Salmon farming in southern Chile has its origins in fishing companies and entrepreneurs who were looking for a new market outside the purse-seine/trawl fishery that boomed in the late 1970s and 1980s, in a way similar to the activity in Norway, Iceland, Scotland, and Japan. These fishing and fish farming activities uncovered the beautiful scenery surrounding the fish farms—locations boasting natural beauty and minimal human intervention, which help to promote tourism in these regions. In Chile, the fishing and fish farming centers are in the southern part of the country, from the Los Lagos region to the Magallanes region, a vast and wild area of islands and channels that are covered in virgin forests and feature a great variety of marine life. The varieties of salmon that are cultivated—Atlantic salmon, Coho, and so forth—are defined by the Asian, Mediterranean, and North American markets to which the product is exported.
The live fish transfer operations in Chile started during the 1990s, accomplished by one of two methods. The first is by the use of common fishing vessels equipped with nets and cranes, stored inside their fish tanks with water circulation pumps equipped only with oxygen sensors for monitoring. The second method was called liftup, or “jota,” a fish lifting method used in Spain, which consists of the towing of the complete fish farm cage to the processing plant and then discharging it via lifting and overflowing the cage nets using cranes.

Later, in the mid 2000s, Asenav Shipyard in Valdivia was the first shipyard in Chile to use its own design and Norwegian technology to build wellboats, including one that, at the time (around 2007), was considered the largest wellboat in operation, M/V Patagon IV. Smaller shipyards, such as the La Peninsula and Detroit shipyards in Puerto Montt, followed by building smaller wellboats around 2007.

Lately, several Chilean maritime shipping companies have contracted shipyards in China to build new wellboats using the designs and the oversight of Chilean engineering companies such as such as Consultoria Naval Maritima Ltda. as owner’s representatives. The current trend is to build boats of higher capacity, with holds between 1,900 and 4,000 m³ and greater autonomy. These include enclosed hold systems; oxygen generators; refrigerated sea water systems; mobile bulkheads; ultraviolet sanitizing systems; rotating filters; complete monitoring systems; vacuum-pressure loading and unloading systems; and specialized equipment to treat the Caligus family of parasites.

Chilean regulations do not allow the operation of fish factory vessels on inland waters like the ones south of the Puerto Montt areas due to the potential of contamination that this type of vessel implies in an area of such environmental fragile balance. Therefore, the future trend in wellboats and fish farming operation is to build or modify ships that will kill the fish during the transfer from the farm cage to the vessel and then proceed to the transport of the fish in liquid ice-cooled tanks, or in bins on barges, to the processing centers.

The first process plant in the Los Lagos region was in Chiquihue, Puerto Montt, and it was the property of the Santa Cruz Company. Later, this company began to transform low-tonnage purse seiners into live fish carriers or wellboats, installing vacuum pressure pumps that were used for loading and unloading fish. These vessels had a video system in the fish tank for counting and monitoring fish inside the holds, water recirculation pumps, and monitoring of variables such as oxygen and fish mortality. These major modifications were carried out in such Chilean shipyards as Asenav, ASMAR, and MARCO Chilena in the late 1990s and early 2000s.

First of their type
At the beginning of 2000, major modifications were made to two purse seiners that were the property of Camanchaca Fishing Company. Camanchaca used Norwegian technology to transform these two first vessels into wellboats at ASMAR Shipyard in Talcahuano. These two wellboats were the first of their type in the world equipped with refrigerated sea water systems and totally enclosed holds, features that allowed the transport of three times the density of fish per m³ than other wellboats operating in the region.

These vessels include accommodations and feeding holds and equipment for nursery and grow-out centers. Salmex 12 feeding vessel.
There are three areas where fish farms are located in Chile. Each of these areas has its own spawning centers, nursery centers, grow-out centers (where fish grow to maturity), and processing plants: continental Chile and the island of Chiloe; South of the Corcovado Gulf to the Chacabuco port; and South of the Penas Gulf to Tierra del Fuego.

**Port and public infrastructure**

Unlike Norway, Scotland, Iceland, or Japan, Chile lacks any public and maritime infrastructure in the fishing areas, especially in the south insular area, south of the Los Lagos region. This lack of infrastructure has led local and foreign companies financing salmon farming and processing projects in the country to include the development of maritime infrastructure such as port offices; control and habitability centers; logistics systems to transport fish; food and personnel for the spawning centers; nursery centers; grow-out centers; and processing plants. This investment has resulted in great development for the Chilean southern region, leading to the migration of inhabitants from the Bio-Bio, Araucanía, Los Rios, and northern Lagos regions.

The mainland infrastructure of southern Chile remains deficient, showing a lack of encouragement from government public investments to improve the design of local connectivity by means of efficient ports, roads, and airports. This continues to be a major impediment for the development of this region. An example of this is the fact that all salmon delivery terminals on Chiloe Island and Puerto Montt for live or slaughtered fish have been developed, designed, and built by salmon farming companies or individuals with private piers or remote pumping systems close to the location of the processing plants.

In the late 1990s, the design of the processing plants required by the operation of the fish farming process was a technological challenge that was overcome with the assistance of foreign companies. The success in this area enabled Chile to become an important player in the global salmon market.

Chilean law does not allow owning or operating factory fishing vessels in Chilean jurisdictional waters; it allows only the slaughter process via gill cutting. The logistics and the design of special-purpose ships are of vital importance, because the nursery and grow-out centers are not located close to the processing plants. The situation is worse in the region of Aysén and Magallanes, due to a lack of access, port infrastructure, and public roads.
The main issue with them is the lack of comfort for the personnel onboard, an issue that is starting to be addressed and needs to be solved by owners and investors in the future.

The transportation of food to the nursery and grow-out centers in the form of pellets has been achieved mostly by the conversion of old and decommissioned fishing vessels. These are modified with dry holds and compressed air-operated feeding equipment, also used in second-hand merchant ships and ferries, specially modified and adapted for food pellets cargo but also operated as passenger vessels used for local tourism. The tourism market has been developed in the routes where these ships operate and in the vicinities of the fish farming grounds.

These two wellboats were the first of their type in the world equipped with refrigerated sea water systems and totally enclosed holds.

The fish transportation from nursery and grow-out centers is achieved via live fish carriers or wellboats. These ships are merchant ships with fish tanks specially designed to transport live fish. Originally, these vessels were not equipped with refrigeration, recirculation, or seawater treatment. But as the designs evolved, these and other systems and improvements were included, such as the treatment of seawater in fish tanks as a way to prevent to prevent the spread of salmon ISA virus, a kind of anemia that affects salmon but which is not transmitted to humans. Two types of fish tanks are currently in operation on wellboats operating in Chile. One tank system is designed for a circular flow of water inside a circular fish tank, and the second is designed around a longitudinal flow of water inside the holds. These system maintain a constant flow of water inside the tank, circular or longitudinal, to keep the fish swimming against the water flow. Wellboats have a common load/unload system for cargo handling via pressurizing or depressurizing the hold and this is used on the fish farm to load the fish onto the hold and unload the fish at the processing plants.

Transportation to and from these areas is made by air, sea transport, or by long and difficult trips by bus. This requires traveling through Argentina to reach destinations such as Puerto Chacabuco, Puerto Natales, or Punta Arenas. The maritime transport has been developed to a small extent by private companies that have increased the number of ferries and barges for mixed ro-ro cargo transport and passengers. This is still deficient due to the lack of fast and efficient ferries, which demand suitable ports.

The maritime transportation system for the transport of the fish and other process products from the nursery and grow-out centers is a problem that must be solved. The same applies to the maritime transportation of personnel and provisions for these centers.

**Small craft for personnel**
The smaller Chilean shipyards and local naval architects and engineers have designed all kinds of small boats to transport 15 to 30 passengers, but the major issue—yet to be resolved—is the safety and comfort of the passengers transported. This is related to the restrictive current tonnage system used in Chile. Compared to European tonnage regulations, tonnage is 50% higher than the one allowed by Chilean regulations, meaning the vessels in Chile are to be larger than European vessels of the same tonnage. With this in mind, ships designed in Chile cannot be designed using the International Maritime Organization regulations for minor vessels, which is in common usage in Europe. This creates a clear disadvantage and an increase in costs for local maritime transport.

Since the early 2000s, several local shipyards, such as Ascon-Detroit-Sitencia and others in Puerto Montt, have specialized in the design and construction of two types of habitable barges for the isolated nursery and grow-out centers. These barges are mostly made of steel and fibrocement.
The vessels’ navigation track is another important issue to consider for this operation, as it needs to be as smooth as possible to allow a better quality product and the automation of the whole process, which enables lower costs.

**Harvest ships**

Several vessels are specialized for salmon harvesting and processing onboard, including processes such as gill cutting. Salmon are harvested via vacuum from the fish farm cages, pass through a fish stunner or directly to the gill cutting station performed by hand, and are then transported to refrigerated fish tanks for their transfer via barges to inland processing centers.

As in other maritime sectors, the fish farming industry requires the use of smaller auxiliary vessels—for example, to transport fry (small fish that have developed to the point where they are capable of feeding by themselves) in glass reinforced plastic containers, called bins. These bins are usually 1 m³ capacity and are carried from the nursery centers to the grow-out centers. In Chile, this process is used for centers near the island of Chiloe or in the vicinity of Puerto Montt, where the largest process plants are located. Small wellboats, small ferries, and small deck cargo barge trains also are used in this process.

Crane vessels are also used. These move, clean, maintain, or repair the fish farms. These vessels also are used to carry small quantities of supplies such as fuel oil for small generators, food, or fresh water to personnel onsite at the fish farms.

Transport and tourism activities around the fish farming centers are being helped by the opening of new routes and small towns that subsist around the fish farming industry. This is the main motivator for the emerging tourism business in the area. The transport services operate with personnel from the fish farming operators, and these services are scheduled between Puerto Montt and Puerto Chacabuco, with the routes passing by smaller towns such as Melinka, Ayacara, and Puerto Aysén, among others. The port infrastructure is poor, but it is compensated for by landscape isolation and beautiful sightseeing on the marine route itself, and in smaller inland towns only accessible via air or via land through Argentina.

Hot spring tourism is another new activity in development in the area. Together with fly-fishing and adventure tourism in and around the glaciers of southern Chile, such as San Rafael Glacier, this is a new focus of hospitality and a source of income for locals.

**The shipyards**

A number of shipyards in Chile have built wellboats or modified fishing vessels into wellboats. These yards have used their own designs or have purchased designs from naval architecture design companies in Europe. Asenav Shipyard, located in Valdivia, Region de Los Rios, is the shipyard that has built more wellboats than any other yard in Chile, starting with a few modifications to purse seiners in the late 1990s. Detroit-Chile Shipyard is located in Puerto Montt, Region de los Lagos, and follows Asenav in the number of wellboats and feed barges built and operated in the grow-out centers. Ascon Shipyard also is located in Puerto Montt and is mainly focused on modifications from smaller fishing vessels into wellboats or feeder pontoons for grow-out centers.

MARCO Iquique was a shipyard subsidiary of MARCO Industries in Seattle, and is located in Iquique, Region de Iquique. It closed its doors for newbuilds in the early 2010s and currently is focused only on modifications or conversion from
fishing vessels into wellboats. ASMAR Shipyards is a state owned shipyard, located in Talcahuano, Region del Biobío. It is an important player in the sector as it has the dry dock capacity to maintain, modify, and repair the largest vessels of the Chilean fish farming fleet.

CNM.LTDA, located in Chiguayante, Region del Biobío, is an independent naval architecture design office with a portfolio of several wellboats, transport, and auxiliary smaller vessels for fish farming operations. Their wellboat designs have been built in China.

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