEO) E-mail: sergioleiro@toralla.cl www.toralla.cl
	Blue shell Contact: Mrs. Monica Sepulveda. Plant Manager E-mail: msepulveda@blueshell.cl Mr. Cristobal Salinas. Gerente Zonal E-mail: csalinas@blueshell.cl www.blueshell.cl
	Camanchaca Cultivos Sur Contact: Mr.Luis García Huidobro E-mail: lgarcia@camanchaca.cl

	www.camanchaca.cl
	Landes mussels S.A Contact: Mr. Andres Fosk. Chief Executive Officer (CEO) E-mail: afosk@landes.cl Mr. Aldo Soldano. Operations Manager E-mail: asoldano@landes.cl www.landes.cl
	St Andrews Contact: Mr. Felix Howards E-mail: felix@standrews.cl www.
	Sudmaris Chile S.A Contact: Mr. Rodrigo Rosales E-mail: rrosales@sudmaris.com www.sudmaris.com

7. ANNEXES

Annex 1 a) Farming centers registered in the Chilean National Aquaculture Registry, Chile 2022

Area	Algae	Molluscs	Fish	Others
Northern Zone (Arica Parinacota - Coquimbo)	63	111	35	20
Central-southern Zone (Valparaíso - La Araucanía)	13	81	189	10
Southern Zone (Los Ríos - Magallanes)	833	1,220	1,563	16
Total	**909**	**1,412**	**1,787**	**46**

Source: SERNAPESCA. There are centers that have more than one group of species authorized

Annex 1 b) Harvesting main resources, Chile 2022.

Species	Tonnes
Atlantic salmon	758,953
Pacific salmon	241,904
Rainbow trout	73,315

Chilean mussel	427,084
Peruvian scallop	3,465
Red abalone	1,135
Pelillo	13,406
Others	4,914
Total	1,524,176

Source: SERNAPESCA

Annex 1 c) Production lines with operation registered in 2022.

Area	All lines	Human Consumption
Northern Zone (Arica Parinacota - Coquimbo)	294	51
Central-southern Zone (Valparaíso - Los Ríos)	355	268
Southern austral Zone (Los Lagos - Magallanes)	377	347
Total	1,026	666

Source: SERNAPESCA

Annex 2: list of diseases of the salmonid group in force in Chile.

FISH LIST 2	
DISEASE	**ETIOLOGICAL AGENT**
Infection with HPR0 variants and other infectious salmon anemia virus HPR	ISA *Orthomyxovirus* Virus
Infectious pancreatic necrosis	Infectious pancreatic necrosis virus
Piscirickettsiosis	*Piscirickettsia salmonis*
Renibacteriosis	*Renibacterium salmoninarum*
Caligidosis	*Caligus rogercresseyi*

FISH LIST 3	
DISEASE	**ETIOLOGICAL AGENT**
Streptococcosis	*Streptococcus phocae*
Flavobacteriosis	*Flavobacterium psychrophilum*
Atypical Furunculosis	Atypical *Aeromona salmonicida* atypical
Vibriosis	*Vibrio ordalii*; *Listonella anguillarum*

FISH LIST 1	
DISEASE	**ETIOLOGICAL AGENT**
Epizootic haematopoietic necrosis	Epizootic haematopoietic necrosis virus
Infectious hematopoietic necrosis	Infectious hematopoietic necrosis virus
Viral haemorrhagic septicaemia	Viral haemorrhagic septicaemia virus
Spring viraemia of carp	Spring viraemia of carp virus
Infection with *Gyrodactylus salaris*	*Gyrodactylus salaris*
Red sea bream iridoviral disease	Red sea bream iridovirus
Infection with salmonid alphavirus	Salmonid Alphavirus (SAV)
Koi herpesvirus disease	Koi Herpesvirus
Epizootic Ulcerative Syndrome	*Aphanomyces invadans oomicetos*
Infection with *Totivirus*	*Totiviridae* virus family
Amoebic gill disease	*Neoparamoeba perurans*
Haemorrhagic smolt syndrome	(Unidentified, under investigation)
Infection with *Piscine reovirus*	*Piscine reovirus*
Tenacibaculosis	*Tenacibaculum sp.*

Source: SUBPESCA

Annex 3: productive regimes in the Los Lagos and Aysén regions

Productive period 21+3, 1 productive cycle																										
2023												2024												2025		
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Month			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			

Productive period 21+3, 2 productive cycles																										
2023												2024												2025		
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Month			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			

Productive period 24+3, 1 productive cycle

2023												2024												2025					
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Month			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			

Productive period 24+3, 2 productive cycles																													
2023												2024												2025					
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Month			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			

Source: own elaboration

Where:

- Seeding.
- Harvesting.
- ACS coordinated sanitary break.