Contributions of marine capture fisheries to the domestic livelihoods and seafood consumption of Brazil Chile and Peru

Report prepared for Oceana

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Contents

Country-specific data, Chile

1. *SERNAPESCA* -SERNAPESCA - The Chilean National Service of Fisheries is the main entity in charge of keeping track of landings and other fisheries and aquaculture related data in Chile. Most of their data is available on their website but we also obtained additional databases upon request[Cˆ1]. We accessed their databases on landings from wild-caught and farmed fisheries, first transaction prices (ex-vessel price) for artisanal fisheries, and landings used in different types of sea products. These databases provided information at the species and regional level. We also downloaded their data on the geographical distribution of production facilities and the types of sea products they produce. We issued data requests on SERNAPESCA's portal to obtain more detailed information. Via this method, they provided us the national record of artisanal fishers (RPA), which lists current registered fishers and boats, and the national record of industrial vessels (RPI), which lists current registered industrial vessels. The RPA informs the region, gender and age for each artisanal fisher as well as the species-specific permits they hold. Together the RPA and RPI provide information on artisanal and industrial vessels, including length and storing capacity. SERNAPESCA also provided the number of employees of each gender per processing facility.

2. *Aduanas Chile (Chilean Customes).* is the main entity in charge of keeping records of imported and exported goods in the country. We accessed their exports and imports data by product and region via their website. Each product in the original exports and imports datasets is identified through an ID number that matches the name of the product in a code known as the Arancel Aduanero. Most products provided details on the species or groups of species involved.

3. *IFOP* - The Fisheries Development Institute is a private entity that advises fisheries management based on permanent biological, environmental and economic monitoring, and scientific reasoning. Although most of the data collected by IFOP pertains to stock assessments and biological indicators, they also generate economically relevant statistics. We reviewed their most recent annual report on the economic monitoring of Chilean fisheries for 2015. It includes databases and estimates for employment. We also extracted data from their monthly reports on exports of fisheries products, which are based on ADUANAS's data.

4. *CCB* - The Chilean Central Bank (*Banco Central de Chile*) is the entity in charge of establishing the Chilean currency. To fulfill its function it monitors the main economic indicators per economic sector. We accessed their data on sectorial GDP (including fisheries) for each region.

5. We reviewed several reports from other national agencies like the Undersecretary of Fisheries (SUBPESCA), NGOs and scientific publications to complement our analysis.

Results Chile

Fisheries Context

Wild-caught fish

Main wild-caught fisheries in terms of volume

According to landing records from SERNAPESCA over the last five years, the artisanal sector lands on average 1.6 ± 0.58 million annual tonnes of marine species while the industrial sector lands around 0.9 ± 0.16 million tonnes per year. Is worth noting that large part of the artisanal landings are of algae and benthic species that are not targeted by the industrial sector. Both sectors have among their most landed species the Peruvian anchoveta (*Engraulis ringens*) and the Araucanian herring (*Strangomera bentincki*), two species that are mostly used as inputs for fish meal and oil (Figure 19). Other important species in artisanal landings are the Giant grey kelp (*Lessonia nigrescens*), exported mostly as dried algae, and the Jumbo squid (*Dosidicus gigas*), mostly commercialized fresh or frozen for human consumption (HC). The Chilean jack mackerel (*Trachurus murphyi*) is also an important fishery in terms of volume for the industrial sector, which is also mostly used in the production of fish meal and oil and to a lesser extent for direct HC.

Over the last years the catch composition of the artisanal sector has presented no major changes. We observed an abrupt increase in artisanal landings for 2015, which we identified as a data error in SERNAPESCA's records (See Appendix Chile Methods 1). However, this is the only database that allowed us to compare catch compossition per sector over time. In the case of the industrial sector, composition of the main species is also stable over the last years. Yet, the landings of Peruvian anchoveta (*Engraulis ringens*) started declining in 2014 relative to previous years, increasing the relevance of the Chilean jack mackerel (*Trachurus murphyi*).

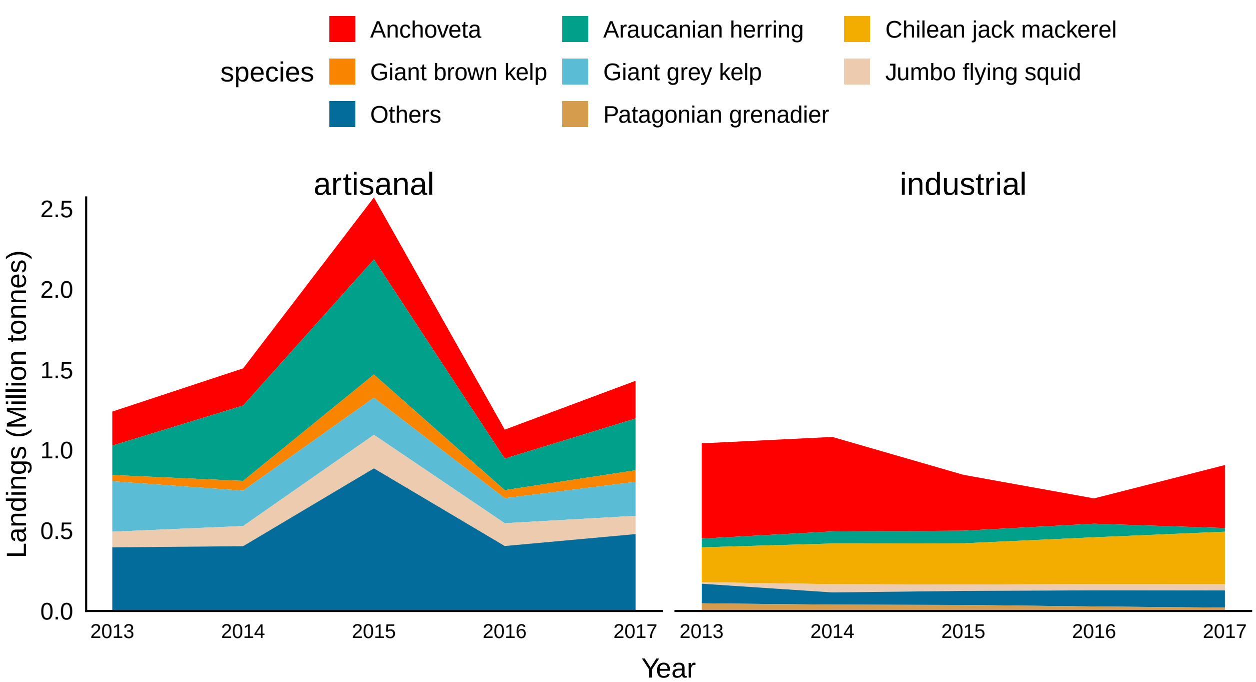

Figure 1: Top 5 species landed in Chile by the artisanal (left pannel) and industrial sector (right pannel) between 2013 and 2017. Data source: Landing records from SERNAPESCA, 2018.

SAU and FAO databases also identify Peruvian anchoveta (*Engraulis ringens*), the Araucarian herring (*Strangomera bentincki*) and the Chilean jack mackerel (*Trachurus murphyi*) as the main landed species in

Chile.

Regional Diferences in volumes of wild-caught fisheries

Landings varies widely along the coast of Chile for both artisanal and industrial sectors. Figure 20 shows the mean total landing per sector and region. The color of the bars represents the most landed species in 2017. We observe that the VIII region is by far the region with most landings from both sectors. However, the industrial sector, also concentrates landings in the north of the country. Artisanals are spread throughout the country. The most landed species vary geographically but tend to be the same over the years (Appendix Results Chile 1 and 2).

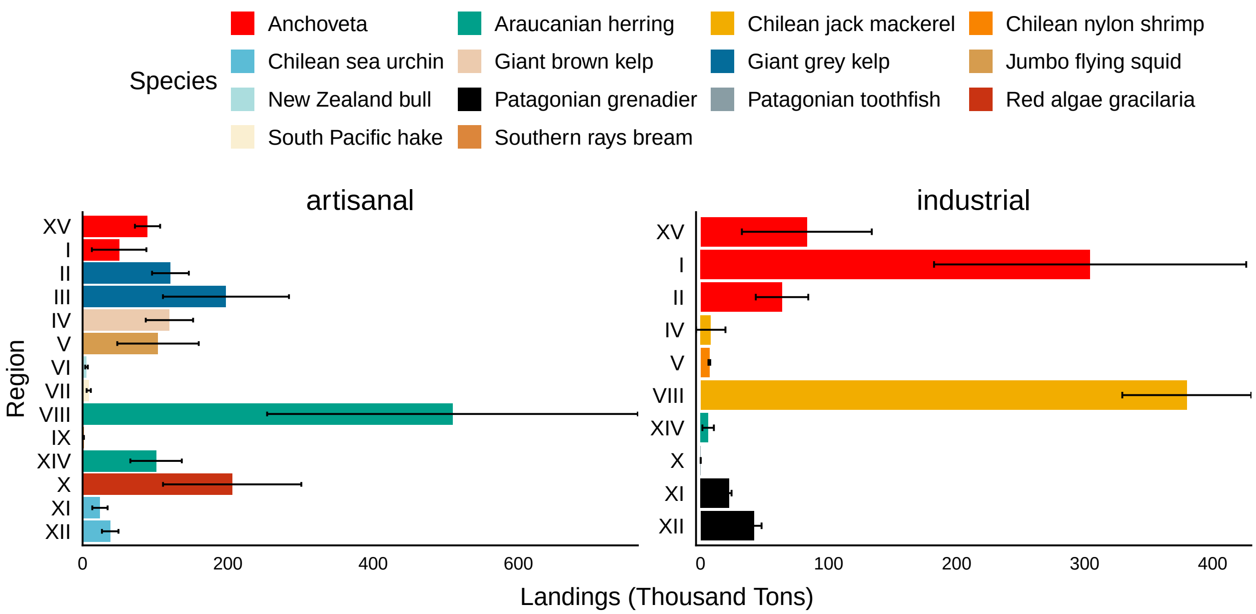

Figure 2: Mean annual total landings per region for the artisanal (left pannel) and industrial sector (right pannel) between 2013 and 2017. The color represents the most landed species in 2017 and regions are ordered from north to south. Error bars represent one standard deviation. Note that scales are different between pannels. Data source: Landing records from SERNAPESCA, 2018.

Aquaculture production

Main farmed fisheries in terms of volume

The main species harvested from aquaculture centers in the last 5 years have been the Atlantic salmon (*Salmo salar*), the Chilean mussels (*Mytilus chilensis*), the Coho salmon (*Oncorhynchus kisutch*), and the Red algae gracilaria (*Gracilaria spp.*) in descending order (Figure 21). These species predominate total aquaculture production. Overall, the composition of the most farmed species and its volumes have been stable over the last 5 years. However, the Rainbow trout (*Oncorhynchus mykiss*) is slightly declining.

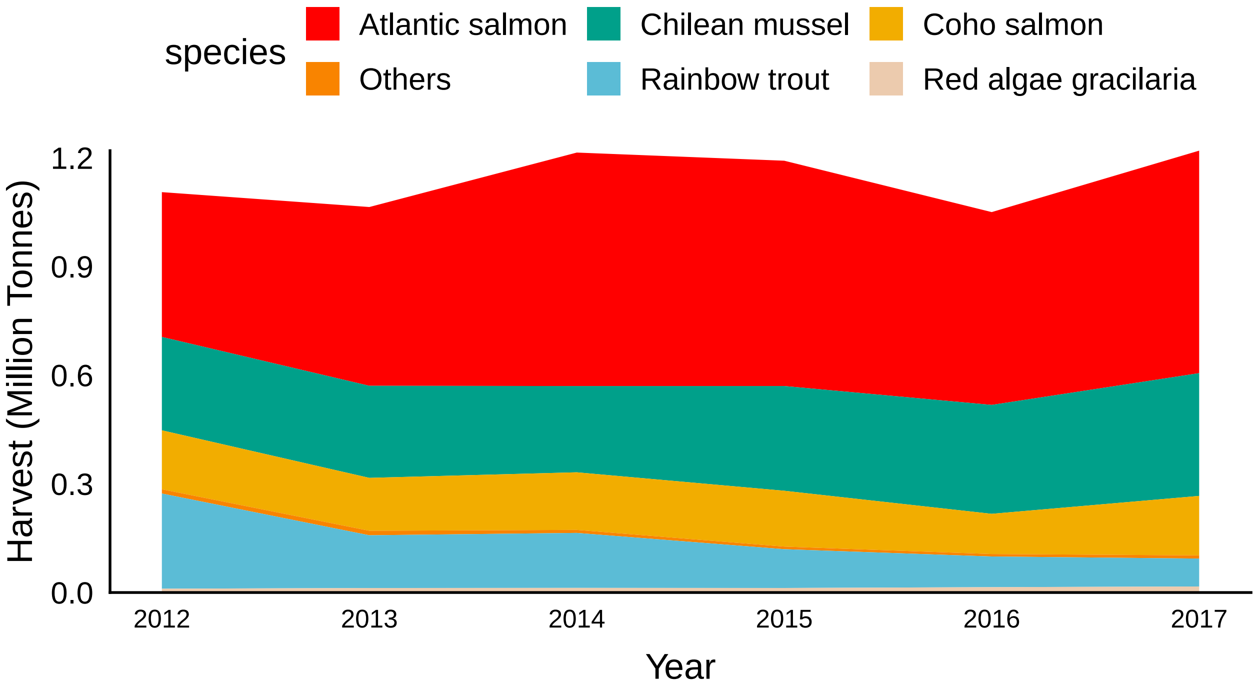

Figure 3: Top 5 species farmed in Chile between 2013 and 2017. Data source: Harvest records from SERNAPESCA, 2018.

Regional diferences in farmed fisheries

Aquaculture production is highly concentrated in the South of the country, between regions X and XII (Figure 22), dominated by the production of salmons and trouts, especially Atlantic salmon (*Salmo salar*). In this area, there is also centers growing algaes and mussels (*Mytilus chilensis*). In the north, from the I to the IV region, the most farmed resources are algaes and scallops (*Argopecten purpuratus*) (Appendix Results Chile 3). The red abalone (*Haliotis rufescens*) became the most farmed in 2013 in the V region, replacing the turbot (*Scophtalmus maximus*).

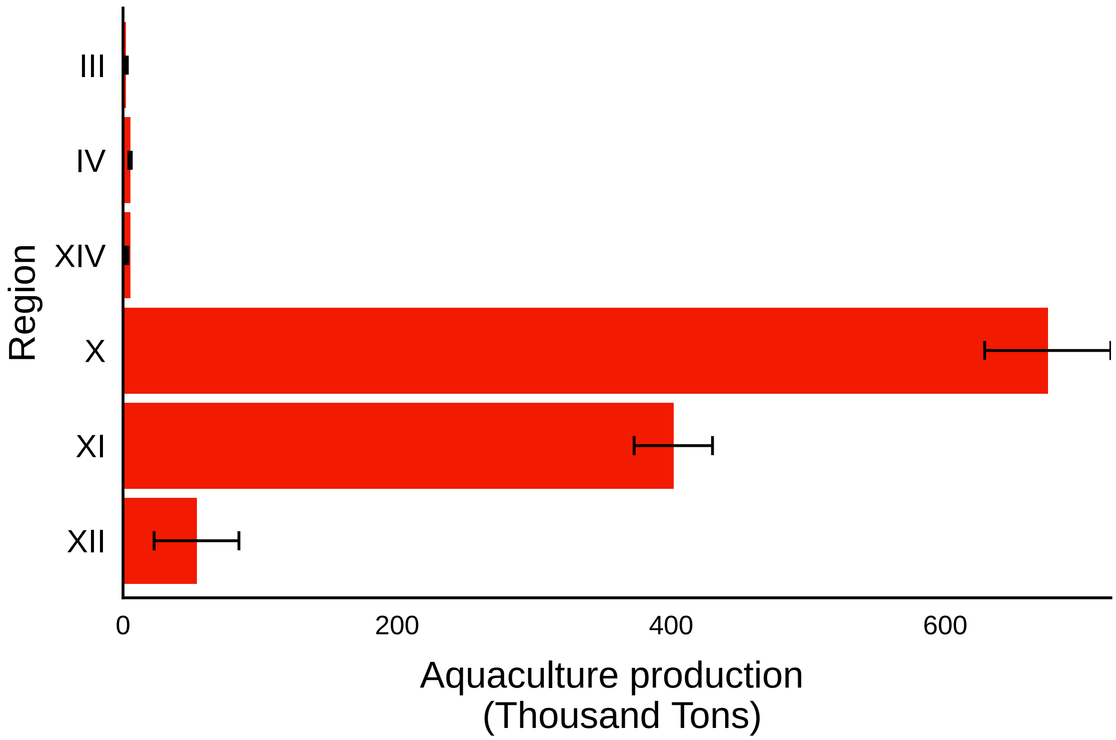

Figure 4: Mean annual harvest per region from aquaculture centers between 2012 and 2017. Error bars represent one standard deviation. Only showing regions with production. Database SERNAPESCA

Fish Trade

Around 72% of the landings from fisheries and aquaculture are exported outside the country [@ifop_monitoreo_2015]. In Chile, exported volumes of marine products are larger than imported volumes. The main group of species being exported is salmon, which is exclussively produced in aquaculture, followed by far by jack mackerel (Figure 23). Tunas lead the import activities followed, by jack mackerels. If we consider net trade, by substracting Chilean exported volumes of similar species, tuna is still the main group of imported species with a net trade of ~ 25,000 ± 4,200 tonnes per year (Table 1). When considering net trade, the second most imported group is no longer jack mackerels but shrimp. These results are in line with those done using international databases, which estimate tunas net trade to be ~ 22,000 tonnes per year and also identify jack mackerel and shrimp as groups with high net trade in Chile.

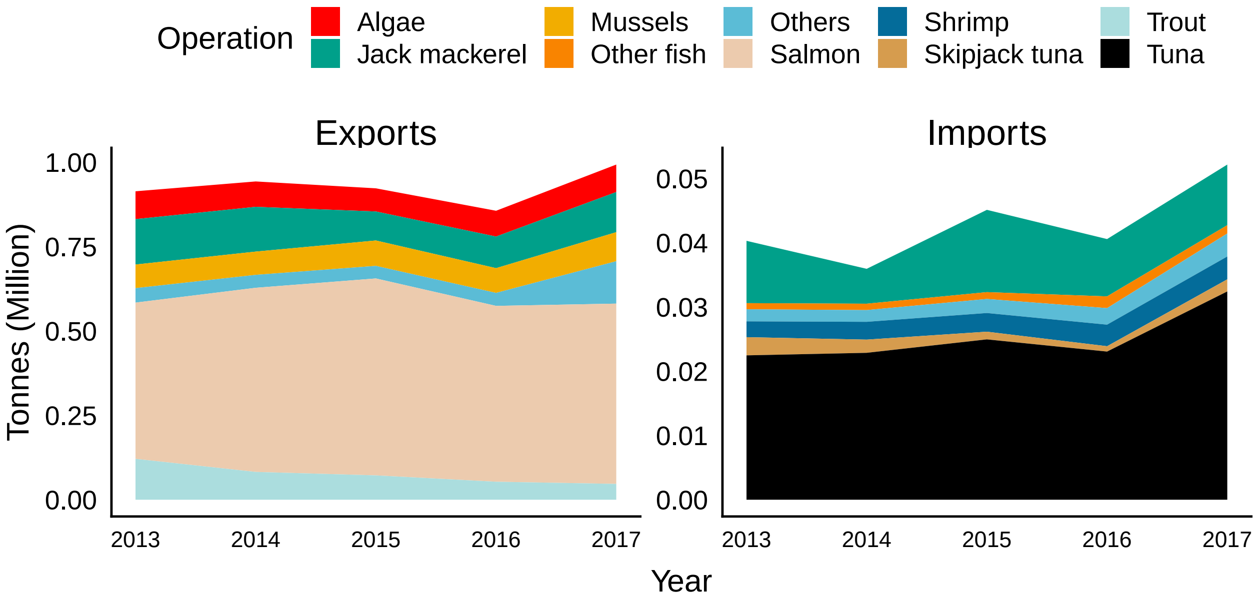

Figure 5: Main species exported and imported in Chile between 2013 and 2017. Note that the scales differ. Thousand Tonnes

National Seafood Supply

Species contribution to Human and Non-human consumption

As a first approach to analyzed main fisheries that countribute to human conssumption in Chile, we looked into landings and aquaculture harvest that goes to processing facilities as raw material for products for human consumpotion (HC) and for non-human consumption (NHC) (See Appendix Method Chile 2). Our results show that the main species that enter supply chains for HC are the Atlantic slamon (*Salmo salar*) and the Chilean mussel (*Mytilus chilensis*), two of the main aquaculture products from Chile (Figure 23). On the other hand species that are used for NHC products are Peruvian anchoveta (*Engraulis ringens*) Araucarian herring (*Strangomera bentincki*), the two main wild-caught fisheries of the country (Figure 23). A third important species for NHC are the Giant grey kelp (*Lessonia nigrescens*). Chilean jack mackerel (*Trachurus murphyi*) which contributs similarly to both HC and NHC products. The proportion of contribution of each specie to HC and NHC is relatively stable through time.

Table 1: Export and Import value, and net trade (Import - Exports) for the most imported species in Chile

species	2013	2014	2015	2016	2017	Total	Mean	s.d.
Exports								
Others	686,731.582	726,770.259	746,297.03	672,771.059	763,181.8855	3,595,751.8186	719,150.3637	38,522.0607
Jack mackerel	134,526.806	132,665.326	86,039.93	93,724.071	119,011.2486	565,967.3856	113,193.4771	22,273.7681
Mussels	69,986.953	68,918.296	75,203.93	73,284.777	86,025.1143	373,419.0725	74,683.8145	6,821.9244
Hake	22,075.593	13,949.153	14,160.71	15,115.303	21,680.3227	86,981.0803	17,396.2161	4,117.1428
Mackerel	38.220	212.228	465.56	432.392	2,557.1251	3,705.5277	741.1055	1,029.9168
Shrimp	505.785	485.597	460.85	520.780	584.8891	2,557.9039	511.5808	46.7461
Tuna	39.463	103.577	61.57	441.643	24.1595	670.4131	134.0826	174.5120
Sardines	56.773	29.125	64.73	2.739	3.0964	156.4641	31.2928	29.0794
Other fish	0.048	2.102	0.00	1.774	103.5751	107.4991	21.4998	45.8916
Skipjack tuna	0.000	0.000	0.00	0.000	0.7278	0.7278	0.1456	0.3255
Imports								
Tuna	22,472.774	22,869.098	24,961.06	23,062.745	32,424.0302	125,789.7115	25,157.9423	4,173.5352
Jack mackerel	9,703.526	5,431.318	12,810.40	8,919.248	9,436.2942	46,300.7848	9,260.1570	2,627.1675
Shrimp	2,460.766	2,771.602	2,908.96	3,356.637	3,557.9566	15,055.9224	3,011.1845	444.1588
Skipjack tuna	2,834.515	2,054.538	1,196.23	833.597	1,885.1999	8,804.0830	1,760.8166	779.9138
Other fish	956.557	992.384	1,062.48	1,832.219	1,295.2449	6,138.8813	1,227.7762	362.6973
Mackerel	174.607	245.680	776.56	1,502.919	2,133.0969	4,832.8624	966.5725	841.3451
Sardines	745.749	586.124	418.77	274.763	375.8759	2,401.2797	480.2559	186.1436
Mussels	460.810	406.452	386.19	243.065	421.2252	1,917.7456	383.5491	83.1506
Hake	259.401	374.785	293.92	224.550	310.5364	1,463.1926	292.6385	56.5924
Others	236.915	214.183	312.61	327.451	337.7228	1,428.8864	285.7773	56.2770
Net Trade								
Tuna	22,433.311	22,765.520	24,899.49	22,621.103	32,399.8707	125,119.2983	25,023.8597	4,242.7964
Shrimp	1,954.981	2,286.005	2,448.11	2,835.858	2,973.0676	12,498.0185	2,499.6037	412.9543
Skipjack tuna	2,834.515	2,054.538	1,196.23	833.597	1,884.4721	8,803.3552	1,760.6710	779.8849
Other fish	956.509	990.282	1,062.48	1,830.446	1,191.6699	6,031.3822	1,206.2764	360.3874
Sardines	688.976	556.999	354.04	272.025	372.7794	2,244.8156	448.9631	169.8528
Mackerel	136.388	33.452	311.00	1,070.527	-424.0282	1,127.3347	225.4669	544.9977
Hake	-21,816.192	-13,574.368	-13,866.79	-14,890.753	-21,369.7864	-85,517.8877	-17,103.5775	4,130.3146
Mussels	-69,526.143	-68,511.844	-74,817.74	-73,041.712	-85,603.8891	-371,501.3270	-74,300.2654	6,817.6555
Jack mackerel	-124,823.280	-127,234.008	-73,229.54	-84,804.822	-109,574.9544	-519,666.6008	-103,933.3202	24,081.9554
Others	-686,494.667	-726,556.076	-745,984.42	-672,443.609	-762,844.1627	-3,594,322.9322	-718,864.5864	38,508.3314

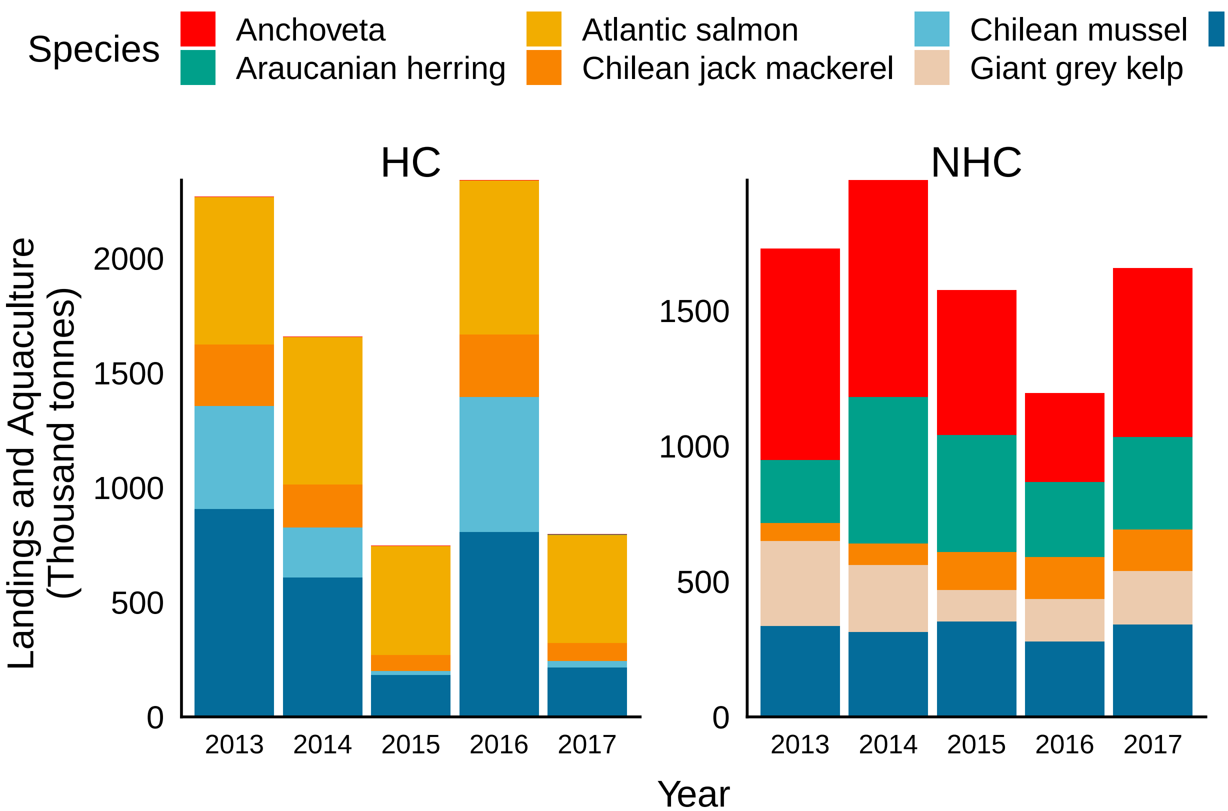

Figure 6: Main species landed and harvest in aquaculture designated for human and non human consumption. Data source: SERNAPESCA, 2018

We then looked into only wild-caught species and identified that the species that have historically contributed more to human consumption products are: Chilean jack mackerel (*Trachurus murphyi*), Jumbo flying squid (*Dosidicus gigas*), and in a minor contribution Chilean sea urchins (*Loxechinus albus*) (HC_no_Aq, 24). These results (*Figure HC_with_Aq NHC and HC_no_Aq VER NUMERO*) also shows that the amount of wild caught fisheries that go to NHC is more than the double than what goes to HC. Algaes are not included because we assumed that they all go for non-human consumption use.

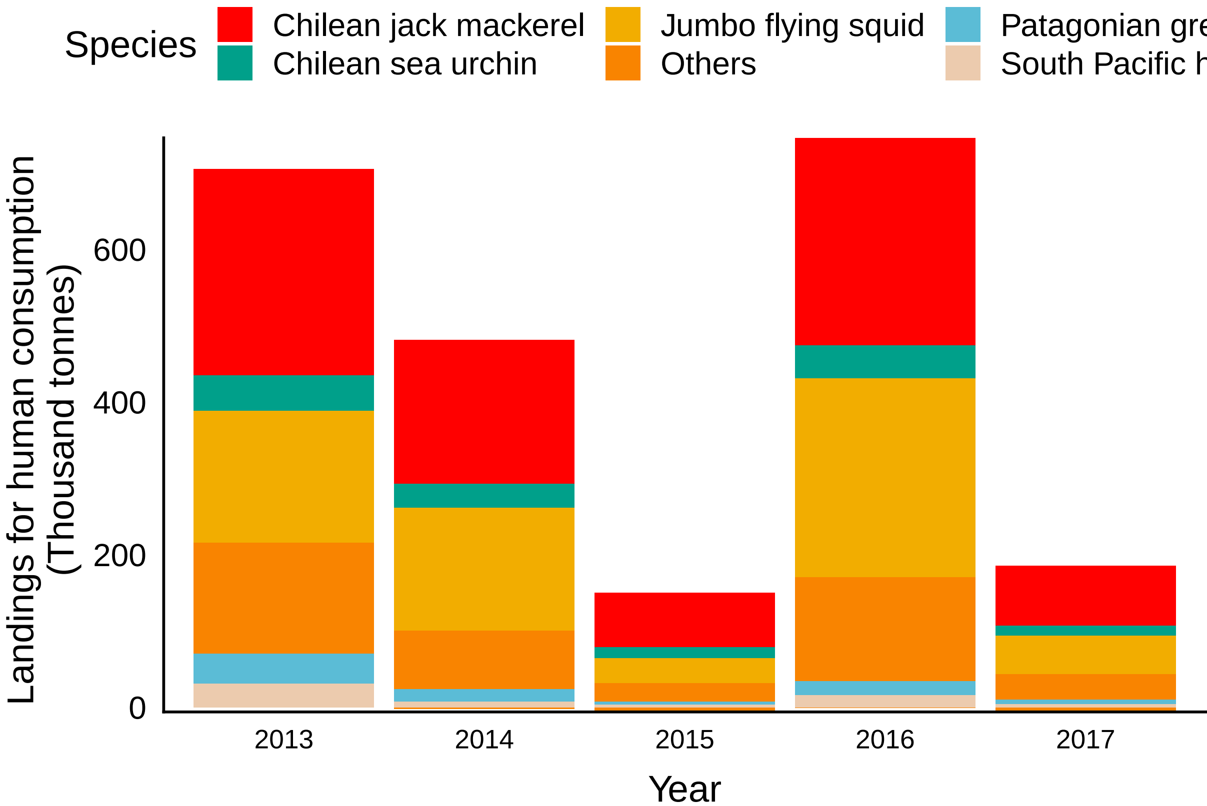

Figure 7: Tonnes of wild-cought species that are used for human consumption. Data source: SERNAPESCA, 2018

Artisanal fishers in Chile sell products directly for human consumption on deck. We assumed that the the artisanals' catches that are not sent to processing facilities are sold directly by fishers (See Methods Chile 2). Results show that species vary across years, but the Southern rays bream (*Brama australis*) is the only specie that is common for every year of data (Figure 25). Indicating that historically has been an importat specie for direct human consumption. This aligns with results obtained in a survey implemented along Chile where 51% answered that Southern rays bream was their first preference (@fundacion_chile_chile_2016). Within 2013, 2014 and 2016, we can see the presence of Anchoveta (*Engraulis ringens*), while in 2017 there is high increase in Jumbo flying squid (*Dosidicus gigas*). We removed year 2015 from this analysis becasue data on landings per sector was not accurate (See Appendix Chile Method 1).

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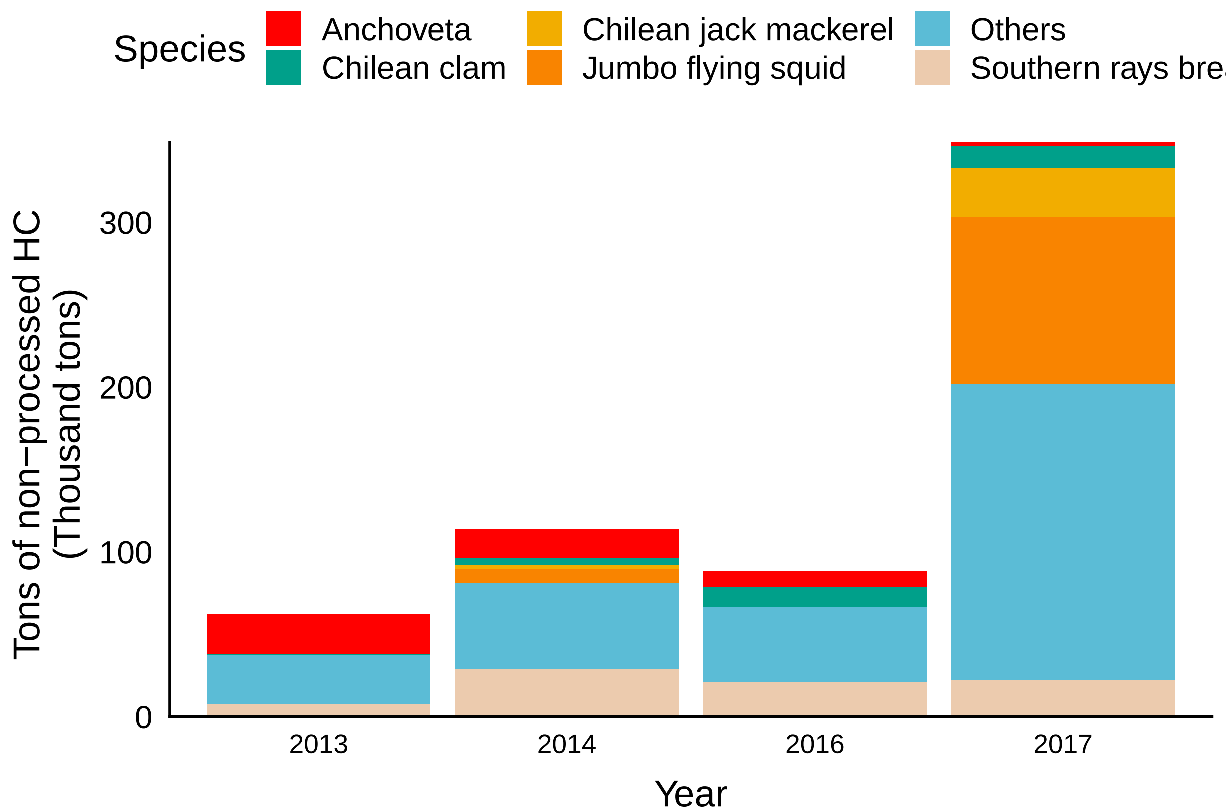

Figure 8: Main artisanal landings that are not processed in facilities. Data source: SERNAPESCA, 2018

Main fisheries for food supply

To identify the main fisheries for human food supply in Chile we combined datasets from landings, aquaculture, raw material that goes into facilities for non-human consumption, imports and exports. Assuming that all local landings and harvest that is not processed as non-human consumption products nor exported is comsumed locally. Eventhough landings and aquaculture databases are detailed at a species level, we agragated the data in larger groups (See Appendix Chile Method 2) to be able to combine them with the Chilean Customs datasets. Our results show, that the main fishery for local consumption across the years has been squid. Within this group we considered: Patagonian squid (*Loligo gahi*), Jumbo flying squid (*Dosidicus gigas*), Argentine shortfin squid (*Illex argentinus*) and Japanese flying squid (*Todarodes Pacificus*). These species predominate local consumption across years. In 2017 there was a significant increase in squid's exports, reducing the total amount of seafood available to be consumed locally. Other fisheries important for domestic HC in Chile are Hakes, (Including: Southern hake (*Merluccius australis*), South Pacific hake (*Merluccius gayi gayi*), Patagonian grenadier (*Macruronus magellanicus*) and Southern blue whiting (*Micromesistius australis*)) and Southern rays bream (*Brama australis*) (Figure line *939*). It is important to mention that the Southern rays bream is classified on its own group, therefore its relative contribution to domestic consumption is higher compared to other aggregated groups. Squids have the highest yield of all species, therfore their contribution to domestic consumption per landed tonnes is higher, partly explining its high predominance in our results.

These resutls are similar to results obtained with the international databases, where we identify that the main sources of seafood in Chile are landings of species such as jumbo squid or mackerels, and aquaculture with species such as Atlantic salmon and Chilean mussel. However, the local analysis shows that all salmon and mussels produced in Chile is expoted, therefore non is consumed locally Through our model we probably underestimated salmon production or overestimated salmon exports, beacause, eventhough salmon is not the most consumed species in Chile, we know that some salmon stays in the country and is sold in the supermarket.

Our model shows that the chilean population also consumes high volumens of Tuna, a group of specie that is mainly imported in a canned format. This result aligned with the chilean population preferences, based on a study along the country, where 84% of the respondee aswered that their normal format for eating fish within a month was canned fish, follwed by freshed fish (80%) and frozen fish (37%) [@fundacion_chile_chile_2016]. The ten most importat fisheries according to our model are provided in the Appendix (Appendix Chile Results 4).

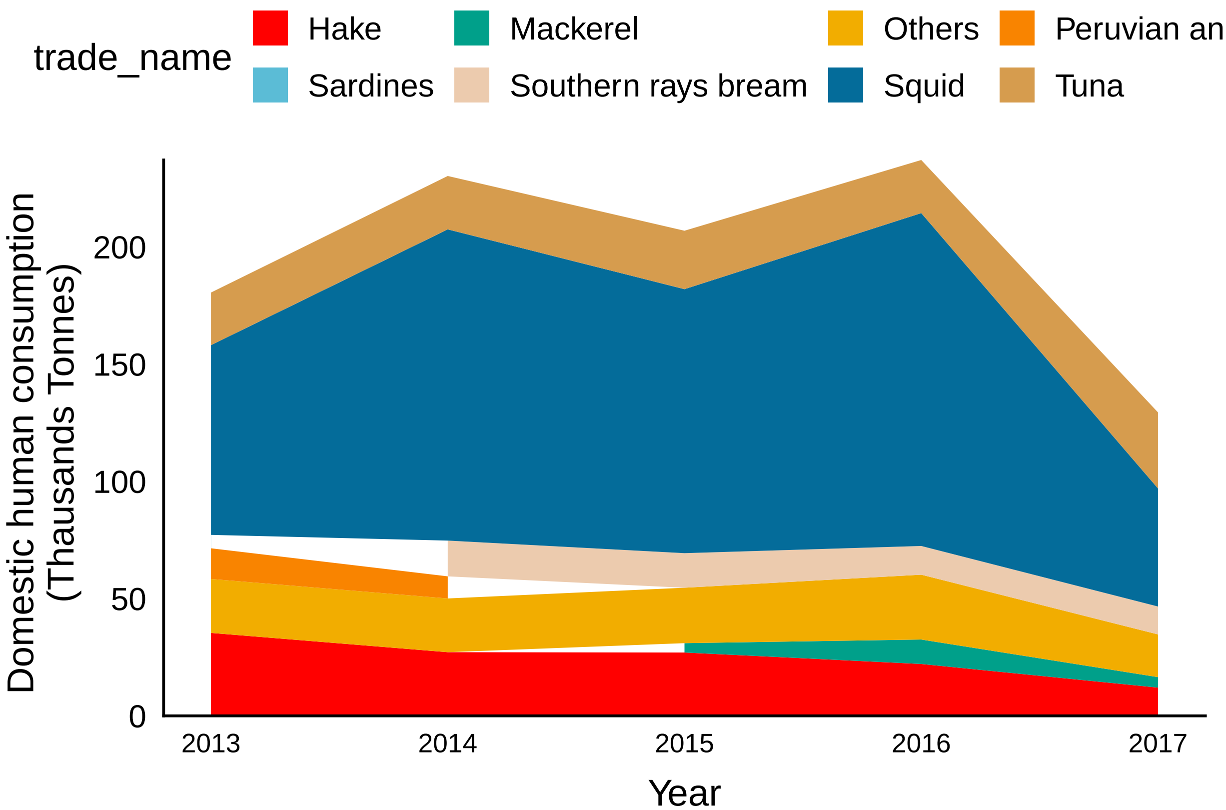

Figure 9: Main groups of species consumed by the chilean population in the last 5 years

Total and per capita seafood consumption in the country

Besed on the results of our model and the current estimate of Chilean population (17,574,033), we calculated an average of 11.5 kg of seafood compsumption per person a year. This estimate is similar to what has been projected by the FAO (2016) of 10-13kg. Total HC consumption per year is stable with an average of 204,656 tonnes a year. In 2017 we obsered a drastic decrese in total and percapita HC of seafood. We are uncertain if this is due to assumtions in our model or the data. However, we have identified that the exports for Squid that year increased drastically.

Regional differences in per capita and total consumption

We where not able to do a regional analysis for domestic consuption. Even though most of the data is provided at a regional level. We realized that is was not possible to assume that what was landed in a region was processed and then exported in that same area. Nor that the imports per area accounted for the actual imported food consumed in the regions because there is internal transport within regions. There is a study done in 2016, along the Chilean coast where people were asked how much fish they eat in a week. Regional results say that 62% of the population from the north declares to eat fish once a week. In

Table 2: Total tones of seafood for humanc consumption and per-capita consumption per year (kg) considering a popilation of 17,762,681 individuals

Year	Total Human Consumption (tonnes)	Per-capita consumption/year (kg)
2,013	191,537	10.783
2,014	238,605	13.433
2,015	213,436	12.016
2,016	245,095	13.798
2,017	134,609	7.578

the north centre region that numbers decreases to 54% and it reaches its lowest point in the Metropolitan Region (42%). In the center south, 48% eat fish at least once a week while in the southern most area 45% (@fundacion_chile_chile_2016)

National Economic Participation

Fisheries, as an economic sector in Chile, includes activities of extraction and farming of marine and freshwater products. This sector contributes to around 0.4% of the national GDP although it has highly variable production [@central_cuentas_2017]. An estimate for 2014 indicates that 90% of sales for the sector came from marine farmed products, reflecting the importance of aquaculture in economic terms relative to wild fisheries [@sence_reporte_2015]. Yet, the extractive sector has a higher number of firms (58% of the total) and contributes to various sectors throughout the economy [@sence_reporte_2015]. Fishing manufacturing closely relates to fisheries. Based on the latest input-output matrix for the country's economy (Banco Central de Chile, 2013), for every US$ 100 spent in the fisheries sector, a further US$ 52.2 dollars are generated in the manufacturing sector. Other sectors impacted by fisheries are the financing sector (US$ 24.8 generated for every US$100) and transportation, and communication (US$13.4 generated for every US$100).

Wild-caught Fish Economic Participation

The contribution of fisheries to regional GDP suggests that the economic importance of the sector to regional economies varies widely, ranging from almost 30% in region XI to 0% in the Metropolitan (RM) and IX regions (Figure X).

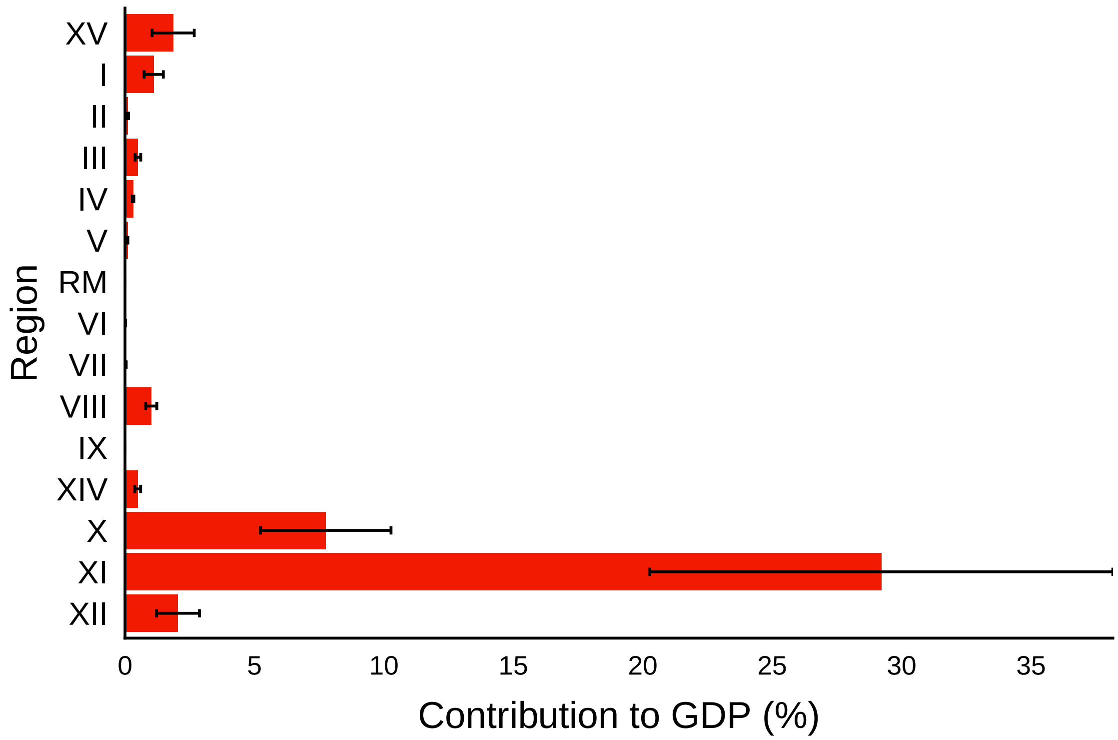

Figure 10: Percent of the regional GDP contirbuted by the fisheries sector averaging data between 2013 and 2016. Data source: Banco Central de Chile.

Based on our estimates of species-specific revenue, the most important species for the artisanal sector are the Southern king crab (*Lithodes santolla*) and the Chilean sea urchin (*Loxechinus albus*) (Figure X). Nonetheless, this varies across years. In 2017 the Patagonian toothfish (*Dissostichus eleginoides*) and the Southern rays bream (*Brama australis*) were the species that provided more revenue, followed by the pink cusk-eel (*Genypterus blacodes*).

These species are among the most expensive (Appendix Chile Results 5). The Patagonian toothfish (*Dissostichus eleginoides*) has the highest mean ex-vessel price in the artisanal sector what explains, in part, why is one of the top five in term of revenues. We should note that the fishing costs for different types of species could vary widely and we are not accounting for this in our analysis. Yet, we can qualitatively consider the costs of different types of fishing. For example, some of these species are fished by diving near the shore like the Chilean abalone (*Concholepas concholepas*) and the Chilean sea urchin (*Loxechinus albus*), while others like the Patagonian toothfish (*Dissostichus eleginoides*), the Southern king crab (*Lithodes santolla*) or the Swordfish (*Xiphias gladius*) involve offshore fishing, which tends to be much more expensive. The gathering of algae from the shore is arguably one of the least costly extractive activities for the artisanal sector but it is not among the ones that generate more revenue. We could not generate similar estimates for the industrial and aquaculture subsectors due to lack of data on their first-transaction prices.

Trade Economic Participation

Seafood products are one of the most important exports of the country. IFOP valued the exportation of fisheries-related products in US$6.28 billion dollars in 2017 (@ifop_boletines_2017). This corresponded to ~ 9 % of the total value of national exports. By far, the most important group of species in terms of exports value are salmons, particularly the Atlantic salmon (*Salmo salar*) (Figure X). The net value of salmons is, on average, US/$ ~3.4 billion (Table 3). They are almost exclussivelly produced by aquaculture. Mussels, specifically the Chilean Ribbed Mussel (*Aulacomya ater*) and the Chorus mussels (*Choromytilus chorus*) are also among the most valuable exports. These are landed by artisanal fishers and to a lesser extent produced in aquaculture centers, contributing with ~ US$167 million. In general, the value composition of exports is stable. Yet, salmon seems to be driving an increase in exports value since 2015.

The most valuable sea products in terms of exports are frozen and fresh followed by fish meal and dried algae [@ifop_boletines_2017]. In 2016, fish fillets were the fourth most exported product by Chile. This commodity generates around US$2 billion per year and is mainly composed of farmed salmons [@datachile_fish_2016].

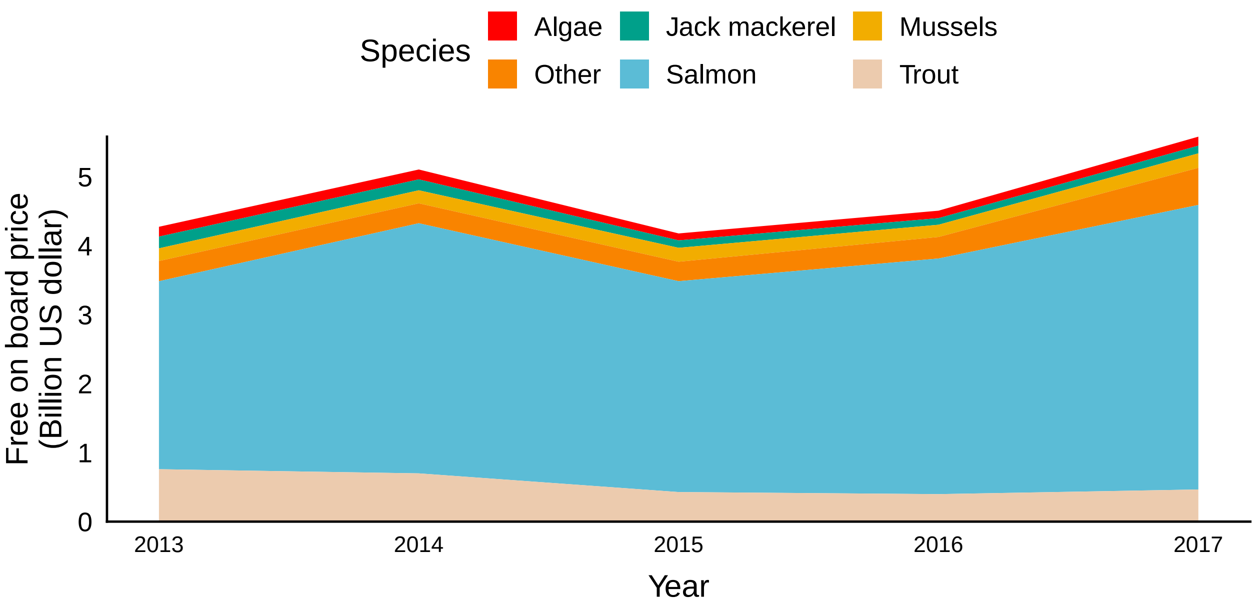

Figure 11: Main exported species in terms of econmic value. Source: Dataset Aduanas Chile

Fish and Aquaculture Employment

Fisheries and aquaculture are considered to be the second activity that provide less direct employment in the country, after agriculture [@sense_reporte_2015]. But, the number of people employed in the sector has been on the rise since 2010 [@sence_reporte_2015]. We estimated a total of ~278,000 job positions generated by fisheries and aquaculture. This estimate considers artisanal and industrial fishers, workers in processing facilities and aquaculture centers and indirect jobs generated by the manufacturing sector (Table 4). It does not include other indirect jobs generated by the extractive activities and its commercialization (for example, in the sectors impacted by fisheries noted above). Thus, the number of total people directly and indirectly employed by fisheries and aquaculture in Chile could be higher.

People employed in the fisheries and aquaculture activities have an average monthly income of US$579, the lowest mean income in the country after the agriculture sector [@sence_reporte_2015]. This value ranges from US$258 per month for people working independently and part-time to US$1,160 per month for full-time employee (Appendix Chile Results 6).

On average, people employed in the fisheries and aquaculture sector are younger and less educated relative to the national average and are mostly men (Appendix Chile Results 7). However, there is high variation within subsectors, for example, artisanal fishers tend to be older [@tam_gone_2018]. Based on estimates from the national survey of employment (NENE, 2015), only 57.7% of the people employed in the sector are formally hired, the rest work independently, which usually means they do not have pension [@sense_reporte_2015].

Employment in the Artisanal Sector

Table 3: Export and Import value, and net trade (Exports - Import) for the most exported species in Chile

species	2013	2014	2015	2016	2017	Total	Mean	s.d.
Exports								
Salmon	2,726,184,990	3,627,320,351	3,057,757,021	3,416,695,754	4,126,112,342.19	16,954,070,457.42	3,390,814,091.48	536,173,349.70
Trout	759,895,458	699,666,910	428,815,133	398,536,115	466,086,067.48	2,752,999,683.02	550,599,936.60	166,675,670.05
Mussels	184,142,579	189,031,994	201,716,449	177,232,041	209,788,867.18	961,911,928.81	192,382,385.76	13,217,061.16
Jack mackerel	170,353,371	158,337,649	107,831,593	95,979,598	111,365,912.10	643,868,123.65	128,773,624.73	33,241,360.52
Algae	142,127,885	142,955,782	100,725,942	108,189,974	130,646,508.36	624,646,092.55	124,929,218.51	19,489,993.54
Others	90,604,136	101,626,587	93,316,516	92,004,544	234,763,247.68	612,315,031.12	122,463,006.22	62,924,009.71
Patagonian toothfish	70,953,333	62,681,048	60,473,248	88,453,574	76,118,477.26	358,679,680.12	71,735,936.02	11,270,955.04
King crab	50,883,098	65,313,957	58,790,228	60,766,290	79,738,638.85	315,492,211.81	63,098,442.36	10,665,586.42
Hake	69,586,497	49,537,417	55,578,895	61,404,851	71,940,888.07	308,048,547.76	61,609,709.55	9,387,695.97
Sea urchin	10,536,396	9,569,123	14,012,431	9,579,959	75,610,733.27	119,308,643.19	23,861,728.64	28,986,117.94
Imports								
Others	149,323,678	134,410,034	12,014,916,287	11,568,576,076	163,003,126.43	24,030,229,201.37	4,806,045,840.27	6,379,002,985.57
Jack mackerel	17,565,338	9,516,172	2,070,298,477	1,342,452,782	14,030,355.34	3,453,863,124.03	690,772,624.81	962,169,048.17
Hake	864,675	1,298,517	110,956,558	81,920,141	774,787.21	195,814,678.62	39,162,935.72	53,283,730.39
Mussels	1,544,975	1,400,763	123,685,212	0	1,370,170.11	128,001,120.05	25,600,224.01	54,834,753.39
Salmon	4,655	8,901	24,916,549	25,257,998	320,917.84	50,509,020.16	10,101,804.03	13,680,933.15
King crab	10,057	0	0	13,144,158	640,125.69	13,794,341.01	2,758,868.20	5,812,099.08
Trout	0	0	0	0	68.12	68.12	13.62	30.46
Algae	0	0	0	0	0.00	0.00	0.00	0.00
Patagonian toothfish	0	0	0	0	0.00	0.00	0.00	0.00
Sea urchin	0	0	0	0	0.00	0.00	0.00	0.00
Net Trade								
Salmon	2,726,180,335	3,627,311,450	3,032,840,472	3,391,437,756	4,125,791,424.35	16,903,561,437.26	3,380,712,287.45	539,790,695.61
Trout	759,895,458	699,666,910	428,815,133	398,536,115	466,085,999.36	2,752,999,614.90	550,599,922.98	166,675,678.69
Mussels	182,597,604	187,631,230	78,031,237	177,232,041	208,418,697.07	833,910,808.76	166,782,161.75	51,000,832.35
Algae	142,127,885	142,955,782	100,725,942	108,189,974	130,646,508.36	624,646,092.55	124,929,218.51	19,489,993.54
Patagonian toothfish	70,953,333	62,681,048	60,473,248	88,453,574	76,118,477.26	358,679,680.12	71,735,936.02	11,270,955.04
King crab	50,873,040	65,313,957	58,790,228	47,622,132	79,098,513.16	301,697,870.80	60,339,574.16	12,553,797.68
Sea urchin	10,536,396	9,569,123	14,012,431	9,579,959	75,610,733.27	119,308,643.19	23,861,728.64	28,986,117.94
Hake	68,721,822	48,238,899	-55,377,663	-20,515,290	71,166,100.86	112,233,869.14	22,446,773.83	57,189,528.23
Jack mackerel	152,788,033	148,821,478	-1,962,466,883	-1,246,473,184	97,335,556.76	-2,809,995,000.38	-561,999,000.08	984,977,603.02
Others	-58,719,542	-32,783,447	-11,921,599,771	-11,476,571,532	71,760,121.25	-23,417,914,170.25	-4,683,582,834.05	6,406,367,275.17

Table 4: Most recent estimates of people employed in different stages of the supply chain of sea products in Chile. Note that the estimate of indirect employment only considers the processing stage.

Stage of the supply chain	Employees	Year of the estimate	Source
Artisanal Extraction	88,968	2018	RPA (SERNAPESCA, 2018)
Industrial Extraction	3,525	2018	RPI (SERNAPESCA, 2018) and SUBPESCA website (2018)
Aquaculture Centers	17,631	2017	Maturana et al., 2017 (SERNAPESCA, 2018)
Manufacturing	65,451	2017	Maturana et al., 2017 (SERNAPESCA, 2018)
Indirect employment	102,758	2018	Own estimate based on IFOP,2015 multipliers

The artisanal sector corresponds to fishing activities performed by vessels equal to or smaller than 18 meters in length and by collectors in the inter-tidal zone [@subpesca_panorama_2018]. Based on the current national record of artisanal fishers (RPA), there are around 89,000 artisanal fishers along with 12,700 vessels in Chile. Figure X, shows the number of artisanal fishers per region and gender. They are concentrated in the X and VIII regions and are mostly men. The main activity in the artisanal sector is harvester or collector (mostly shoreline algae collection). All regions present similar composition of fishing activities (Figure X). However, region X seems to rely more on benthic resources for employment than the others since they have a greater share of divers and algae collectors.

Employment in the Industrial Sector

The industrial sector comprises activities performed by vessels larger than 18 meters. Currently, there are 475 industrial vessels and 164 vessel owners according to national industrial records (RPI), from which only 25 are individual owners and the rest are firms [@maturana_mujeres_2017]. A further 3,500 jobs are generated through vessels operations [@subpesca_pesca_2018]. Based on information on the distribution of vessels (Figure X), most industrial extractive activities occur in region VIII, as is also reflected by landings estimates discussed above. Still, vessels are registered along the entire coast. Some of the firms that own industrial vessels also own processing facilities whose employees are included in estimates as part of the processing stage.

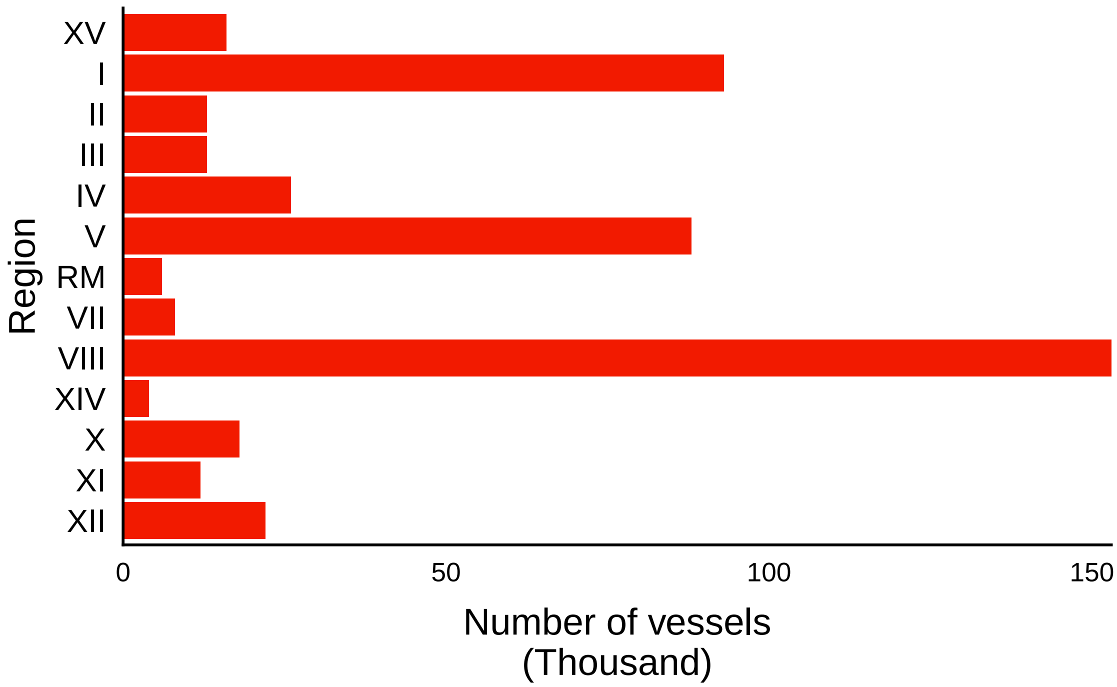

Figure 12: Number of industrial vessels per region. Dataset SERNAPESCA.

Employment in the Industry

A rigorous study by IFOP estimated a total of ~50,000 job positions in the manufacturing of marine products in processing facilities in 2014 [@ifop_monitoring_2015]. However, a more recent report from SERNAPESCA suggests a total of 65,451 jobs [@maturana_mujeres_2017]. Figure X displays the geographic distribution of people employed in the manufacturing sector by gender and type of product for 2015. Employment in the processing facilities is mainly in products for human consumption (HC), with ~ 40,000 job positions. Products for animal consumption (AC) generated around 5,000 positions, while algae products, mainly destined for industrial uses, employed less than 3,000 people. Most people employed by the manufacturing sector are located in the southern part of the country and the majority are men.

Figure 13: Number of employees in the fisheries manufacturing sector in each region by gender in 2015. AC refers to products for animal consumption and HC products for human consumption. Source: Report by IFOP based on facilities survey (IFOP, 2015)

Employment in the Aquaculture Sector

There are 17,631 people employed among the 3,683 aquaculture centers currently registered in Chile [@maturana_mujeres_2017], including ~4,500 women. Figure X shows the distribution of aquaculture centers per region and type of farmed species. The main type of product being farmed is fish, mostly salmon, followed by mollusks and algae. Region X hosts more than half of the aquaculture centers in the country.

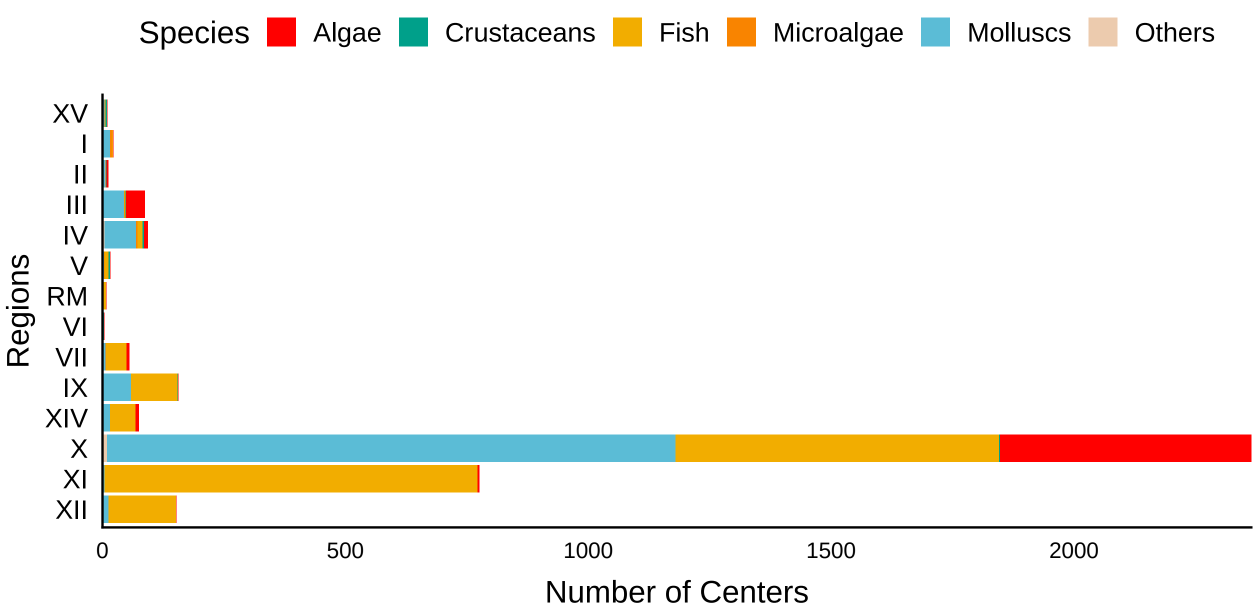

Figure 14: Number of aquaculture centers in each region by type of species in 2017. Source: Report Subsector Acuicultura 2017 by SERNAPESCA (SERNAPESCA website, 2017)

Critical Analysis

Data Uncertainty and Gaps

- Most of our analysis relied on publicly-available data collected by government institutions. Although data collection has improved over the years and there have been important national efforts towards transparency, there are still some potential biases in data. Particularly concerning is landings data, since they are mainly generated via landings declarations. This requires fishers to announce their intention to land their catch to the authority in charge in their macrozone who must weight and certify the catch. Without the certification of their catch, fishers cannot sell it in legal establishments and they risk their permits and penalty fees. Still, incomplete enforcement may generate incentives to underreport. Illegal unreported and unregulated (IUU) fishing has been highlighted in Chile, even in systems where fishers are expected to have high incentives against it, such as Territorial Users Rights systems [@oyanedel_illegal_2018].
- A lack of consistency in data collection between and within agencies brings another source of uncertainty for an analysis like ours. A major challenge was to match trade and landings data. SERNAPESCA collects data under common names, while Aduanas Chile record exported and imported products under the International Harmonized System nomenclature. We designated the groups and did all the corresponfing matching, however this step is prone to human error, theredfore add uncerteinty to our analysis.
- We found lack of consistency in two datasets provided from SERNPESCA for the year 2015. Data segregated by sector, month and region did not match aggregated data published in a differen document. This confirms that even though official data is our most reliable source, it also provides uncerteinty.
- It is possible that we have overestimated exports volumes for some species since some products combine the species of interest with other ingredients. We could not account for this since we did not have data on the products composition on different ingredients. However, for the most exported products this is not a major issue since fish fillets and fresh products are usually almost 100% made by fish meat or shellfish. Similarly, we lacked data on species-specific yields to estimate how many Kg of a species translates into different marine products. We found our analysis to be particularly sensitive to the values of species-specific yields, highlighting the importance of improving this aspect of the model.
- A major information gap we identified is the lack of publically available data on ex-vessel prices and employment for the industrial sector. To our knowledge neither SERNAPESCA, IFOP nor SUBPESCA collect data on this regard. Even though we were able to estimate the total impact of the fisheries industry (supply chain) in the country's GDP using the SAU data and the multiplier developed by Dyck and Sumaila [@Dyck], there is no detailed information from the national sources for the industrial sector as there is for the artisanla sector in Chile. Thus, identifying what were the most valuable species for the industrial sector was not possible. One possibe future exploration could be to derive ex-vessel prices from trade data [@melnychuk_reconstruction_2017]. The fisheries sector for which we found most available information was the artisanal sector. We were able to get a count of the direct employment generated by this sector through to the National Record of Artisanal Fishers (RPA). Eventhough the RPA is an official registration for fishers, we know enforcement is weak specially in remote areas of the country therefore there is room for illigal activity which could lead to underestimation of the the amount of people working in this area. We were also able to estimate species-specific revenues by using landings and prices of first transactions. Finally, information on employees in processing facilities was also available. However, some values were unrealistic since they were larger than the entire population of the country. Thus, we prefered relied on a survey study performed by IFOP to fullfill this estimate.
- We also lacked data on the transportation of landings and products between Chilean regions and final destinations. This prevented us from applying our model of food supply at the regional level. The problem is that the catch landed in one region could be processed in a different one and then the final product sold in a third region. Running the regional analysis without accounting for this issue would have led to incorrect estimates of food consumption.

Fisheries context

Key messages:

- The most landed species in Chile are the Peruvian anchoveta (*Engraulis ringens*), the Araucanian herring (*Strangomera bentincki*), and the Chilean jack mackerel (*Trachurus murphyi*). All of these species are fish by both the industrial and artisanal sectors.
- An important volume of artisanals' landings comes from algae, especially from the Giant grey and brown kelp (*Lessonia nigrescens* and *Macrocystis*, respectively).
- The group of species that is most imported to Chile is Tuna, while the most exported are salmons.
- Salmons are by far the most important species in terms of volume for aquaculture, followed by mussels.

Seafood Consumption

Key messages:

- Most importants species in terms of food consumption in Chile are Jumbo Squid (*Dosidicus gigas*) and Southern rays bream (*Brama australis*) followed by hakes and mackerel.
- Trends in food consumption show that in general the species that contribute to domestic food consumption have been constant through time except from Hake, that has been slowly declining.
- Tuna is one of the main groups of species consumed in the country but is mainly imported.
- Most of wild-caught fish is processed for non-human consumption products.
- Despite its massive production, aquaculutre is not a major source of food supply for the Chilean population. Most of its production is exported or are too expenssive to be accessed by lower income groups which is the population of interest in the contxt of food security.

Chile is considered one of the main countries in fishery production worldwide [@fao_estado_2016], however studies suggest the Chilean population does not consume as many marine products [@gonzales_solo_2018]. We found that on average between 2013 to 2017 the chilean population eats ~11kg of seafood a year. This is lower than the 20 kg a year recommended by Food and Agriculture organization (2016). According to the National Health Survey [@ministerio_de_salud_gobierno_de_chile_encuesta_2018], only 9.2% of the Chilean population eats fish at least two times a week as recommended. This value has decreased since the early 2000s where this percentage was 10.7% [@ministerio_de_salud_gobierno_de_chile_encuesta_2018]. World Data [@ritchie_our_nodate] also shows a decrease in the amount of per capita seafood consumed per year by the Chilean population from ~16kg consumed in 2004 to 12.5kg in 2013.

Looking into what type of seafood the Chilean population consumes, a study done in 2012 showed that 60% of the seafood consumed are pelagic fishes, 12% are mollusk and 2% are crustaceans [@villena_marcelo_diagnostico_2012]. With our model we also identifyed that Chileans moslty rely on pelagic fisheries as their primary source for seafood. The most important groups of species for domestic food consumption are squids, tuna, hake, and the Southern ray beam. However, it is likely that we have overestimated squid consumption. It is worth noting that Tuna is mostly imported into the country, while most of the species that are use in HC like salmon, trouts and mussels are mostle exported outside the country. This reflects the importance of market forces on world-wide seafood distirbution and supply. Salmon and trouts get better prices a broad and are too expensive for Chileans in general.

Seafood consumption in Chile has been shown to be correlated with income, as in other parts of the world. However, the data is spotty and is probably missing some of the consumption that occurs in coastal communities. According to a study done in 2016 by Fundación Chile and Adimark [@fundacion_chile_chile_2016], the frequency of seafood consumption varies along socio-economic groups in Chile, 55% of the high-income group consumes seafood at least once a week compared to the 38% of the lower-income group. It has also been identified [@ministerio_de_salud_gobierno_de_chile_encuesta_2018] that people with less years of schooling tend to eat less fish (only 6.3 percent eats seafood twice a week) than people that have completed high school education, where 11.2% eats as frequently.

Within the Chilean population there is a strong belief that seafood is expensive. However, there is wide range of fish prices. There are expensive products such as salmon and affordable alternatives such as Chilean Jack Mackerel (*Trachurus murphyi*), Jumbo Flying Squid (*Dosidicus gigas*) and Southern Rays Bream (*Brama australis*) [@ministerio_de_salud_gobierno_de_chile_encuesta_2018].

Economic participation

Key messages: - Aquaculture, specifically that of Atlantic salmon (*Salmo salar*), is the marine activity that contributes the most to the national economy. - Valued and benthic species like the Chilean sea urchin (*Loxechinus albus*) and the Loco (*Concholepas concholepas*) have a high potential to bring revenues to the artisanal sector due to their high ex-vessel prices and relatively low costs of fishing. - Despite being spread along the entire coast, fishing activities and the processing of marine products concentrate mostly in the South and Austral South of the country. - While there are estimates about how many people directly and indirectly relies on fisheries a source of income an employment there is lack of an official record that allow to answer this question. - There is a large share of the people employed in the sector that are not formally hired, what translates into the lack of a pension system for those individuals.

Aquaculuture is the most important activity in the fisheries sector in terms of economic value. Their profits come mainly from the exportation of salmon products, placing salmons and trouts as the species that mostly contributes to the country's economy. Wild-caught species that have contirbuted the most to exports these past years are the jack mackerel (*Trachurus murphyi*) and the Jumbo squid (*Dosidicus gigas*). The latter is used for DHC and is targeted by both the artisanal an industrial sector. Yet, current discussions on closing access to the industrials to this fishery could bring consequences for both income and food supply. Among wild-caught fisheries the ones that seems to generate more revenues for the artisanal sector are the Southern king crab (*Lithodes santolla*) and the Chilean sea urchin (*Loxechinus albus*). While the first fishery occurs only in the South of the country, the latter is ditributed along the coast of Chile.

Although the direct employment in aquaculture centers is low relative to the number of artisanal fishers, it is very likely that an important share of the job positions in the manufacturing sector are being supported by aquaculture. Especially in the South where most job positions for manufacturing of human consumption products are concetrated. The role of Algaes in terms of employment for the artisanal sector is also worth notice. The revenues of most these species are not particularly high, however the lower costs of extraction relative to other types of fishing make algae collection an attractive form of livelihood for coastal communities.

Chile requieres a better understanding of the number of people relying on fisheries. An important data gap we identified was the lack of information from the industrial and aquaculture sector on the number of workers and the value that different species bring to their industries.

Oceana Next Steps

We learned that there is poor undertanding on Chile regarding the specific species that support food and economic security in the country. Although people have tried to answered these kind of questions before, there is not a constant track of what species are being eaten and how much do chilean people eat. We think that an approach like the one presented here could be easily automatized to keep track of the trends on domestic seafood consumption. Nonetheless, it would requiere some improvements to get more reliable estimates by full-filling some of the datagaps.

A mayor challenge we faced was to combine all datasets without losing species resolution. We think there is potential to improve the methods we used for scraping data from the imports and exports databases. For example, the Chilean customs recently uploaded the export information for 2018 as an excel file combining type of products, identification codes, exported tonnes and values. When we ask for this sort of document back in October, the Chilean customes told us they were working on it so hopefully they will publish historic data in that fomat too. This could increase the species resolution, reduce human error and facilitate automatization. Other two things that would improve the estimates we obtained here are species-specific IUU estimates and yields per type of product for Chilean species. IUU estimates are becoming more popular and different methods have been developed for estimate them from elliciation tasks to more model driven approaches [@wwfchile_estimacion_2017, @oyanedel_illegal_2018]. This kinds of estimate could be also of interested to management authorities. Thus, Oceana could cooperate with them to ellaborate them .

Chile is increasingly pushing for an increase in seafood consumption. Currently, there are programs that promote seafood consumption like *Del Mar a mia Mesa* (From the sea to my table). We think Oceana could contribute adding to the discussion the whole picture of the state of the fisheries and the economic implication for the country of transitioning to a more fish based diet. For this an integrated analysis about the state of the fishery and its economic importance for the country needs to be done. More than just promoting the increase in domestic seafood consumption we think it is necesary to know why is it important and who will benefit and loose. These are key elements for the success of any project of this type. Furthermore it in order to assure food security it is necesary to promote eating fish from well managed fisheries.

In our analysis we did not explore the role of the commercialization chain on food supply and distribution. Investing in better understanding from where can people access seafood and at what prices is crucial to improve food security. Thus, there is a need to better characterize the distribution network of seafood in Chile and explore opportunities to improve seafood access by better managing the supply chain.

Finally, it would be interesting to study the preferences an attitudes of Chileans towards products that have not been historically consumed but that are becoming important in terms of landings like algae and squid. Understanding the potential for these species to succed as food products within the country may be important to improve access to marine protein for more vulnerable communities.

Conclusions

The main takeaway of our analysis regarding the contribution of domestic fisheries for human consumption is that most of the wild-caught fish currently does not go to human consumption, but to produce no human consumption products like fish meal and oil or algae products. On the other hand, most of the aquiculture produced in the country is for human consumption but it is exported elsewhere. Less than 30% of the local production stays in the country for human consumption. Additionally, one of the most relevant species for human consumption in Chile is tuna, which is mainly imported and canned.

In economic terms, aquaculture is more important than wild-caught fisheries producing ~ 90% of the sales of the economic sector. Nontheless, wild fisheries is more important in terms of employment if we consider both the artisanal and industrial sector.

Chile

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Supplemental Material List

Chile

Methods

Fisheries Context

Estimates of landings and harvest

- To evaluate the volume contribution of specific fisheries over the last five years, we used records of landings and aquaculture harvests from SERNAPESCA (2013-2017). These records include species-specific landing per region or month (not both simultaneously) for each subsector (i.e. industrial and artisanal). We downloaded them for each year since 2007, cleaned them and compiled them in a signle tidy database of landings and harvests to make visualizations and get estimates.
- We identified an abrupt increase in landings for year 2015 in the artisanal sector. After consulting with other databases and reports and reviewing our coding, we concluded that observations for 2015 were not reliable. SERNAPESCA has another dataset called *Anuario* avaiable at their website, that lists species-specific landings but no detail regarding region nor sector. We used this dataset to compare landing values and test whether they matched. We found no differences for years other than 2015, but the landing estimates did differ between our detailed dataset and *Anuario* in 2015. We assumed that *Anuario* is more accurate since its estimates were more similar to other years. Nontheless, we keep on using the detailed dataset whenever we wanted to identify trends within sectors or regions but, ignoring 2015.

Estimates of trades

We use data from *ADUANAS Chile* to quantify the volumes and value of each group of species being imported or exported into the country. These records detail the weight and value of traded products, which are recorded under an id code for prodcuts categories. These categories are not species-specific, although a lot of them aggregate products of species that belong to the same genus o family. To come up with categories that we could match between import and export dataset as well as between trade and landing datasets, we generated a linking datset (See Index of Species below). To generate this index we first review all the datsets and then, came up with categories that were broad and detail enough that allowed us to identify groups of species between datasets of SERNAPECA and ADUANAS Chile. Using these databases we categorize exported and imported products into species groups that could be matched to calculate net trade.

National Seafood Supply

Species contribution to human and non-human consumption

Landings come either from industrial, which includes fabric vessels (l_i), or artisanal vessels (l_a). Here, we assume that all l_i are send to processing facilities while l_a can either go to processing facilities or be sold as non-processed products, which we assume, are used for HC (NP_{HC}).

Landings can either be sold as non-processed products (NP_{HC}) or go to processing facilities where they will be transformed in products for human consumption (P_{HC}) or products for other uses (P_{NHC}). In our analisys we are considering the following types of products to be use for human consumption: fresh, frozen, salty dry, salty wet, smoked, canned, dehydrate. While fish meal, oil, dehydrate, dried algae, and other algae derivatives are use for non human consumption. We assumed that all agae are for non human consumption therefore removed.

Aquaculture (Aq) reffers to the harvest of different species being farmed at the sea or freshwater centers. We assume all the volumes coming from aquaculture center enter processing facilities.

In Chile, almost all L_i and Aq are send to processing facilities while only some of the L_a is processed. We assume that the rest of the artisanals' catch that is not sent to processing facilities is sold as non-processed products for human consumption (NP_{HC}). To get an estimate of NP_{HC} we substracted Aq and L_i to all the raw material entering processing facilities and use the residual as the volume of L_a that is processed. We then, substracted this volume from L_i to get NP_{HC}, which is the rest of the artisanals' catch that is not being processed. The assumptions behind this method are (i) that all the raw material in processing facilities that is not being supplied by industrial fishing or aquaculture is supplied by artisanals, and (ii) all the catch that artisanals do not sell to processing facilities is sold directly for human consumption.

Main fisheries for food supply

On order to develop the model described in the general methods, we had to match all products impoted and exported with the species landed or harvested. We used as references products that containd multiple species within the Aduana's databases. All species classified under a same *Aduna code* (Using the International Harmonized System) where put together in the same group. Whenever possible we mantaind single species. This allowed us to aggregate products per groups of species and match volumes and values to landing record by SERNAPESCA. In addition, SERNAPESCA applies several variations of a species common name between databases. This difficults the calculation of aggregated estimates. We solve this by generating a dataset that categorize all the names currently used by SERNAPESCA under a common group among the import and export data (See appendix for group details).

We found inconsistencies between two databases of landings published by SERNAPESCA in their website. They differed in the level at which data was aggregated. One database was clasified per sector (artisanal, industria, fabric vessels) and the other was the summary for landings and aquaculture for each year per region. When we aggregated the most detailed database to the same level as the anual summary database we observed differences in landing volumes for the year 2015. We considered this to be part of the measurement error involved in any process of data collection or data entry. We used the summary annual data for our domestic human consumption model because 2015 data alinged better with amounts reported all other years.

We calculated yield by estimating an average between the range of losses from discards and processing provided by Christensen et al. (2014) for Peruvian species. For species that did not have a direct matching yield we used the yield of the most similar species. Yields within a group of species where averaged for the final calculations of the model. See table XX for details on yeilds per sepcies used in our analysis.

We use the processing facilities raw material and product data as a way to account for discard. SERNAPESCA provided us with a databased that contains tonnes of raw material per species that goes into facilities. We summed up all the raw material for products not for human consumption and discounted it from landings to the corresponding groups of speceis.

Total and percapita seafood consumption in the country

Our models is highly sensitive to species yield, therefore in many cases results of our calculations return a negative number implaying that exports are higher than the product of the yield times the local production (landings and aquaculture) minus all tons that go for non-human consumption products. Assuming that all negative numbers do not contribut to domestic consumption because they are mainly exported or used for non human consumption (eg:algae) and none is imported, we calculated a per capita consumption per year. We summed all the human consumption per year (Table XX, chunk below) and devided by the chilean population of 17,574,033. [@instituto_nacional_de_estadisticas_-_chile_sintesis_2018].

Economic Participation

Any conversion from Chilean pesos to dollars was done by first converting the amount in Chilean pesos to its value in Chilean Units of account (UF, a monetary unit corrected by inflation) of the respective year. Then, transformed to the equivalent in 2018 Chilean pesos using the 2018 UF value and finally, converting the 2018 value in Chilean pesos to its equivalent in 2018 US dollars, based on the conversion for Dec, 2018 (US$ 1 corresponds to 676 Chilean pesos).

We combined different sources of data to answer questions of economic participation. We collect data from the Central Bank of Chile to understand the contribution of fisheries to regional economies. To estimate net trade, we use the ADUANAs Chile trade database and products of imports and exports in matching categories. To generate estimates of species-specific revenue, we use data from SERNAPESCA on artisanal ex-vessel prices by species, year and region and multiply them by the landed volume per species, year and region. Most estimates of employment were extracted from reports but some of them were done using data from SERNAPESCA on processing facilities.

Results

Table 5: Index of all species considered in this analysis and their corresponding group

Name SERNAPESCA	Scientific Name	Group
AGUJILLA	Scomberesox saurus scombroides	King gar
ALBACORA O PEZ ESPADA	Xiphias gladius	Swordfish
ALBACORA	Xiphias gladius	Swordfish
ALFONSINO	Beryx splendens	Splendid alfonsino
ALMEJA	Venus antiqua	Clams
ANCHOVETA	Engraulis ringens	Peruvian anchoveta
ANCHOVETA BLANCA	Anchoa nasus	Anchovy
ANGUILA	Ophichthus spp.	Eel
APANADO	Hemilutjanus macrophthalmos	Grape-eye seabass
ATUN ALETA AMARILLA	Thunnus albacares	Tuna
ATUN ALETA LARGA	Thunnus alalunga	Tuna
ATUN CHAUCHERA	Gatrochisma melampus	Tuna
ATUN OJOS GRANDES	Thunnus obesus	Tuna
AYANQUE	Cynoscion analis	Peruvian weakfish
AZULEJO	Prionace glauca	Shark
BACALADILLO O MOTE	Normanichthys crockeri	Mote sculpin
BACALADILLO	Normanichthys crockeri	Mote sculpin
BACALAO DE PROFUNDIDAD	Dissostichus eleginoides	Patagonian toothfish
BAGRE AGUA DULCE	Ictalurus punctatus	Channel catfish
BESUGO	Epigonus crassicaudus	Sea bream
BLANQUILLO	Prolatilus jugularis	Pacific sandperch
BONITO	Sarda chiliensis	Skipjack tuna
BRECA O BILAGAY	Cheilodactylus variegatus	Peruvian morwong
BILAGAY	Cheilodactylus variegatus	Peruvian morwong
BRECA	Cheilodactylus variegatus	Peruvian morwong
VILAGAY	Cheilodactylus variegatus	Peruvian morwong
BRECA O VILAGAY	Cheilodactylus variegatus	Peruvian morwong
BROTULA	Salilota australis	Tadpole codling
CABALLA	Scomber japonicus	Mackerel
CABINZA	Isacia conceptionis	Cabinza grunt
CABRILLA	Paralabrax humeralis	Peruvian rock seabass
CABRILLA COMUN	Paralabrax humeralis	Peruvian rock seabass
CALAMAR	Loligo gahi	Squid
CAMARON DE ROCA	Rhynchocinetes typus	Shrimp
CAMARON NAILON	Heterocarpus reedi	Shrimp
CANGREJO DORADO DE J. FERNANDEZ	Chaceon chilensis	Crabs
CANGREJO D. DE J. FERNANDEZ	Chaceon chilensis	Crabs
CANGREJO DORADO DE JF	Chaceon chilensis	Crabs
CANQUE	Stellifer minor	Minor stardrum
CARACOL LOCATE	Thais chocolata	Snails
CARACOL PALO PALO	Argobuccinum spp.	Snails
CARACOL PICUYO	Odontocymbiola magellanica	Snails
CARACOL PIQUILHUE	Adelomelon ancilla	Snails
CARACOL RUBIO	Xantochorus cassidiformis	Snails
CARACOL TEGULA	Tegula atra	Snails
CARACOL TRUMULCO	Chorus giganteus	Snails
CENTOLLA	Lithodes santolla	King crab
CENTOLLON	Paralomis granulosa	King crab
CENTOLLON DEL NORTE	Paralomis spp.	King crab
CHANCHARRO	Helicolenus lengerichi	Rockfish helicolenus
CHASCA	Gelidium rex	Algae
CHASCON O HUIRO NEGRO	Lessonia nigrescens	Algae
CHICOREA DE MAR	Chondracanthus chamissoi	Algae
CHOCHA	Trochita trochiformes	Snails
CHOLGA	Aulacomya ater	Mussels
CHORITO	Mytilus chilensis	Mussels
CHORO	Choromytilus chorus	Mussels
COCHAYUYO	Durvillaea antarctica	Algae
COCHINILLA	Navodon Paschalis	Navodon
COJINOBA DEL NORTE	Seriolella violacea	Warehou
COJINOBA DEL SUR	Seriolella caerulea	Warehou
COJINOBA	Seriolella	Warehou

Table 6: Species and their correspondding yield based on Christensen et al. (2014)

Scientific Name	Yield
Scomberesox saurus scombroides	0.500
Xiphias gladius	0.425
Xiphias gladius	0.425
Beryx splendens	0.500
Venus antiqua	0.225
Engraulis ringens	0.550
Anchoa nasus	0.550
Ophichthus spp.	0.400
Hemilutjanus macrophthalmos	0.525
Thunnus albacares	0.475
Thunnus alalunga	0.475
Gatrochisma melampus	0.475
Thunnus obesus	0.475
Cynoscion analis	0.600
Prionace glauca	0.560
Normanichthys crockeri	0.500
Normanichthys crockeri	0.500
Dissostichus eleginoides	0.424
Ictalurus punctatus	0.475
Epigonus crassicaudus	0.500
Prolatilus jugularis	0.500
Sarda chiliensis	0.600
Cheilodactylus variegatus	0.500
Cheilodactylus variegatus	0.500
Cheilodactylus variegatus	0.500
Cheilodactylus variegatus	0.500
Cheilodactylus variegatus	0.500
Salilota australis	0.500
Scomber japonicus	0.600
Isacia conceptionis	0.500
Paralabrax humeralis	0.525
Paralabrax humeralis	0.525
Loligo gahi	0.775
Rhynchocinetes typus	0.200
Heterocarpus reedi	0.200
Chaceon chilensis	0.225
Chaceon chilensis	0.225
Chaceon chilensis	0.225
Stellifer minor	0.525
Thais chocolata	0.200
Argobuccinum spp.	0.200
Odontocymbiola magellanica	0.200
Adelomelon ancilla	0.200
Xantochorus cassidiformis	0.200
Tegula atra	0.200
Chorus giganteus	0.200
Lithodes santolla	0.225
Paralomis granulosa	0.225
Paralomis spp.	0.225
Helicolenus lengerichi	0.500
Gelidium rex	0.750
Lessonia nigrescens	0.750
Chondracanthus chamissoi	0.750
Trochita trochiformes	0.200
Aulacomya ater	0.175
Mytilus chilensis	0.175
Choromytilus chorus	0.175
Durvillaea antarctica	0.750
Navodon Paschalis	0.500
Seriolella violacea	0.600
Seriolella caerulea	0.600
Seriolella	0.600

Table 7: Most landed species per year and region in the artisanal sector. Source: Landing records from SERNAPESCA, 2018

Region	Most landed in 2013	Most landed in 2014	Most landed in 2015	Most landed in 2016	Most landed in 2017
I	Anchoveta	Giant grey kelp	Anchoveta	Anchoveta	Anchoveta
II	Giant grey kelp	Giant grey kelp	Anchoveta	Giant grey kelp	Giant grey kelp
III	Giant grey kelp	Giant grey kelp	Giant grey kelp	Giant grey kelp	Giant grey kelp
IV	Giant grey kelp	Jumbo flying squid	Giant brown kelp	Jumbo flying squid	Giant brown kelp
IX	Southern rays bream	Southern rays bream	Snoek	Southern rays bream	Southern rays bream
V	Jumbo flying squid	Jumbo flying squid	Jumbo flying squid	Jumbo flying squid	Jumbo flying squid
VI	New Zealand bull	New Zealand bull	New Zealand bull	New Zealand bull	New Zealand bull
VII	South Pacific hake	South Pacific hake	South Pacific hake	South Pacific hake	South Pacific hake
VIII	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring
X	Red algae gracilaria	Black algae luga	Red algae gracilaria	Black algae luga	Red algae gracilaria
XI	Chilean sea urchin	Chilean sea urchin	Chilean sea urchin	Chilean sea urchin	Chilean sea urchin
XII	Red luga	Red luga	Chilean sea urchin	Chilean sea urchin	Chilean sea urchin
XIV	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring
XV	Anchoveta	Anchoveta	Anchoveta	Anchoveta	Anchoveta

Table 8: Most landed species per region and year in the industrial sector. Source: Landing records from SERNAPESCA, 2018

Region	Most landed in 2013	Most landed in 2014	Most landed in 2015	Most landed in 2016	Most landed in 2017
NA	NA	NA	NA	Patagonian toothfish	Patagonian toothfish
I	Anchoveta	Anchoveta	Anchoveta	Anchoveta	Anchoveta
II	Anchoveta	Anchoveta	Anchoveta	Anchoveta	Anchoveta
IV	Chilean jack mackerel	Chilean jack mackerel	Blue squat lobster	Blue squat lobster	Chilean jack mackerel
V	South Pacific hake	Chilean nylon shrimp	Chilean nylon shrimp	Chilean nylon shrimp	Chilean nylon shrimp
VIII	Chilean jack mackerel	Chilean jack mackerel	Chilean jack mackerel	Chilean jack mackerel	Chilean jack mackerel
X	Southern king crab	Southern king crab	Southern king crab	Patagonian toothfish	Patagonian toothfish
XI	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier
XII	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier	Patagonian grenadier
XIV	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring	Araucanian herring
XV	Anchoveta	Anchoveta	Anchoveta	Anchoveta	Anchoveta

Table 9: Most harvested species per region and year. When no data is available means there were no aquaculure that year in that region. Source: Harvest records from SERNAPESCA, 2018

Region	2012	2013	2014	2015	2016
I	Haematococcus	Haematococcus	Haematococcus	NA	Haematococcus
II	Red algae gracilaria	Red algae gracilaria	Red algae gracilaria	Peruvian calico scallop	Peruvian calico scal
III	Peruvian calico scallop	Peruvian calico scallop	Red algae gracilaria	Red algae gracilaria	Red algae gracilaria
IV	Peruvian calico scallop	Peruvian calico scallop	Peruvian calico scallop	Peruvian calico scallop	Peruvian calico scal
IX	Atlantic salmon	Rainbow trout	Atlantic salmon	Rainbow trout	Chorus Mussel
V	Turbot	Red Abalone	Red Abalone	Red Abalone	Red Abalone
VII	Atlantic salmon	NA	NA	NA	NA
VIII	Rainbow trout	Atlantic salmon	Red algae gracilaria	Red algae gracilaria	Red algae gracilaria
X	Chilean mussel	Chilean mussel	Atlantic salmon	Chilean mussel	Chilean mussel
XI	Atlantic salmon	Atlantic salmon	Atlantic salmon	Atlantic salmon	Atlantic salmon
XII	Atlantic salmon	Atlantic salmon	Atlantic salmon	Atlantic salmon	Atlantic salmon
XIV	Rainbow trout	Rainbow trout	Rainbow trout	Rainbow trout	Rainbow trout

Table 10: Main groups of species for human consumption

2013	2014	2015	2016	2017
Squid	Squid	Squid	Squid	Squid
Hake	Hake	Hake	Tuna	Tuna
Tuna	Tuna	Tuna	Hake	Hake
Peruvian anchoveta	Southern rays bream	Southern rays bream	Southern rays bream	Southern rays bream
Sardines	Peruvian anchoveta	Mackerel	Mackerel	Mackerel
Southern rays bream	Sardines	Clams	Peruvian anchoveta	Shrimp
Mackerel	Mackerel	Sardines	Other fish	Sardines
Shrimp	Shrimp	Shrimp	Clams	Other fish
Skipjack tuna	Clams	Peruvian anchoveta	Shrimp	Clams
Clams	Skipjack tuna	Sea urchin	Sardines	Skipjack tuna

Table 11: Most expensive species in Chile based on their mean ex-vessel price between 2013 and 2017. Source: Data on ex-vessel prices for artisanal sector, SERNAPESCA, 2018.

Species	Mean price (US$/Kg)	SD Price
Patagonian toothfish	21.00	5.74
Common galaxias	18.82	0.25
Sea Chab	11.91	3.96
Chilean abalone	9.22	5.72
Large-tooth flounders	8.44	1.97
Small-eye flounder	7.98	2.62
Red cusk-eel	7.18	1.65
Southern king crab	7.13	2.70
Southern blue whiting	6.75	1.49
Chalapo clinid	6.59	2.47

Table 12: Monthly incomes of fisheries sector in 2018 US dollars. Source: Elaborated based on data from New national employment survey (NENE) in 2015 and published in SENSE, 2015

Type	Employer	Independent	Dependent with contract	Dependent without contract	Mean income
Full time	1,160.8	352.0	885.6	381.7	674
Part time	707.3	258.1	465.1	288.9	302

Table 13: Average demographic characteristics of people employed in the fisheries and aquaculture sector in Chile. Source: Elaborated based on data from New supplementary income survey (NESI) in 2015 and published in SENSE, 2015

Characteristic	Fisheries_and_Aquaculture	National
Average age	42.1	43.2
Years of formal education	9.5	11.9
Percentage of women	8.2	40