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GHOTI

WILEY FISH and FISHERIES

Is there a blue transition underway?

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Abstract

In this study, we describe what we term a *Blue Transition*, defined as the passage from fish biomass reduction to recovery in exploited aquatic resources, enabled by aquaculture. A *Blue Transition* is a key component of emergent "blue" discourses which support that the expansion of aquaculture would relieve pressure on declining capture fisheries, thus contributing to global food security, particularly of the poorest populations. Based on global secondary data and the case of Chile, we explore the evidence of such claim and the implications of a *Blue Transition* for fisheries and aquaculture development. In 2012, worldwide aquaculture production surpassed wild captures; nevertheless, such turnaround would have not taken place without China's contribution. In Chile, this turnaround occurred in 2014, concurrently with the lowest industrial landings registered since the 1960s (1,227,359 tons). Chile's aquaculture is not relieving wild fisheries or satisfying food demands of the lower income population, in the country or elsewhere. Salmon, the main aquaculture product, is destined mainly to Japan, Russia and United States where, due to its high prices, it is consumed mostly by wealthy consumers. For the case at hand, evidence suggests that a blue transition may be underway but is going in the wrong direction: from what may have been sustainable fisheries management before the 1970s to the overexploited wild fisheries of today.

KEYWORDS
aquaculture, blue growth, blue revolution, Chile, ecological modernization, fisheries governance

1 | INTRODUCTION

In 1990, Alexander Mather gave the name the Forest Transition for the passage from net forest biomass reduction to net forest biomass recovery (Mather, 1992). More than two decades later, another transition might allegedly be occurring, this time in the oceans, involving the passage from net fish biomass decline to net fish biomass recovery, enabled by aquaculture (Figure 1). We term this passage the *Blue Transition*.

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Etymology of Ghoti

George Bernard Shaw (1856–1950), polymath, playwright, Nobel prize winner, and the most prolific letter writer in history, was an advocate of English spelling reform. He was reportedly fond of pointing out its absurdities by proving that "fish" could be spelt "ghoti". That is: "gh" as in "rough", "o" as in "women" and "ti" as in palatial.

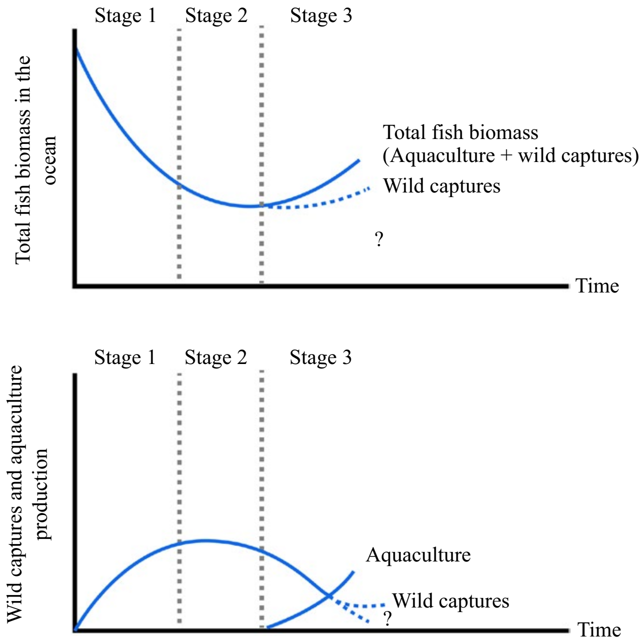

FIGURE 1 A hypothesized *Blue Transition*. Modified from the Forest Transition curve (Barbier, Burgess, & Grainger, 2010)

TABLE 1 Description of the four blue discourses

Aquaculture is frequently celebrated as the "Blue Revolution"— a key source of high-quality animal protein, essential to feed the growing human population in light of declining marine stocks (Bardach, 1997). As the Green Revolution before it, the Blue Revolution is often welcomed as a way to increase local income and expand the available supply of affordable food among the poor in the third world (Stonich & Bailey, 2000)
The "Blue Economy" concept aims at promoting economic growth, social inclusion, and the preservation or improvement of livelihoods, while at the same time ensuring environmental sustainability of oceans and coastal areas. Aquaculture is expected to help lessen the need for fish imports and increase employment, as well as contribute to food security and nutrition needs (World Bank and United Nations Department of Economic and Social Affairs, 2017)
FAO's "Blue Growth" emphasizes the ecosystem approach to capture fisheries and aquaculture, while embracing the promotion of sustainable livelihoods for coastal fishing communities, recognition and support for small-scale fisheries and aquaculture development, and fair access to trade, markets, social protection and decent work conditions along the fish value chain (FAO, 2016a, 2016b)
The concept of "Blue Carbon" was recently drawn into the Blue Economy discourse through reports from FAO and UNEP, among others (Nellemann et al., 2009), and has since been actively pushed for inclusion in the UN Climate Change Framework at the COPs 21 and 22 (Barbesgaard, 2018). Blue Carbon stresses that coastal ecosystems, through their ability to capture and store carbon, provide a major "service" in the fight against climate change—as they sequester carbon more quickly than terrestrial ecosystems (Campbell, Vermeulen, & Aggarwal, 2016)

The idea of transition emerges first in the context of Modernization Theory, which was the dominant development paradigm in the 1950s. More recent expressions of Modernization Theory are the Forest Transition, Ecological Modernization and the Environmental Kuznets Curve. A *Blue Transition* would share some common features with these propositions, specifically: (a) an understanding of transitions as changes that are smooth, incremental and unidirectional (there is no way back); (b) a focus on changes occurring over long time periods, from decades to centuries (Rostow, 1959); (c) a common tendency to universalism of transitions, ignoring subnational and local context; (d) an emphasis on explaining modernization, and specially the lack of it, as caused by factors endogenous to a country (e.g., Gross Domestic Product, GDP; land and agricultural markets); and (e) an emphasis on national policies, democratization, rationalization, urbanization, industrialization and population growth as hallmarks of development (Perz, 2007).

In turn, modernization ideas share common features with neoliberalism (Dore, 1997; Kothari & Minogue, 2002) regarding unilineal pathways and universalistic one-size fits all paradigms that ignore history, politics, culture and levels of social and economic equality. Above all, they share having promoted "hubristic development programs that have rarely met their stated goals and aims, and in many respects run counter to efforts towards liberalization and democratization" (Ellison & Pino, 2012 p. 36).

The idea of a *Blue Transition* is indeed a pillar of four powerful "blue" modernization discourses which, in turn, are guiding recent development programmes by FAO, the World Bank and private companies (e.g., Marine Harvest; Table 1).

These discourses are the blue revolution, the blue economy, the blue growth and the blue carbon, which among other components sustain that: (a) aquaculture production would compensate for the shortage of harvests as ocean fisheries deteriorate, and would restore wild populations by relieving pressure on capture fisheries; and (b) aquaculture expansion would contribute to food security and employment of the poorest people in the world (World Bank and United Nations Department of Economic and Social Affairs, 2017).

Blue discourses have accepted a standpoint similar to the Green Revolution. With such parallelism, they indicate the shifts towards the exploration of new markets and the exploitation of aquatic ecosystems, which become a new commodity frontier for further capital accumulation (Campling, Havice, & McCall Howard, 2012; Saguin, 2016). Yet, these ideas have started to be strongly contested as humanity approaches ecological thresholds and rising levels of inequality that may lead to irreversible loss of resilience, catastrophic shifts (Scheffer, Carpenter, Foley, Folke, & Walker, 2001) and social conflicts.

Based on FAO world data and the case of Chile, we counter the optimistic views of a potential *Blue Transition*. We explore its drivers by building on the forest transition paths synthesized by Lambin and Meyfroidt (2010). We finally discuss the implications of our findings for fisheries and aquaculture development. In doing so, we remain critical of environmental solutions embedded in modernization and transition theories, which: (a) adopt weak sustainability criteria assuming perfect substitution between human-made capital (e.g., aquaculture technology) and natural capital of ecosystems, in times where ecological and social limits are being surpassed; (b) do not take the historic context and national and local realities into account; (c) potentially, or essentially, decrease the concern on resources depletion by promoting more economic growth as a solution to the environmental crisis; and (d) legitimize a political philosophy that releases the agents of environmental degradation and the state from their responsibilities (Buttel, 2000; Perz, 2007).

The analysis focuses on seafood from both wild fisheries and aquaculture (marine and fresh water), excluding seaweed products which are mostly destined to industrial production. We rely on available secondary data from FAO and from Chilean fisheries agencies, and an extensive revision of literature.

2 | A HYPOTHESIZED BLUE TRANSITION

A transition can be defined as a process of system change in which the structural character of the system is transformed (Martens & Rotmans, 2005). In a transition, the system will change from one state to another—for example, from a system dominated by wild fish for local consumption to a system with large fish farms in response to market demand or new institutions.

A *Blue Transition*, alike other environmental transitions, is presumed to be caused by social-ecological feedbacks that are triggered by natural resources depletion, wild fisheries in this case. A social-ecological feedback refers to a situation in which the ecological and the social systems (or components of the two) are connected together such that each system influences the other and their dynamics are thus strongly coupled (Berkes & Folke, 1998).

The logic of a *Blue Transition* can be depicted in three stages (Figure 1). Initially (stage 1), wild fish biomass sharply declines as a direct result of increasing fishing effort, facilitated by fishing technology, to meet growing seafood demand. This biomass decline is paralleled by increasing captures, which would inevitably diminish as biomass thresholds are reached and regulations are enacted to prevent further declines. In stage 2, as aquaculture starts to expand, wild biomass reduction would allegedly slow down, as wild captures are replaced by farmed fish. Finally, in stage 3, aquaculture would surpass wild captures, potentially promoting a net biomass recovery based on farmed and wild fish (Figure 1).

A central debate around transitions focuses on the respective causal roles of structural, long-term driving forces in the economic, technological, and demographic realms versus contextual and contingent processes, in particular social and political dynamics triggered by key actors and events. Mimicking the forest transition paths (Lambin & Meyfroidt, 2010; Rudel et al., 2005), arguments for the net biomass recovery of exploited fish populations enabled by aquaculture (stage 3) could be arranged under four general paths, which represent conceptual abstractions and remarkably parallel the hypothetical resurgence of forests. In this framework, a particular pathway represents a dominant cause that can be considered responsible for the *Blue Transition*.

2.1 | Fish scarcity path

In this path, as fisheries decline, fish products become scarcer and fish prices rise, encouraging the search of substitutes—farmed fish—and the protection of wild fisheries. Political and economic changes affecting the fisheries sector arise as a response to the adverse impacts of wild fisheries decline and overexploitation. The scarcity path assumes that there are few effective substitutes for wild fish as it becomes scarcer, reason why prices increase. Substitution possibilities may indeed exist in some cases, but they could also be very narrow depending on the species. This path also assumes that scarcity will promote aquaculture development within a relatively short period of time, which undoubtedly depends on technology availability.

2.2 | Economic development path

The economic development path argues that countries go through an initial period of industrialization and economic and population growth, causing overexploitation or depletion of fishery stocks. At a later stage of development, the resulting higher incomes increase environmental awareness and promote the exit of people from natural resource extractive activities, which in turn reduces the pressure on fisheries, finally leading to the recovery of stocks.

2.3 | State policy path

In some cases, changes in national policies could play a central role in stirring the transition. In this context, aquaculture policies may be partly triggered by elements of the scarcity pathway, but their underlying motivations are often outside the fisheries and aquaculture sector, such as a willingness to modernize the economy and generate employment and foreign exchange. Unlike the scarcity pathway, the state-driven transition does not inevitably result from economic development policies focused on industrialization and/or a decentralized implementation.

2.4 | Globalization path

A more modern version of the economic development pathway occurs when a national economy becomes increasingly integrated into global markets for commodities, labour, capital, tourism and ideas (Rudel, Bates, & Machinguiashi, 2002). Compared to transitions in developed countries, developing economies are strongly affected by globalization. Several processes associated with globalization can impact fisheries and aquaculture dynamics: neoliberal economic reforms, labour out-migration, local manifestations of international conservation ideologies, and growing demand for luxury goods as emergent economies expand personal income (Aguilar Ibarra, Reid, & Thorpe, 2000).

3 | GLOBAL TRENDS ON WILD FISHERIES CAPTURES AND AQUACULTURE

The initial period of increased captures depicted in stage 1 is consistent with world data (Figure 2). The second industrialization of fisheries—following the first, which occurred between the 1870s and 1950s—began in developed countries in the 1950s and extended to developing countries few years later, and lasted until the introduction of Exclusive Economic Zones near the late 1970s (Gelchu & Pauly, 2007; Thurstan, Brockington, & Roberts, 2010). This second industrialization was characterized by the following features: (a) the large scale of its operations; (b) the existence of global commodity chains providing fresh fish to wealthy consumers; (c) state-led policies of industrialization and modernization; (d) the displacement of more equitable and environmentally friendly small-scale fisheries; and (e) the contradiction between cost reduction and environmental degradation (Mansfield, 2010).

The rapid industrialization of fisheries worldwide coincides with the enactment of policies during the 1950s and 1970s inspired by Modernization Theory of capitalist economic development (Platteau, 1989), by which wealth was to be found in national capacity for industrial transformation of raw materials coupled with international trade. In the case of Latin American countries, modernization ideas came along with the influence of the Economic Commission for Latin America and the Caribbean (ECLAC) and dependency theory, which unlike Rostow's ideas (Rostow, 1959), gave the state a central role in the process of industrialization and infrastructural modernization, and was critical to the historical subordination of peripheral countries that international commerce perpetuated. This influence translated in a series of policies and incentives promoting the public-private investment on fishing fleets, infrastructure, processing plants and research (Nazer, 2016) that led countries such as Peru and Chile to fishing production increases surrounding 1,300% between 1955 and 1970, constituting the biggest boom in international fishing history (Luna, 1970).

Fleet expansion and specialization, together with more efficient but also destructive fishing technologies (e.g., trawling, purse seine, long-line and gillnets) (Mansfield, 2010), and high demand for fish products, led to the rapid collapse of fisheries (stage 2) such as the Californian sardine (*Sardinops caeruleus*, *Clupeidae*), North Sea mackerel (*Scomber scombrus*, *Scombridae*) and Peruvian anchovy (*Engraulis ringens*, *Engraulidae*) in the 1960s and 1970s (Bjørndal, 2002; Gulland, 1974; Pauly, Christensen, Dalsgaard, Froese, & Torres, 1998; Pauly et al., 2002; Radovich, 1982).

Stage 3 signs the exponential expansion of aquaculture and the point where aquaculture exceeds wild captures: the turnaround point that denotes the advent of a *Blue Transition* (Figure 2). Globally, aquaculture grew exponentially since the early 1970s, currently accounting for nearly half of the world's total supply of seafood. According to FAO (2018a, 2018b), in the year 2012 aquaculture production for human consumption (excluding algae) surpassed wild capture seafood at the global level for the first time (Figure 2).

However, a remarkable fact is that if China is excluded, the 2012 turnaround does not occur and it is very far from happening. China produces more than one-third of the global fish supply, largely from its ever-expanding aquaculture sector, as most of its domestic fisheries are overexploited (FAO, 2018a, 2018b; USDA, 2017). In 2016, China accounted for 61.5% of aquaculture production and 19.3% of wild fisheries landings.

Whereas the expansion of aquaculture worldwide is a well-supported fact, the recovery of wild fisheries enabled by aquaculture has little or no evidence. The decreasing trends in wild fisheries

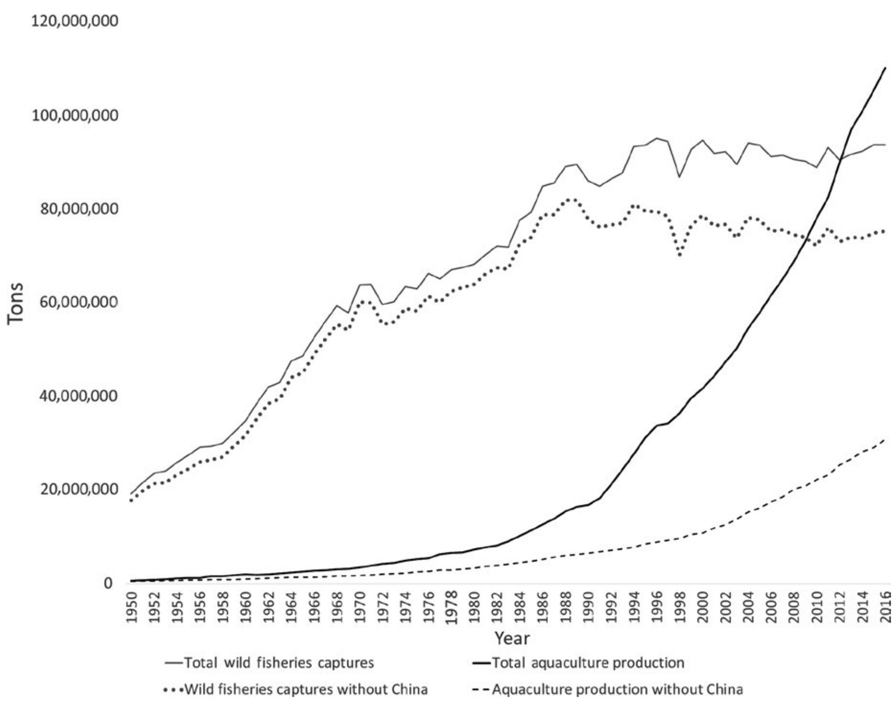

FIGURE 2 Historic dynamics of wild captures and aquaculture between 1950 and 2015 based on FAO (2016a, 2016b). The dotted line shows aquaculture production for human consumption, excluding algae. The wide black line shows wild captures for human consumption excluding algae. The lower lines show the effect of excluding China from the analysis

have been consistently documented (Christensen et al., 2015; Global Ocean Commission, 2014; Reid et al., 2005; WWF, 2016) as well as the risk of collapse of several fish stocks within the next few decades (Pauly et al., 2002; Stock et al., 2017; Zeller & Pauly, 2005).

4 | A CLOSER LOOK TO REGIONAL DYNAMICS: THE CASE OF CHILE

Chile is located in the southern tip of South America and has 4,000 km of coastline, along which rich ecosystems that can be found in both the nearshore and offshore environments. Chile is also among the top 10 fish producers and exporters globally (FAO, 2016a, 2016b). Its fisheries can be divided into three sectors: (a) offshore industrial, (b) small-scale nearshore artisanal, which extends five miles from shore; and (c) the aquaculture industry (Jarvis & Wilen, 2016).

4.1 | Stage 1: Rapid increase in wild captures

Both industrial and artisanal captures grew steadily during this stage (Figure 3). The offshore industrial fishery began in the 1950s with investments in vessels and processing plants designed to catch and handle large volumes of pelagic species, including Chilean jack mackerel (*Trachurus murphyi*, *Carangidae*), South American pilchard (*Sardinops sagax*, *Clupeidae*) and anchovy into fishmeal.

During the 1960s, policies to promote industrial fishing were applied, led by state institutions (Luna, 1970; Nazer, 2016). The establishment of the Dictatorship regime in 1973 gave a neoliberal ideological orientation to such policies, which included lower import taxes on fishing-related capital, tax credits for vessel owners and tax breaks to increase internal processing capacity (Jarvis & Wilen, 2016). Dominant governance regimes under this neoliberal ideology favoured production, leading to high growth rates in these sectors at the expense of labour (fewer safeguards, greater flexibility) and ecosystems (Barton & Fløysand, 2010). During this period (until the early 1990s), Chilean fisheries operated under open access regime. This condition together with the expansion of the fishing industry (e.g., new on-shore plants to process catches from small-scale fishers and large-scale factory trawlers) sets the basis for fisheries collapse.

4.2 | Stage 2: Fisheries collapse and the new regulations

As a result of the dynamics in stage 1, by the late 1980s and early 1990s, the majority of wild fisheries showed signs of overexploitation. In response, the Chilean government implemented top-down regulatory

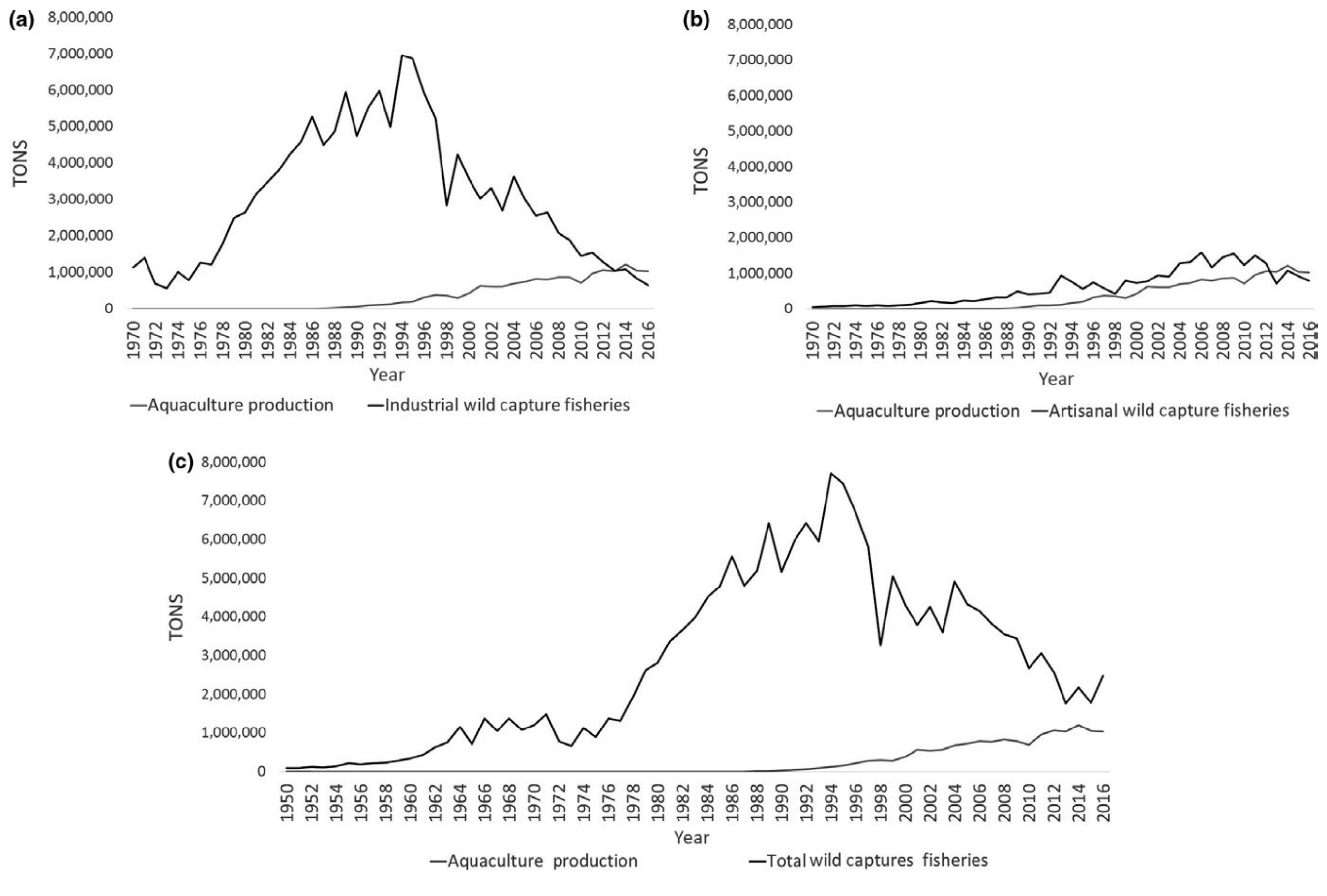

FIGURE 3 (a) Aquaculture production versus industrial wild capture for human consumption; (b) Aquaculture production versus small-scale wild capture for human consumption; (c) Aquaculture versus total wild captures. The differentiated register of landings from fishing and aquaculture started in the 1970s. The grouped statistics of both fisheries started in the 1950s

measures for industrial and small-scale fisheries such as minimum landings sizes, closed seasons and gear restrictions (Ministerio de Economía, 1989; Peña-Torres, 1997). In the early 1990s, Chile enacted the Fishing and Aquaculture General Act (FAGA), inspired by rights-based fishery management, the predominant doctrine at the time (and the present). The implementation of measures such as Total Allowable Catch (TAC), Individual Fishing Quotas (IFQs), Individual Transferable Quotas (ITQs) and Territorial User's Rights in Fisheries (TURFs) had the immediate effect of regulating access, which is reflected in the sustained decreases in landings since then.

Fishing and Aquaculture General Act was amended in 2013 to incorporate the precautionary principle and ecosystem-based management approaches. In this framework, the maximum sustainable yield (MSY) turned out to be the cornerstone as a target reference point and became one of the most controversial issues in the discussion of FAGA at the time (Wiff, Quiroz, Neira, Gacitúa, & Barrientos, 2016).

Whereas Chile has committed to the implementation of the ecosystem approach to fisheries as recommended by FAO Committee on Fisheries (COFI), the country is still far away from this target (FAO, 2016a, 2016b).

Along with the collapse of most industrial and artisanal fisheries, stage 2 sets the beginning of intensive aquaculture with the culture of oysters and mussels (Basulto, 2003) and salmon farming, as well as the adoption of central planning to further aquaculture development.

4.3 | Stage 3: The booming of aquaculture and the turnaround

This stage is characterized by the rapid development of the aquaculture industry (sponsored by national and international private investors) and by a continuous decline in industrial and artisanal wild captures. The aquaculture sector, almost entirely represented by salmon farming, evolved from experimental production to a major global industry, expanding exponentially from less than 200 tons in the early 1970s to over 1 million tons in 2016 (Figures 3 and 4). Main

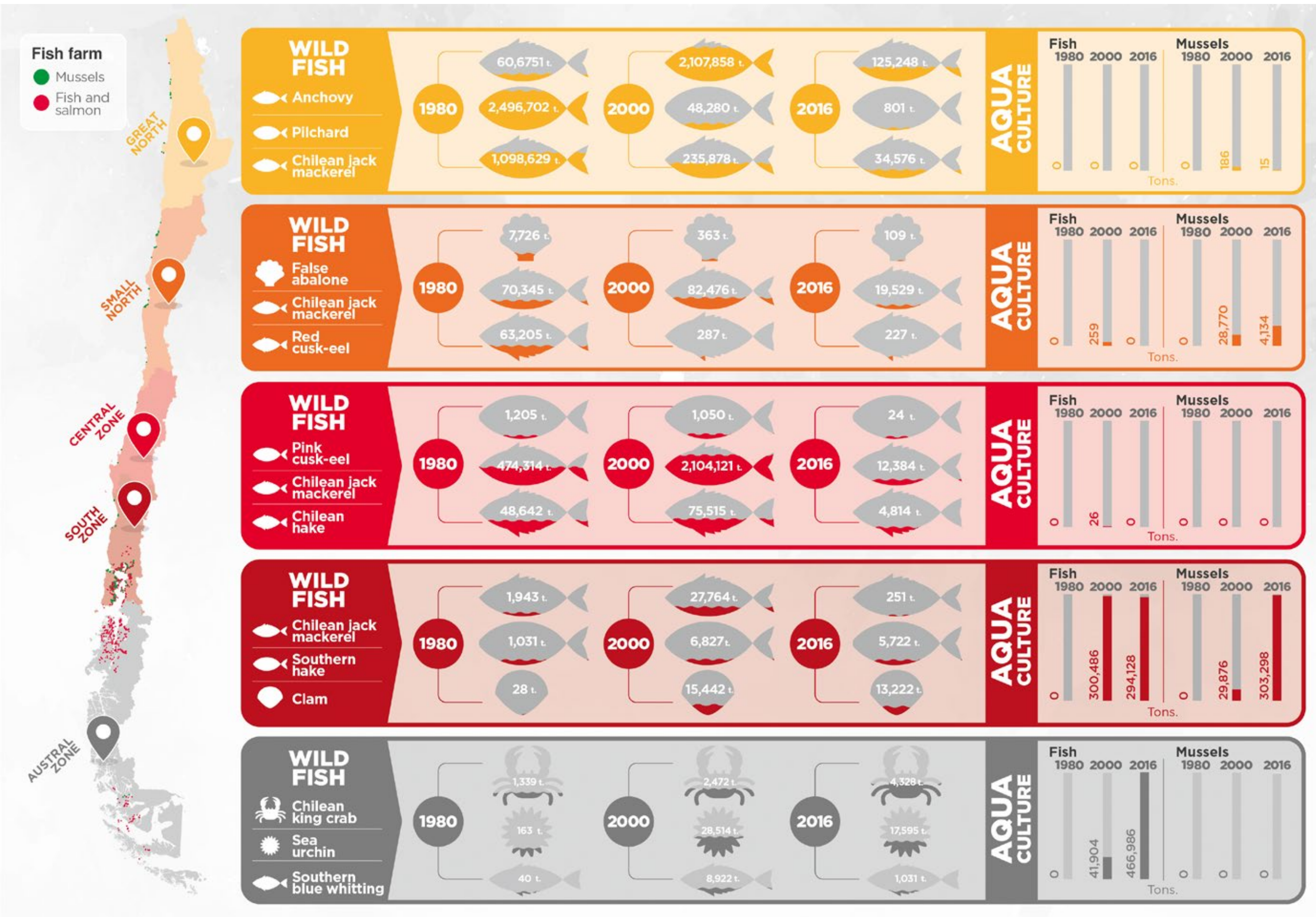

FIGURE 4 Temporal dynamics of main wild fisheries and aquaculture production for human consumption by administrative macro-region of the country between 1980 and 2016. Macro-regions are areas with similar natural and economic characteristics, distinct from administrative regions. Disaggregated data are not available before 1980. Great North: anchovy, pilchard, Chilean jack mackerel; Small North: false abalone (*Concholepas concholepas*, *Muricidae*), Chilean jack mackerel, red cusk-eel (*Genypterus chilensis*, *Ophidiidae*); Central Zone: southern hake, Chilean jack mackerel, pink cusk-eel; South Zone: clam (*Venus antiqua*, *Veneridae*), southern hake (*Merluccius australis*, *Merlucciidae*), Chilean jack mackerel; Austral Zone: southern king crab, Chilean sea urchin), southern blue whitting (*Micromesistius australis*, *Gadidae*). The scales (*y*-axis) of the graphs are adjusted to the volumes of each species since they differ widely across macro-regions

species farmed have been Atlantic salmon (*Salmo salar*, *Salmonidae*), coho salmon (*Oncorhynchus kisutch*, *Salmonidae*) and rainbow trout (*Oncorhynchus mykiss*, *Salmonidae*).

Salmonids are not native species in the southern hemisphere. Commercial salmon farming in Chile was preceded in the late 1960s by experimental activity oriented to salmon ranching in lakes, rivers and fjords of southern Chile, in a joint effort of the state and the international cooperation (Basulto, 2003). During the late 1970s, this experimental phase turned from salmon ranching to salmon farming thanks to both the adaptation of the net-pen technology and the favourable scenario for export-based activities brought by trade liberalization policies fostered by the Dictatorship regime (Blanco, Arce, & Fisher, 2015; Hosono, 2016). Chilean fish farmers rapidly succeeded in transforming salmonid production into a world known seafood commodity. From locally owned small and medium companies, salmon farming grew into a large-scale industry owned by national and transnational corporations.

Between 1980 and 2016, salmon production expanded at an average annual rate of 34%, whereas unit prices increased by 142% between 2006 and 2016, exceeding the prices of bovine meat (FAOSTAT, 2018; FishSTAT, 2018). At present, Chile occupies the eighth place in aquaculture production worldwide and the second place in salmon production capacity after Norway, with 727,812 tons of salmon produced in 2016 (FAO, 2018a, 2018b). Salmon represents 70% of the country's aquaculture production and 80% is destined to foreign markets, mainly Japan, Russia and United States (Asche, Guttormsen, Sebulonsen, & Sissener, 2005; Kobayashi et al., 2015; USDA, 2017) where it is consumed by wealthy consumers at prices ranging from US$ 7 to US$12/kg in 2018.

At present, there are 3,342 aquaculture farms, or so-called concessions, along the country's coastline, of which 1,402 grow salmon whereas the remaining are dedicated to mussels and/or algae (SERNAPESCA, 2017); the majority of them are located in Southern Chile (Figure 4). A concession is the administrative act by which the Ministry of National Defense grants to a person, natural or legal, the rights of use and enjoyment, for 25 renewable years, on certain national goods, to carry out aquaculture activities.

In terms of employment, salmon farming employed 17,361 workers in 2017 of which 30% was temporary labour. Regarding permanent labour, approximately one-third of the total labourers are women (SUBPESCA, 2017). Some estimations indicate that on average fish farming contributed to two-thirds of the reduction in rural poverty in the region of Los Lagos during the period of 1992–2002 (Ceballos, Dresdner-Cid, & Quiroga-Suazo, 2018), although the subject of poverty reduction is highly debated.

In contrast to the aquaculture figures, the major wild fisheries in each macro-region of the country have shown sustained decreases in landings since the 1980s, except southern king crab (*Lithodes santolla, Lithodidae)* (Figure 4), which operates under a semi open access regime. These trends have placed Chile as one of the Latin American countries with the highest number of overexploited or depleted wild fisheries (SUBPESCA, 2018). Catches of the main species, namely anchovy, southern hake *(Merlucius gayi*, *Merlucciidae),* Pink cusk-eel (*Genypterus blacodes*, *Ophidiidae*), Chilean jack mackerel, South American sardine, Patagonian toothfish (*Dissostichus eleginoides*, *Nototheniidae*), sea urchin (*Loxechinus albus*, *Echinidae*) have decreased from 6.8 million tons in 1994 to 958,391 tons in 2016.

A serious concern is the conversion of capture fisheries into farmed salmon, which nonetheless shows a decreasing trend. Fish-in fish-out (FIFO) ratio for carnivorous fish has decreased from 7.5 to 4.9 in the period 1995–2006 (Tacon & Metian, 2008), and for salmon and trout together it declined from 1.38 to 0.82 in the period 2010–2015 (IFFO, 2018). Such low FIFO ratio (<1) indicates that salmon farming is a net producer of fish protein and oil, as it is using marine ingredients more strategically (IFFO, 2018; Liland et al., 2013; Shepherd & Jackson, 2013). Among the reasons to explain FIFO decreases are the following: (a) the increasing fish meal and fish oil prices, which promotes input substitutions to remain profitable; and (b) the increasing pressure by civil society to improve sustainability of fishery resource use within the aquaculture sector (Shepherd & Jackson, 2013; Tacon & Metian, 2008). FIFO ratio for salmon in Chile is not available, but for the period 2009–2018 feed conversion rate (FCR) for salmonids has not changed significantly, with current values of 1.2 and 1.3 for Atlantic salmon and Coho salmon, respectively, (pers. comm. Intesal – SalmonChile, 2018) and slightly lower than those reported by Tacon and Metian (2008) for these species (1.3 and 1.4, respectively), making salmon one of the most efficient cultured species in terms of feed conversion (Fry, Mailloux, Love, Milli, & Cao, 2018).

In synthesis, the previous analysis indicates that: (a) aquaculture has become more efficient over time (decreasing feed conversion ratios), but there is no evidence to sustain that it is helping to relieve wild fisheries decline; (b) aquaculture has not surpassed aggregated wild captures (industrial plus artisanal; Figure 3c) and the turnaround is uncertain given the recent declines in salmon production; (c) aquaculture has, however, surpassed artisanal and industrial catches taken separately (Figure 3a,b); (d) aquaculture is not intended to produce cheap seafood to satisfy domestic or international nutritional needs of the poor and thus the scarcity path can be ruled out; (e) aquaculture expansion in Chile best matches the economic and globalization paths to transition, whereas state policies have been temporarily functional to this expansion.

5 | *BLUE TRANSITION* AND IMPLICATIONS FOR FISHERIES SUSTAINABILITY

Supporters of environmental transitions tend to present them as an unquestionable good: "to promote economic growth, social inclusion, and the preservation or improvement of livelihoods while at the same time ensuring environmental sustainability of the oceans and coastal areas" (World Bank and United Nations Department of Economic and Social Affairs, 2017 p: 8). Yet, as other modernization ideas, the concept of a *Blue Transition* can be criticized on several grounds (Breitling, 2016; McCay & Rudel, 2012). Firstly, it is too general and does not consider the historical context of national, subnational and local realities. Global statistics can hide more complex dynamics at lower levels, suggesting the need to examine fisheries and aquaculture dynamics at multiple scales. Figure 2 is compelling in showing the high level of dependence of aquaculture production and exports on a single country—China. Secondly, modernization ideas have been confronted for essentially decreasing the concern for natural resources depletion by promoting further economic growth as a solution to the environmental crisis (Bailey, Gouldson, & Newell, 2011; Hovardas, 2016). Finally, modernization and neoliberal ideas, when used as an uncontended discourse, legitimize a political culture that releases the agents of environmental degradation and the state from their responsibilities (Buttel, 2000; Perz, 2007). For example, whereas expansion of ocean aquaculture promises a better future, the pervasive effects of fishing subsidies by national governments accelerate overfishing, a reality usually overlooked in blue discourses. Developed countries grant 70% of fishing subsidies, with Japan, China, the EU and the USA being the highest spenders (Global Ocean Commission, 2014).

The idea of a *Blue Transition* should trigger contentious issues that need to be answered before modernization and neoliberal ideas continue to be implemented. Among them, we highlight the following.

5.1 | The level of wild fisheries depletion at the turnaround

Even in countries where the transition may occur, independently of causal mechanisms, scientific information suggests that the turnaround is associated with still high rates of decline in wild fisheries biomass and catches, as exemplified by the case of Chile. Chilean data clearly indicate that there may be a significant lag between the moment aquaculture exceeds wild captures and wild fisheries recovery, if any. The main commercial species are still described as overexploited or depleted, whereas aquaculture continues to expand in the southernmost regions (SUBPESCA, 2018).

5.2 | The real capacity of aquaculture to substitute wild fish in consumption for the poorest people

An aquaculture-based transition contains the implicit assumption that seafood from aquaculture and capture fish are substitutes in consumption, which is not necessarily the case. In Chile, for example, per capita apparent annual consumption of seafood is low and has remained almost constant at 13 kg per capita in the last 5 years (2014–2016). It has indeed fallen by 23% since it peaked in 2004, contrary to the 25% global increase in seafood consumption that reached 20 kg per capita per year in 2017 (FAO, 2018a, 2018b). The result of the national health survey (MINSAL, 2017) reported that only 9.2% of the Chilean population consumes the amount of fish recommended by the World Health Organization. Fish consumption from aquaculture is especially low, reaching only 1.5 kg per person per year in the 2016 besides being a prohibitive good for the average Chilean consumer given its high prices (US $ 20/kg 450/month). On the other hand, capture fishery products such as Chilean hake can reach US $ 2 per kg (SERNAC, 2016), but are seldom available in the local markets.

Chile has become an exporter of highly valued aquaculture products (e.g., salmon) and, therefore, governmental policies are oriented towards providing incentives for seafood exports that target wealthy consumers in the Global North. While some authors have shown that aquaculture is contributing to a general improvement in the availability, accessibility and stability of fish supply in domestic markets reaching low and middle income consumers of the Global South (Belton, Bush, & Little, 2018), the Chilean case suggests that benefits of regional and national aquaculture should be empirically elucidated and do not constitute a universal trend, as the blue discourse supporters claim.

5.3 | The "stability" of the turnaround

A *Blue Transition* can be an unstable process for several reasons. Firstly, the production of aquaculture monocultures is very fragile; for example, in just one event of harmful algae outcrop, almost 30 thousand tons of salmon were lost from one area in Chile (INDEXSALMON, 2016). Both salmon and mussel farming in Chile have faced crises that significantly affected productivity, cascading into the social and institutional sphere, namely: the outbreak of ISAV in salmonids in 2007; a significant increase in outbreaks of sea lice (*Caligus rogercresseyi*, *Caligidae)* since 2007; a decrease in the recruitment of mussel seeds (2009–2011), and a reduction in fattening in 2011 and 2012 (Lara, Saldías, Tapia, Iriarte, & Broitman, 2016); the bloom of harmful microalgae producing paralyzing toxins in mussels during 2016. In this context, the development of sustainable aquaculture systems is becoming the cornerstone for long-term aquaculture expansion. Integrated multitrophic aquaculture (IMTA) is regarded as a suitable approach to limit aquaculture nutrients and organic matter outputs through biomitigation (Granada, Sousa, Lopes, Marco, & Lemos, 2016; Martins et al. 2010). Recirculating aquaculture systems (RAS) are another sustainable technology in which water is (partially) reused after being treated to reduce waste and water consume, and to improve nutrient recycling (Martins et al., 2010). However, in Chile RAS is being used only for hatchery operations and IMTA combining seaweed with marine fish, and mussels and oysters as biofilters, has only been examined but not implemented (Granada et al., 2016).

Secondly, the dominant "carnivores-only" approach to aquaculture (Neori, Troell, Chopin, Yarish, & Critchley, 2007) is ecologically imbalanced and thus inherently unsustainable. Therefore, measures such as IMTA only delay the point in time when the cumulative effects and impacts of carnivorous fish monoculture become obvious—that is, when "blue revolution aquaculture becomes impractical and possibly unprofitable due to high feeding and energetic costs, environmental degradation, costly environmental monitoring and mitigation, and social disruption of displaced fishers and subsistence fish consumers" (Neori et al., 2007 p. 38).

Thirdly, even though aquaculture may lessen the rate of stock reduction of some wild fisheries, especially when aquaculture species can substitute wild species (Naylor et al., 2000) or are herbivorous or filter feeders (McCay & Rudel, 2012), fish farming can also be a contributing factor to fishery collapse if the cultured species rely on fishmeal and fish oil (McCay & Rudel, 2012).

Finally, results show that the turnaround and the promise of a transition enabled by aquaculture is significantly dependent on one single country—China. Thus, how China develops its aquaculture sector—and whether such development can relieve pressure on wild fisheries—are key questions for the *Blue Transition* and the future of the oceans (Villasante et al., 2013).

5.4 | The trade-offs of a *Blue Transition*

Environmental transitions and the *Blue Transition* in particular, involve ecological and social trade-offs that have been scarcely addressed by their promoters. In the event of a net fish biomass recovery enabled by aquaculture, people will draw attention to the composition and structure of the restored fish supply. At that point, people will realize that the seemingly inevitable trends towards increased exploitation levels have affected biodiversity and other fisheries ecosystem goods and services in an irreversible way such as in tilapia introductions (Deines, Wittmann, Deines, & Lodge, 2016) and salmon aquaculture (Outeiro & Villasante, 2013). Furthermore, increased availability of fish from aquaculture may not fully compensate for the loss of wild fish in terms of dietary diversity, micronutrient intakes and food and nutrition security, particularly for the poorest consumers (Belton, van Asseldonk, & Thilsted, 2014). Finally, the blue discourses promote developing countries to increase exports of higher value fish (caught and farmed) to get revenues, which are used, paradoxically, in imports of lower-value food from industrial fisheries in developed countries (Golden et al., 2016) thus perpetuating capitalistic forms of exchange.

5.5 | The role of governance

Governance in its widest sense is a critical component of fisheries sustainability (Gutiérrez, Hilborn, & Defeo, 2011; Ostrom, 2009). Yet, governance has proved to be a wicked problem in Latin America (De Castro, 2015; Defeo & Castilla, 2012), where government policies, including food production and export policies, have accelerated resource destruction (see Gordillo, 2017 for a comprehensive review). The formal development of management plans with clear long-term policy goals is essential to provide sustainable production systems and, at the same time, to conserve ecosystems (Ostrom, 2009). Yet, this does not mean to refashion past approaches, such as rights-based measures. Evidence for some developing countries has shown that a more favourable regulatory and private property rights structure may be enhancing private agents' legal claims to oceans (as in the case of aquaculture concessions in Chile) and the profitability of their activities, but the result may be increased, rather than decreased, ocean degradation (Bennett, Govan, & Satterfield, 2015; Foley & Mather, 2018).

A responsible and transparent *Blue Transition* defies current governance structures like never before, and previously considered win-win solutions need to be revised. For example, devolution of control over small-scale fisheries to fishers by means of co-management is expected to accelerate (Defeo et al., 2016; Gelcich et al., 2010), but it is not clear whether this power shift will change the fates of many artisanal fisheries. Rates of large-scale depletion in industrial as well as artisanal fisheries may continue, along with illegal fishing, as long as prices soar and these communities remain marginalized, poorly organized, and beset with resource tenure problems and social and power inequalities (Nahuelhual et al., 2018).

Under these conditions, payments for ecosystem services (Bladon, Short, Mohammed, & Milner-Gulland, 2016) and certification of products from well-managed fisheries (Steneck, Parma, Ernst, & Wilson, 2017) could tip the balance towards successful fisheries as long as their implementation effectively hinders governance failures and prevents ocean grabbing by outsiders to capture these rents (Bennett et al., 2015). Regarding aquaculture policy, adopting blue technologies alone, however—no matter how innovative—is not sufficient. There is an urgent need to reconfigure fish farming practices and design and enact more comprehensive policies for the industry to save its status and gain the backing of its many detractors. Aquaculture must be planned along with and not separate from integral management strategies for the restoration and sustainability of ecosystems, fisheries and communities (Costa-Pierce, 2002). In many cases, this transformation will involve law reformulation such as in the case of Chile.

6 | CONCLUSIONS

The destiny of natural resources, and wild fisheries in particular, will continue to be determined by market forces, governmental policies, quality of governance and institutional frameworks (e.g., tenure and rights allocation), and cultural values that interact in complex ways with the diverse impacts of climate change and the many effects of globalization. This future could be improved if interventions are designed to address the complexities of management and conservation in real-world seascapes (e.g., identifying and negotiating trade-offs). The evidence rejects the notion that economic growth and improved aquaculture technology alone will take us to a better environmental performance regarding fisheries, as supported by modernization ideas. Chile is indeed a notable example of the contrary: it is the country with the highest internal economic growth rates in Latin America in recent decades, is a top ten fish producer and exporter, and, paradoxically, it is among the countries with the highest decreasing rates of wild fisheries, with 70% of them overexploited or collapsed, along with alarming indicators of social inequality.

Although there is considerable debate about the processes and causes of transitions, it seems that if a *Blue Transition* is underway, it is going in the wrong direction: from what may have been sustainable fisheries management before the 1970s to the overexploited wild fisheries of today. Thus, before cheerfully accepting these modernization ideas, the discourses have to be tested against local and regional realities. Our expectation is to initiate a debate about the need to undertake this endeavour.

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