CHILE CALIFORNIA COUNCIL

Assessing the economic potential and distribution of Chile's coastal ecosystem services

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Editorial

The Chile California Council has developed through its Coastal Marine Program, a multidisciplinary scientific assessment to determine the economic value of protecting Chile's Coastal Zone, estimating the potential gap between current and future well-managed scenarios. For this, a new methodology was implemented to estimate the value of various coastal ecosystem servicesfor coastal municipalities in Chile, from Arica to Puerto Montt. Besides the aggregated economic impact, the study shows the great diversity between municipalities along Chile's coastal zone, providing valuable tools to design and prioritize conservation policies.

The team effectively designed an innovative methodology to value the three coastal ecosystem services studied (**fisheries, tourism, and wetlands**), using publicly available information, plus available data collected in previous studies. This enabled a collaborative process among the team and other scientists involved in the field, with the vision of integrating and building with what has been done before.

The methodology involved (1) defining the relevant coastal ecosystems and their services, (2) evaluating and quantifying the provision of those services today, (3) constructing plausible scenarios of better-managed trajectories of development for these services, (4) calculating the net present value in each of these scenarios, and finally (5) defining the potential benefit as the difference between the net present value under the "optimistic" and "business as usual" scenarios. This was implemented at a national and local level at coastal municipalities, following two stages: first, through a pilot project in the coastal municipality of the VI Region of Chile (Región del Libertador Bernardo O'Higgins), and then scaling the methodology to all coastal municipalities north of Puerto Montt.

This work is part of a long-term roadmap to implement a Coastal Marine Strategy in Chile, using California's learning curves. This study is a starting point for this, meant to enable an informed public debate towards the economic potential of coastal conservation policies, providing innovative tools to design, evaluate and prioritize these efforts. This initiative can serve as an initial milestone to keep building over, as there's still plenty of granular information to be obtained and analyzed.

This impacts the most when thinking about cultural information and traditional ecological knowledge, which are challenging areas to quantify and establish metrics. However, it's well known that Chile's richness it's not only environmental. Chile still has a tremendous cultural heritage along the coastline - diverse, beautiful, and full of ancestral knowledge that directly relates to the stewardship and protection of ecosystem services.

Then, the better management of those, done locally, should provide long-term resiliency to the natural heritage of the coastal zone as a whole: environment, people, and culture. Those three in balance, provide a healthy and perpetual economic system for local sustainable development. When having more information on the table, bottom-up designs are more feasible and scalable. Therefore, investments to build prototype projects are more necessary than ever, to provide more information and useful experiences.

The learning curves are iterative and continuous in order to keep revising and correcting Conservation toolkits. This work is also meant to elevate the importance of thinking about long-term financial sustainability behind Conservation investments. This can be achieved when Conservation objectives are aligned with local economic development. Part of the activities of the 10 year-roadmap of the Coastal Strategy Framework, relates directly to the importance of the local social tissue and trust, to perpetuate Conservation efforts and monitor the multi-layer benefits. If this is not done locally, financial sustainability behind conservation efforts will remain a challenge.

I want to give special thanks to the team involved in this endeavor. It was fascinating to share a virtuous design process with Rodrigo Oyanedel and Raimundo Atal, and then see their minds thinking and working together, leading their teammates Rayén Mentler and Sebastián Figari. From the Chile California Council, Franco Guillón as Program Manager and Manuela Díaz with the design and communications, it's been a real privilege to work with both of you.

None of this would have been possible without the support of the Ministry of Foreign Affairs of the Government of Chile, the Tinker Foundation and Marisla Foundation. Many thanks for your trust and valuable contributions.

All the best,

Matías Alcalde B.

Coastal Marine Program Director
Chile California Council

Assessing the economic potential and distribution of Chile's coastal ecosystem services

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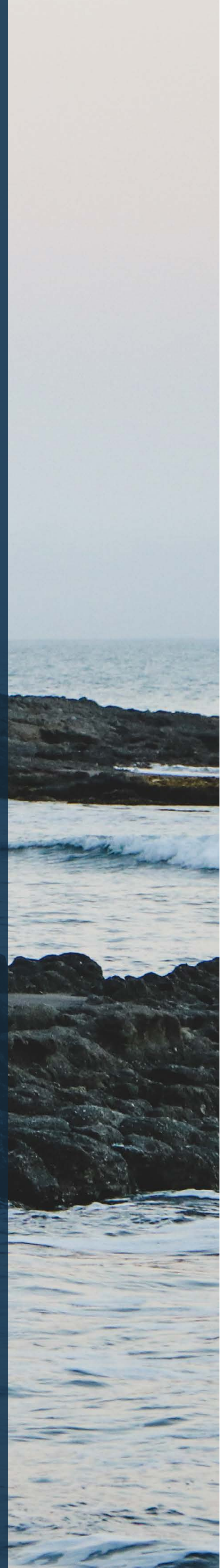
The authors would like to thank Sebastian Figari and Rayen Mertler for invaluable assistance in this project.

Executive Summary

Coastal ecosystems provide essential and diverse services, which can create conflictive uses and degradation. Generally, coastal ecosystems are challenging to manage because they involve land and ocean natural systems dynamics and social interactions. Improving coastal management can benefit from better understanding the value of ecosystem services, because this can help account for the diverse uses those systems provide and help make informed decision on the benefits and costs of management actions. Here, **we developed a methodology for estimating the current and potential economic value of various ecosystem services that Chile's coast provides** and proxies to understand how this value is distributed, all using municipalities at the analytical level. Using diverse methodologies, we find that **tourism provides the largest source of economic value, and our estimates (in conservative scenarios) suggest it more than doubles fisheries**, the second most valuable service. Wetlands are an order of magnitude smaller than the other two bundles that we estimate. We find great diversity in the values across municipalities, which is expected given the sizes, resource endowments, population, and development strategies. Moreover, our results show that **fisheries resources are unevenly distributed at the municipality level, which increases as more value is produced by fisheries**. Overall, our results provide a first approximation to the order of magnitude of the value of three ecosystem services bundles in the coast of Chile.



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Pichilemu, Chile

1. Introduction

Coastal ecosystems are essential to the planet's functioning and sustaining human life. The coast is home to biodiverse spots, provides livelihoods to millions, and offers recreation and cultural identity[3–6]. The variety of benefits coastal systems provide is also the reason for conflictive uses and degradation. This is especially so for people living in coastal areas who face risks associated with climate change and where degradation of ecosystems increases the likelihood of realizing these risks[1]. (Mehvar et al., 2018)

Coastal ecosystems are challenging to manage because they involve land and ocean natural systems dynamics and social interactions. This can lead to poor governance and lack of protection, aggravated by significant uncertainties about how coastal ecosystems work and conflictive uses and interests. Chile's coast is also affected by these issues, which has resulted in **over-exploitation and degradation** under a context of historically weak social and environmental safeguards against extractive industries. **Moreover, the country lacks an integrated vision for sustainable coastal development and a science-based system designed to guide public policy**[7–9].

There is consensus that in Chile (and worldwide), poor ecosystem management results in the sub-optimal provision of their services[2]. For instance, around 70% of commercial fishery stocks are overexploited along the Chilean coastline, leading to current catches that are well below estimated maximum sustainable yields[10]. Improving coastal management can benefit from better understanding the value of ecosystem services, because this can help account for the diverse present uses those systems provide and help make informed decision on the benefits and costs of management actions[11,12]. Better ecosystem accounting can also assist in comparing potential futures (for instance developing or not an infrastructure project) and as such weighting, with a common unit, the benefits and costs these potential futures might have[13].

Chile is a coastal country. More than **4,300 km of coast** merge a narrow strip of geographically accidented land with the ocean. Indeed, only **757,000 km2** of land contrast with the **~3,600,000 km2 of Chile's oceanic Exclusive Economic Zone**. The ocean has been a crucial part of the development of Chile's culture since ancient times. Archaeological evidence suggests fishing by indigenous communities along the Chilean coast had a significant role in these communities' nutrition, economy, and culture. Today, the picture is not that different. **Chile is one of the top world fishing and aquaculture producers, has an extensive tourism industry entrenched with the ocean, a large shipping operation, and considerable potential for marine-based renewable energy sources.** Besides Santiago (Chile's capital), most of Chile's population lives by the coast.

Accordingly, many people depend on the coast for their livelihood. **Only the small-scale fishing sector employs over 90,000 fishers directly.** This figure increases dramatically when accounting for the many livelihoods the fishing, processing, transport, and selling sectors provide. In the aquaculture sector, around 20,000 people are directly employed, with many more working in supporting tasks for the activity. Figures for tourism are dispersed, but overall, **tourism employs ~800,000 people in Chile, contributing 3,3% of the GDP, with around half of the most visited destinations being coastal.**

Chile is an unequal country. Although it experienced substantial increases in GDP per capita in the last few decades, it remains one of the most unequal countries in the world, ranking 35 in its Gini coefficient as of 2019 (World Bank), and the most unequal country in the OECD. In this line, while the ocean benefits many people in Chile, these benefits are unevenly distributed. Few industrial companies concentrate most fishing rights, leaving too many small-scale fishers with too few fish to catch. For instance, for one of the essential fisheries in Chile (the common hake), **only 2-3 industrial fishing vessels fish 60% of the quota, while over 1,000 small-scale boats need to share the remaining 40%**[6]. This concentration occurs not only between sectors (small vs large scale), but also within the small-scale sector, which is often overlooked. Aquaculture and tourism see similar issues along the coast, with benefits from natural resources being captured by few, while local communities bear costs and impacts.

With this backdrop, we developed a methodology for estimating the current and potential economic value of various ecosystem services that Chile's coast provides and proxies to understand how this value is distributed.

A key explanation of these uneven outcomes is overlapping, dispersed, and ineffective governance structures for the coast. Because the coastline is dynamic and complex, many governmental agencies deal with its management, **usually lacking appropriate tools**[8]. This creates inefficiencies as agencies' responsibilities overlap, interact, and even contradict each other. This dispersed governance structures for the coast also prevents the development of the necessary processes for allowing coastal communities to influence how their resources and spaces are managed. While there are some examples of successful governance policies along the coast (e.g., Management and Exploitation Areas for Benthic Resources, and Marine and Coastal Areas for Indigenous Peoples policies), these are isolated and only cover small portions of the coast[14]. **For most of the 4,300 km of coastline, management is ineffective, unfair, and doesn't appropriately consider the input of coastal communities.**

In this context, **the Chile California Council (CCC) has been part of broad and ongoing discussions about potential changes to the governance of the Chilean coastline.** This has been further motivated by likely collaboration pathways between Chile and California. California is an interesting case because of its efforts to protect coastal areas, which provide key livelihood and economic benefits. Through different legislative initiatives (e.g., Coastal Act and Marine Life Protection Act) it has transformed the way its coastal resources are managed and protected. Our work, then, follows some of the ideas and principles for coastal conservation in California and elsewhere, for implementing policies that can improve the way coastal resources are conserved and managed in Chile for the long-term[15].

With this backdrop, we developed a methodology for estimating the current and potential economic value of various ecosystem services that Chile's coast provides and proxies to understand how this value is distributed. Ultimately, we expect that **understanding the potential economic value of better managing Chile's coastal ecosystem services can promote an informed public debate about potential changes in Chile's coast governance.** The report is structured as follows. First, we describe the conceptual framework which outlines the main theoretical foundations to estimate the economic value of ecosystem services. Second, we describe the methods that we employ to approach the estimation as well as the data available. Then, we present the results. Final sections discuss these results and suggests ways of moving forward.

2. Conceptual Framework

The "value" humans attach to nature can be understood as stemming from the "services" it provides to humans. For example, a forest provides raw materials (timber) as well as climate regulation, carbon sequestration, and water filtration. All these services are beneficial -directly or indirectly- to humans[4,16,17], and as such can potentially be valued in monetary terms.

The valuation of Ecosystem Services is an increasingly popular exercise, with significant potential for natural resource management[2,18]. Its importance comes, in part, because it allows for a comparison between costs and benefits of alternative uses of ecosystems in a common -monetary- metric. For example, valuing the climate regulation services provided by a forest in monetary terms reveals the opportunity costs of cutting it down for timber production, which should be considered in a complete cost-benefit analysis of that decision. Thus, a complete evaluation of all private and social costs and benefits is enriched by this perspective [19]. This perspective can also align economic forces with conservation and explicitly link human and environmental well-being [20].

Ecosystem Services

Ecosystem services are a flow that stems from the "stock" of natural capital. Natural capital has been defined as "the living and nonliving components of the ecosystem -other than people and what they manufacture- that contribute to the generation of goods and services of value for people"[16,18]. This definition, however, is open, and natural capital can refer to different things. For instance, it has been defined as the specific components of an ecosystem that provide the goods and services (trees), the extent of the ecosystem when describing the size of the stock (hectares of trees), or the functions that can generate the services[21]. In this framework, ecosystem services interact with different forms of capital: human, physical, and social capital[19,21] . For example, the number of fish captured depends on the stock of fish (and of other species that regulate the habitats where fish can reproduce), as well as of human capital (fishers), physical capital (vessels) and social capital (fisheries governance). This is illustrated in Figure 1.

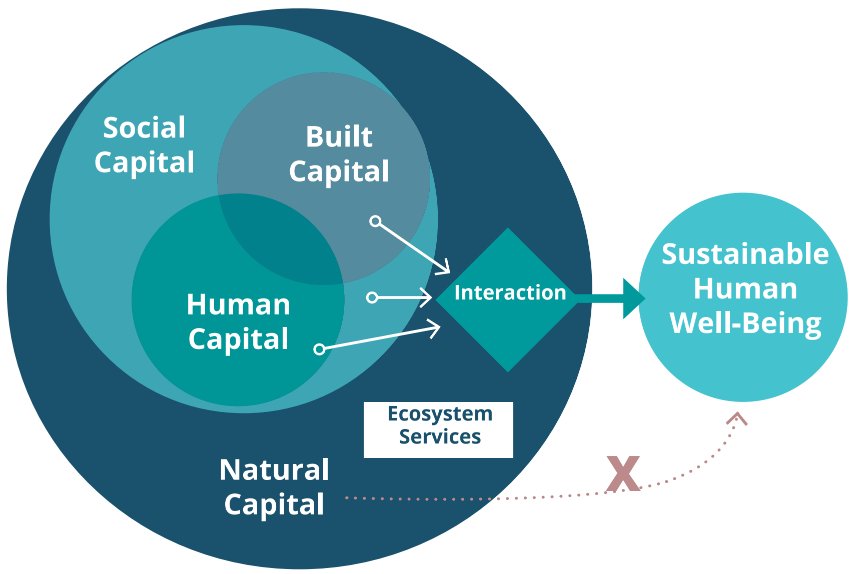


Figure 1. Natural and other types of capital. Natural capital provides benefits to humans by interacting with other forms of capital to produce ecosystem services (Costanza, 2020).

The necessity of observing the trajectory and calculating the net present value (NPV)

As mentioned before, ecosystem services are a flow that stems from the stock of natural capital. Importantly, a high quantity/value of any service today might be misleading with respect to the "health" of natural capital. Indeed, high production of timber today may point to unsustainable over-extraction of the resource rather than high sustainable yields. In this sense, **the economic potential of coastal ecosystem services –one of the focuses of this project– should incorporate an evaluation of their potential trajectory over time, a relevant measure for sustainable development**[22]. In general, natural ecosystems have different paths for recovery, and different timeframes for when impacts can be assessed. Moreover, there can be non-linearities, so assessing trajectories over time is important to assess not only by how much, but also how, the supply of services changes. This is key information that can reveal conflicts between short term profit-maximization and long-term conservation goals.

As discussed above, the current value of –at least some– ecosystem services can certainly be approximated, and this is a challenging task. Extrapolating or modeling alternative future scenarios of the trajectory of the provision, and the value of the provision of the services is even more challenging, but necessary. The additional required exercises involve projecting ecological and social response functions to changes in ecosystem management practices and under the "current/ business as usual" trajectory. This is challenging given the complexity of socio-ecological interactions and how people might respond to changes in regulations. As such, and considering data limitations, modeling future scenarios of ecosystem services use is uncommon[1]. Though complex, thinking about future scenarios is still useful for making decisions today and can shed light on the importance of protecting ecosystem functioning's, the benefits of which are realized over time. **Despite the significant uncertainties in the construction of future scenarios, considering the available information and literature, we explore ways of approximating this exercise.** We do so because of three reasons. First, it can give us a first approximation of the total economic value of the Chilean coast's ecosystem services, that is, one that considers their provision over time and not just the current flow. While uncertainties won't allow us to derive precise figures, they can still give us an idea of the orders of magnitude of potential economic losses of poor planning and management. We think this can be a crucial input for the policy discussion on coastal management in Chile. Second, it can shed light on "where" there might be larger or smaller gaps between "business as usual" and alternative scenarios, which can help prioritize efforts to mitigate overexploitation. Third, it can provide additional information on where data gathering efforts are more relevant so that better estimations can be performed to inform management.

The relevant framework to analyze costs and benefits of consuming goods or services over time is the net present value. Following our proposed trajectories for the provision of ecosystem services over time in different scenarios **we calculate the net present value of the provision of these services.** This number approaches an estimation of the value of natural capital.

[1] An interesting exception is Nelson et al (2009) that use the InVest software tool to model the provision of ecosystem services under different Land Use scenarios. No such model exists for coastal ecosystem services.

Table 1 shows a classification proposed by The Economics of Ecosystem Services and Biodiversity (TEEB) group for different types of ecosystem services where they are divided into provisioning, regulating/habitat, and cultural services[2]. These can be further divided into more than 20 specific services, such as providing food, water, the regulation of air quality, or biological controls. Furthermore, natural capital also provides "cultural" services associated with the enjoyment of nature in terms of its aesthetics, the opportunities it gives to recreation and tourism, its spiritual experience, etc.

Table 1. TEEB Classification of ecosystem services.

Type	Ecosystem Service
Provisioning	• Food • Water • Raw materials • Genetic resources • Medicinal resources • Ornamental resources
Regulating /habitat	• Air quality regulation • Climate regulation • Moderation of extreme events • Regulation of water flows • Waste treatment • Erosion prevention • Biological control • Maintenance of life cycles • Maintenance of genetic diversity • Gene pool protection
Cultural	• Aesthetics information • Opportunities for recreation and tourism • Inspiration for culture, art, and design • Spiritual experience • Information for cognitive development • Existence, bequest values

[2] TEEB is a G8+ led initiative to assess the costs of biodiversity loss and the decline in ecosystem services in the world that currently systematizes empirical evidence on the economic value of ecosystem services around the world.

Zapallar Chile

The value of ecosystem services

We begin this section by clarifying what is understood for "economic value".

In this project, we understand the "value" of a good or service (ecosystem services included) as the maximum willingness to pay for it.

For example, if the protection of a forest (the natural capital) results in an increase in timber production with a market value of $300, and a reduction in CO_2 in the atmosphere with an estimated monetary value of $400, then the maximum willingness to pay for the protection of the forest would be $700, and we understand this to be the "economic value" of the ecosystem services it provides.

Unfortunately, the maximum willingness to pay is rarely observed. Indeed, note that whereas the maximum willingness to pay is related to market prices, they are not the same, and is typically inferred from surveys. This is expensive to do, and difficult from a methodological point of view. Moreover, it is particularly difficult to infer the value of ecosystem services from market values because many of these services are not traded in the market[21]. Thus, alternative approaches are employed to approximate their value. Table 2 presents a typology of valuation methods for ecosystem services, classified in terms of how reliant on market transactions each evaluation is.

Table 2. Valuation methods for ecosystem services.

Type of Valuation	Valuation method	Brief description
Direct market valuation	Market price	Economic values can be derived by looking at actual market transaction
	Production function	Some ecosystem services are used as inputs in production processes, and their values can be obtained by measuring their contribution to the economic value (consumer + producer surplus) of the final good through production functions
	Cost-based methods	Values of ecosystem services based on either the costs of avoiding damages due to lost services, the cost of replacing environmental assets, or the cost of providing substitute service
	Hedonic pricing	The implicit price of an ecosystem service that is not traded on the market, as revealed through the observed price of a product that is sold on markets
Indirect market valuation	Travel Cost	The value of recreation services is retrieved by analyzing revealed consumer behavior in the transport market. The underlying premise is that the travel expenses that people incur to visit a recreation site represent the implicit price of access to the site
Non-market valuation	Contingent valuation	Valuation is based on a specific hypothetical scenario and description of the environmental service. This involves directly asking people for their maximum willingness to pay (WTP) for a positive change in an ecosystem service or for their minimum willingness to accept (WTA) an adverse change in an ecosystem service
	Choice experiment	Values are inferred from the hypothetical choices or trade-offs that people make between different combinations of attributes

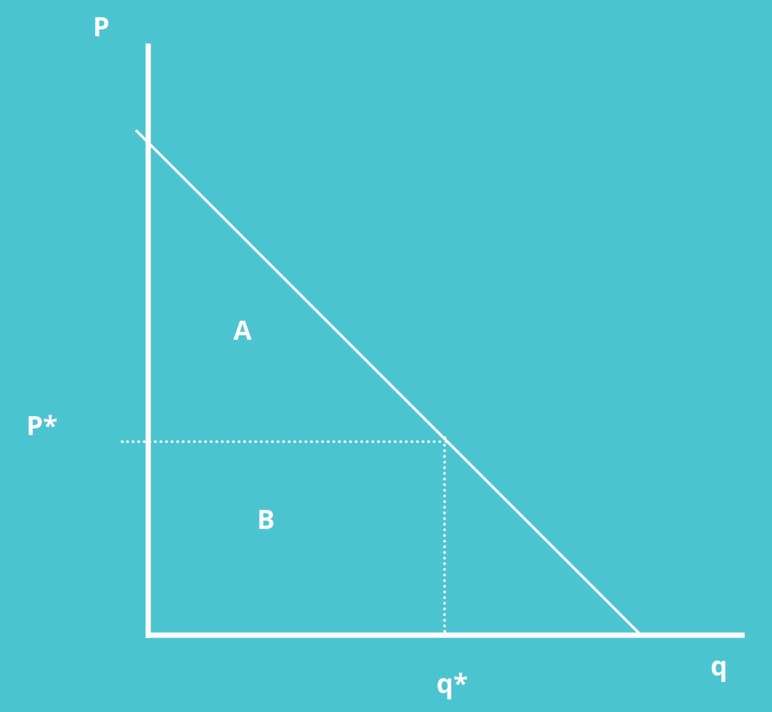
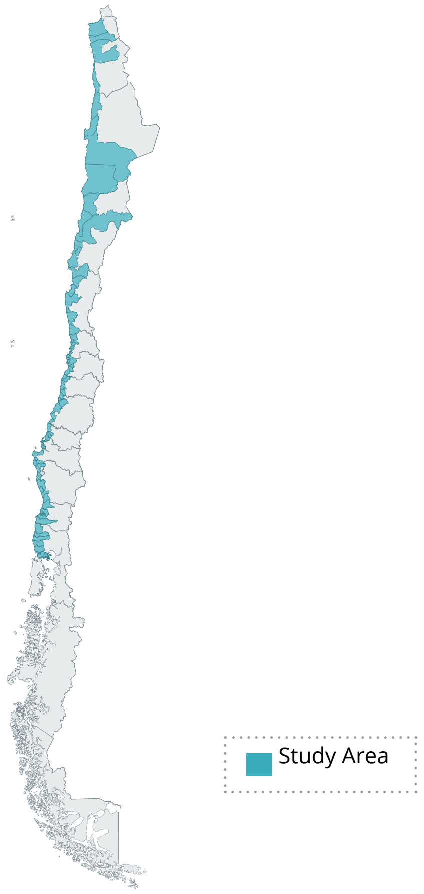


Figure 2. Maximum willingness to pay versus price times quantity. The maximum willingness to pay is not observed. The market value of the transactions (AREA A) provides an underestimation of the maximum willingness to pay (A+B).

3. Case Study: Chile's municipalities

While we have an interest in Chile's coastal ecosystems, **we limit our analysis to continental coastal municipalities north of Puerto Montt.** We exclude oceanic islands (such as Juan Fernandez Archipelago and Rapa Nui) as they have specific environmental, economic, and social conditions which require more tailored methods. We also exclude southern fjords and inner channels, as it is not feasible to adapt our methodology to consider the geographical singularities needed to estimate the value of ecosystem services in these areas. Moreover, there is already some interesting work in these areas estimating the value of ecosystem services[23].

We define the analytical unit at the administrative municipality level. This is due to data availability constraints and because municipalities have key influence on the local management of some of the services. For example, municipalities manage real-estate regulatory plans, that can heavily influence the development of the tourism industry and the extent to which wetlands are affected by urban development. For wetlands, municipalities also have a say in their administration, and can provide key regulations for their protection or exploitation. While fisheries are mostly managed through a country-level or regional office, the municipal scale is relevant as this considers the "caletas" (fishing cove) from which fish is landed. As such, our case study involves coastal municipalities between Chile's northern border and Puerto Montt's municipality.



4. Methods

Our approach to valuing ecosystem services follows three basic steps. **First, we define the relevant coastal ecosystems and their services. Second, we quantify and evaluate the provision of those services today. Third, we construct plausible scenarios for the future trajectory of the provision of these services and calculate the net present value in each of these scenarios. Then, we define the "potential" as the difference between the net present value under the "optimistic" and "business as usual" scenarios.** In this section, we briefly describe the main features of each step and its challenges.

A. Definition of the relevant coastal ecosystem and their services → **B. Quantify and evaluate the provision of services** → **C. Construction of future scenarios, net present value, and management potential**

Define the "potential" as the difference between the net present value under the "optimistic" and "business as usual" scenarios.

A. Definition of the relevant coastal ecosystem and their services

"Ecological phenomena occur at different scales of space, time, and ecological organization"[24]. This implies that there is no single scale at which processes are to be studied. In the end, the spatial and temporal scales depend on the question at hand and data limitations. Nonetheless, it is essential to highlight that coastal ecosystems will be defined in recognition of the interactions between the physical proximity of the coastline and all agents that interact with it, not only the geographical area near the shore. In this sense, coastal ecosystems operate under "permeable processes originating in land and sea"[8].

In practice, this amounts to considering socioeconomic and ecological processes that occur not necessarily in the proximity of the coastline but also further inland or deeper in the sea when estimating the economic value of coastal ecosystems. For example, fishers' food provision ecosystem service necessitates healthy fish stocks, which are determined in part by deep-sea upwelling processes; as well as protected bays to land the catch, and further inland market channels. Also, cultural ecosystem services are enjoyed by population that does not necessarily live near the coast.

Understanding that the delimitation of the relevant ecosystems is arbitrary, we take a flexible approach defining first an area of interest (in our case, an administrative region of the country for the case study and municipalities for the specific analyses, see below), then considering coastal ecosystem components that could potentially be assigned value per hectare (such as carbon sequestration services per hectare of wetland). We also consider ecosystem services that operate at larger scales, such as cultural values (tourism), and some broader regulation services, where location-specific values are harder to justify, and a "bundle" approach is better suited. In this latter case, the value cannot be assigned to an hectare of wetland or to a type of beach. Instead, it is the conjunction of all the components, or an area, that provide the value. For example, the tourism associated with a coastal wetland cannot be convincingly separated from the tourism associated to the sandy beach near it[25]. As such, we have identified three ecosystem services bundles to assess: tourism (cultural services), fisheries (provisioning services) and wetlands (provisioning/regulatory services).

B. Quantification and valuation of the provision of the services

Fisheries

To evaluate the ecosystem services provided by fisheries, we consider landings and off-vessel price data of the fish and algae products harvested from coastal areas at each municipality. To do this we looked at data from the two management regimes used in coastal areas: **Benthic Resources Exploitation Areas (AMERB in Spanish)**, and open access areas. AMERBs are exclusive access rights given to small-scale fisheries organizations to fish a group of benthic resources (extracted by divers) over demarcated, small, coastal seabed areas[27,28]. For both systems we relied on artisanal landings data. Here, we used data reported to **SERNAPESCA** from 1997 to 2017. This data included species and fishing cove where fish was landed. By pairing fishing coves with municipalities, we were able to calculate sum of fish products landed by municipality. Landings considered only coastal marine species harvested by artisanal fishers. For both AMERB and open access areas, we multiplied the amount of each species landed in 2019, by their off-vessel price. When price data for a species was not available, we used a similar species value. From this we were able to obtain a per municipality and per AMERB economic evaluation.

We then multiplied these estimations by an "economic multiplier". Economic multipliers are broadly used to account for the far-reaching indirect impacts of economic activities. In the case of fisheries, this reflects the value that landed fish has across the supply chain, considering the processing, restaurant, and end markets. Based on a literature review by[29], we used an economic **multiplier factor of 1.24.** We were not able to consider cost of fishing operations as this varies considerably between fishing gear, and we did not have enough data to link species landings with gear used.

For fisheries, we also developed a within sector GINI index. This was used to assess how landings were distributed within the small-scale sector in each municipality. The GINI index is a measure of how resources concentrate within a group. A value of 0 reflects perfect distribution (i.e., everyone has the same number of resources), while a value of 1 reflects perfect concentration (i.e., all resources are concentrated in one individual). To calculate this index, we aggregated registered landings by the boat owner ID number in each municipality. We then calculated the GINI index per municipality, which gave us a value for each municipality reflecting how landings are distributed.

Wetlands

To value wetlands, we map them according to information publicly available from the Ministerio de Medio Ambiente. Then, to establish their value, we used the adjusted value transfer methodology. In this approximation, the economic value of a unit of area (e.g., hectare) of a specific ecosystem is assessed by transferring the value from a similar context and adjusting it to consider year and location[26]. This approach is based on the idea that ecosystems in similar contexts produce similar value.

We used a study developed for the Cahuil wetland (which belongs to the VI Region), that calculated US$/hectare values. Accordingly, we used the same value per hectare for different ecosystem services in wetlands in each of the Chile's municipalities, as we believe these are similar enough to be assumed to hold the same value, considering the ecosystem services that are present in the other wetlands. As such, we assume equal value of provision per hectare per for wetland services (1.121 USD/hectare for wetlands, and 21.610 USD/hectare when there are salt marshes). For the work in Cahuil, several services where included, but many of these apply exclusively for the that wetland (e.g., oyster and quinoa cultivation) or we don't have data to link those services to other wetlands in the country as to include those values.

Pichilemu, Chile

Tourism

The value of the services associated with tourism is inferred from the travel costs and the number of visitors to each coastal municipality. Here, again, we do not observe the maximum willingness to pay to visit each site, which would allow us to estimate the full demand profile. We do not collect primary data and, to the best of our knowledge, there is no comprehensive contingent valuations for the Chilean coastline, that would allow us to directly estimate the demand for coastal tourism.

The travel costs methodology relies on the idea that the "price" each visitor pays to visit a site can be understood as the total travel costs associated with his/her visit[30]. These costs are comprised of the time spend traveling —the opportunity costs—, the fuel costs, and the extra lodging and consumption expenses that he/she would not have incurred if it did not visit the destination. If there are entrance fees to a particular park, these should also be included. This is not our case, since we restrict our attention to public access sites. The travel costs can be then attributed to the number of visitors for each destination. Note that not all touristic travels to a particular municipality can be attributed to "coastal" tourism, that is, many visitors to a coastal municipality might visit it for reasons others that the cultural benefits that stem from the coast and thus should not be included in the value of coastal ecosystem services. To account for this, we have filtered the number of visitors to coastal municipalities based on the touristic infrastructure within 1km to the coast, to reflect the area of coastal influence.

C. Construction of future scenarios, net present value, and management potential

After estimating the economic value of the ecosystem services as described above for the baseline year (2019), we **project the provision and value of those services into the future according to different plausible scenarios.** The baseline year represents an estimation of the current per year value, calculated with the most recent data available. We then construct alternative scenarios that can provide us with a range of estimates for the value of those services in the future. Then, we define the "management potential" as the difference, for wetlands and fisheries, between the net present value of the services in a "business as usual" scenario and a "optimistic" scenario. This optimistic scenario for fisheries and wetlands (described below) represents potential gains that could be observed through better managing natural resources (protection of wetlands and fisheries management). For tourism in turn, we define the future scenarios based on structural GDP growth scenarios established by the Central Bank of Chile, and do not explicitly link it to better management of particular ecosystems, thus it is not incorporated in the calculation of the potential.

Below, we describe in further detail the ways in which we construct these future scenarios for wetlands, fisheries, and tourism, respectively.

Both for wetlands and fisheries, we define two scenarios for each bundle: an "optimistic" scenario in which negative trends are equalized to zero (no loss), and a "business as usual", where past trends are projected into the future.

This is sensible as, for wetlands, the optimistic scenario would mean no further loss of area. For fisheries, the optimistic scenario would mean that future catches remain at current levels, except in cases where trends suggest increase or growth. This is an ample assumption and its only optimistic in that further losses are reversed. We chose not to consider a scenario with growing catches in the future as our optimistic scenario for fisheries, as it would require having data for specific stocks that is not currently available. Furthermore, setting our optimistic scenario as a "no loss" scenario might be a **conservative approach**, which we favor in this project. For wetlands, there is no data specific to Chile, but we rely instead on global estimates that suggest that, between 1970 and 2005, 50% of coastal wetlands have been lost globally[31]. This translates into a per year loss rate of 1.3%. This constitutes our business-as-usual scenario, where we assume that, in each municipality, **wetlands are lost at 1.3% per year**.

For fisheries, we calculated past trends based on catch data for each municipality available from SERNAPESCA. To obtain the rate of per year catch change for each municipality, we ran a linear model where the response variable was catch and the predictor was year: here the slope estimate of the regression represents an approximation of by how much the catch was reduced or increased each year. We recognize that while these approaches use past trends to project future scenarios, which is not ideal, it was the only way given available data to project future scenarios to calculate net present value and therefore account for future streams of resources. Building recovery scenarios require much data not currently available for coastal fisheries or wetlands. In cases where growth was positive, we assume growth continues at the same pace into the future, but with an asymptotic declining rate when reaching historic maximum landings.

To the best of our knowledge, there are no projections for the growth of tourism in Chile. For this reason, we rely on projections for GDP growth as follows. Data available for Chile suggests that in the period 2013-2019, tourism represented around 3% of GDP, without much variation each year (OECD). With this, we construct future scenarios of the value of the tourism industry assuming that tourism will continue to represent 3% of GDP in the future, and thus its growth rate will correspond to the growth rate of GDP. Table 3 below shows a summary of the scenarios considered for the growth of structural GDP by the Central Bank of Chile, labeled from A to C for different time periods (Central Bank of Chile, 2021).

Table 3 Tourism and GDP growth scenarios. Table shows three scenarios for the growth of structural GDP from the Central Bank of Chile for three different time frames. These are used to estimate the projected growth of tourism. SOURCE: CENTRAL BANK OF CHILE.

Central Bank of Chile's scenario label	2021-2030	2026-2030	2021-2050
A	3,40%	2,40%	2,30%
B	2,90%	1,70%	1,70%
C	2,40%	1,00%	1,00%

The calculations of the net present value are constructed using a time frame of 30 years, and a discount rate of 5%, which corresponds to the 6% social discount rate published by Ministerio de Desarrollo Social, corrected by 1%, as suggested by studies that apply discount rates to the evaluation of ecosystem services[32]. The time frame is chosen as this is the longest time period for which there are estimates of GDP growth. This is of course an arbitrary time frame as we do not expect ecosystems to stop delivering services after 30 years. Choosing this time frame instead of perpetuities leads us to provide conservative estimates, which, again, we favor in this project.

5. Data

In this section, we describe the data that we use in this study. As mentioned above, we do not collect primary data, that is, we do not perform surveys and instead rely on already published information.

Fisheries

For fisheries, we considered two sources of data. First, we considered landings in 2019 registered at each fishing cove from open access areas and AMERB, and then multiplied these values by the per kilo price obtained from SERNAPESCA. We then aggregated these values by Municipality to obtain a value per Municipality for 2019. Past trends in landings are used to calculate future projections in the "business as usual" scenarios (Table 4).

Table 4. Current (2019) value fisheries per municipality. table shows the value of fish coming from open access fisheries and AMERB in 2019. The value is calculated as the quantity times the price. Source: own elaboration using data from SERNAPESCA. (All values expressed as USD of 2020).

Municipality	Value ($)
Algarrobo	115.431
Antofagasta	4.177.952
Arauco	4.189.588
Arica	33.032.733
Caldera	168.132.254
Camarones	31.848
Canela	1.889.778
Carahue	445
Casablanca	373.870
Chañaral	740.199
Chanco	395.111
Cobquecura	131.455
Concepción	243.164
Concón	193.988
Constitución	10.233.289
Coquimbo	78.123.176
Coronel	102.447.153
Corral	21.547.882
El Quisco	475.110
El Tabo	136
Freirina	2.974.675
Huasco	1.230.160
Iquique	33.278.814
La Higuera	2.942.788
La Ligua	399.972
Lebu	63.890.076
Licantén	7.422.926
Los Vilos	1.788.674
Lota	34.312.496
Mariquina	1.546.789
Maullín	5.017.105
Mejillones	18.892.150
Navidad	26.479

Ovalle	4.962.374
Palena	11.120
Papudo	253.733
Paredones	589.731
Pelluhue	3.810.444
Penco	334.982
Pichilemu	573.379
Puchuncaví	162.292
Puerto Montt	3.642.389
Puqueldón	54.662
Purranque	440
Quintero	4.537.839
Río Verde	205.966
San Antonio	6.871.387
San Juan De La Costa	253.063
Talcahuano	65.659.602
Taltal	1.047.518
Tirúa	1.664.779
Tocopilla	760.319
Toltén	4.067.089
Tomé	2.340.541
Valdivia	8.921.101
Valparaíso	1.223.095
Vichuquén	611.591
Viña Del Mar	8.000
Zapallar	7.289
TOTAL: 59 Municipalities	**711.904.299**

Zapallar, Chile

Wetlands

For wetland, we considered the size of wetlands in each municipality and the value per hectare described in the methods section. Aggregated results for both baseline values and area in hectares, are presented in Table 5, for each of the coastal municipalities considered in this study, in 2019.

Table 5. Current 2019 value wetland per municipality. Table shows the value of wetlands in each municipality based on the area. Source: own elaboration using data from Ministry of Environment and Cahuil evaluation. (All values expressed as USD of 2020).

Municipality	Baseline value ($)	Area (ha)
Algarrobo	106.574	95
Antofagasta	14.998	13
Arauco	4.492.277	4.006
Arica	1.101.769	982
Calbuco	191.335	171
Caldera	267.064	238
Camarones	891.452	795
Canela	833.800	744
Cañete	2.272.199	2.026
Carahue	5.698.943	5.082
Cartagena	24.877	22
Casablanca	59.613	53
Chañaral	265.132	236
Chanco	284.702	254
Cobquecura	179.453	160
Coelemu	644.137	574
Concón	140.713	125
Constitución	2.800.997	2.498
Copiapó	18.356	16
Coquimbo	1.408.098	1.256
Coronel	1.252.608	1.117
Corral	3.048.166	2.718
Curepto	767.609	684
El quisco	12.823	11
El tabo	37.885	34
Freirina	292.091	260
Fresia	258.386	230
Hualpén	1.759.084	1.569
Huara	57.386	51
Huasco	485.022	433
Iquique	80.435	72
La higuera	29.099	26
La ligua	537.255	479
La serena	537.919	480
La unión	1.097.753	979
Lebu	266.741	238
Licantén	421.862	376
Litueche	100.388	90
Los alamos	23.644	21
Los muermos	1.514.660	1.351
Los vilos	266.905	238
Lota	16.458	15
Mariquina	6.806.667	6.070
Maullín	12.867.579	11.474
Navidad	285.021	254
Ovalle	694.409	619

Papudo	413.504	369
Paredones	1.543.412	415
Pelluhue	170.233	152
Penco	211.052	188
Pichilemu	4.113.593	599
Puchuncaví	280.150	250
Puerto montt	2.219.191	1.979
Purranque	141.849	126
Quintero	310.146	277
Río negro	330.368	295
Saavedra	9.971.379	8.892
San antonio	511.662	456
San juan de la costa	740.210	660
San pedro de la paz	2.547.111	2.271
Santo domingo	3.636.699	1.625
Talcahuano	1.119.267	998
Teodoro schmidt	3.265.776	2.912
Tirúa	3.687.469	3.288
Tocopilla	121.077	108
Toltén	7.913.499	7.057
Tomé	145.635	130
Treguaco	776.947	693
Valdivia	10.493.250	9.357
Valparaíso	25.717	23
Vichuquén	3.442.442	1.500
Viña del mar	23.982	21
Zapallar	39.040	35
TOTAL: 73 Municipalities	**111.515.804**	**86.341**


Chile

Tourism

The number of visitors to the coast is calculated using data from Servicio Nacional de Turismo (SERNATUR), the Chilean government agency of tourism. SERNATUR is currently developing an experimental method to estimate the number of visitors from each municipality to every other municipality in the country using cellphone movement data. The agency publishes two different datasets: one of "frequent" visits and another of "non-frequent" visitors. These are not perfectly complementary, and thus total visits cannot be inferred from the sum of the two[3]. Since we do not have information on how these two sets can be combined to infer the total number of visits (SERNATUR did not respond a request on how this could be achieved), we restrict our attention to "non-frequent" visits, noting that it will result in an underestimation of the total number of visits. It is important to note that this database does not consider international travelers, another reason for the figures calculated here to be conservative estimates of the total value. Currently, SERNATUR has produced estimates of the number of monthly visitors for 2019, 2020 and 2021. In this study, we estimate the current number of visitors using the 2019 numbers, as 2020 and 2021 where years where tourism was greatly affected by the COVID-19 pandemic.

As mentioned before, some visits to coastal municipalities might not correspond to a visit associated with the coast. To take this into account, we have identified the share of restaurants, lodging, and overall touristic infrastructure that is located within less than 1 km from the shore for each municipality and consider just this fraction of visits from the total visits to each municipality[4]. On average, our estimates suggest that around 60% of infrastructure is located within 1km of the coast. Then, on average, we consider that the share of tourism that is related to the coast is around 60% of total tourism to coastal municipalities. Figure 3 shows the distribution of touristic infrastructure around coastal municipalities. In the sample, twelve municipalities do not have touristic infrastructure within 1km from the shore. We interpret this result as that these municipalities do not have tourism associated with the coast. Figure 4 shows our estimates of the total number of visitors per month to selected municipalities (the ones with the highest number of visitors), after filtering for what we consider to be coastal tourism. Not surprisingly, coastal municipalities are typically most visited during the summer months.

Figure 3. Share of tourism infraestructure that lies within 1km to the shore for all cosatal municipalities in the sample. Twelve coastal municipalities in the sample do not have infraestructure within 1km of the shore. Source: Own elaboration using data from Google Maps.

[3] Frequent visits correspond to travels that are made with a maximum frequency of 3 times to the same destination during the month of analysis. Non-frequent visits correspond to travels where the same principal destination is not repeated for three months.
[4] This data was obtained with Google Maps. In total, we collected information and location on about 7,600 places for coastal municipalities north of Puerto Montt.

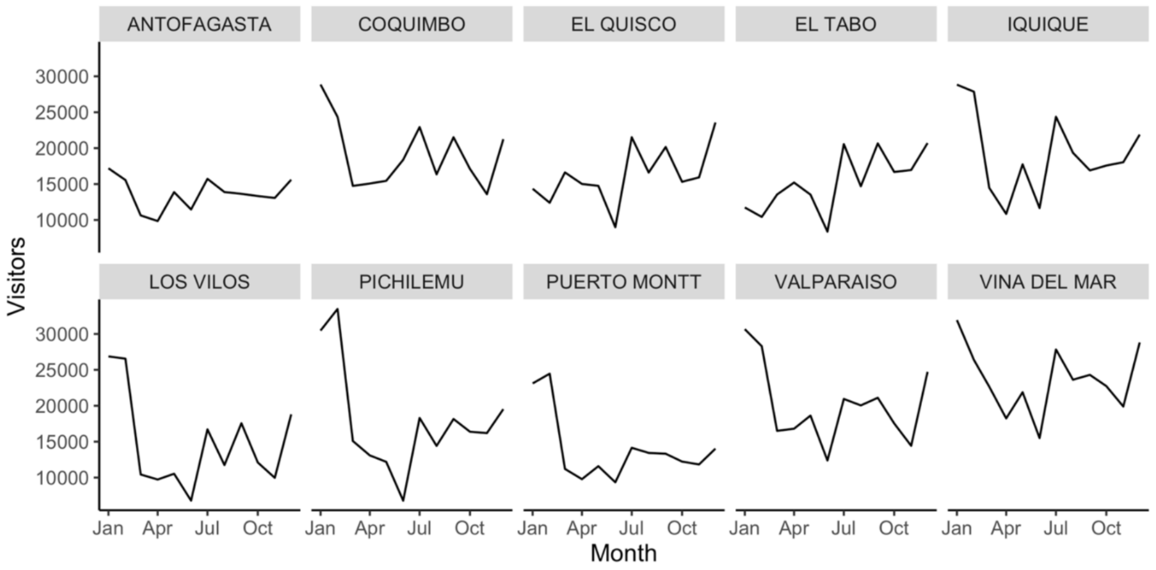


Figure 4. Number of coastal visitors to selected municipalities in 2019. Source: Own elaboration using data from SERNATUR and Google Maps.

A necessary step for calculating travel costs is to estimate the travel times and distances between each pair of origin destination. We extract this information from Google Maps. Without knowing the exact origin and destination of each visitor from the SERNATUR dataset, we considered the distance between the municipality administrative buildings from both municipalities. Figure 5 shows the number of visitors to a selection of municipalities as a function of the duration of the travels.

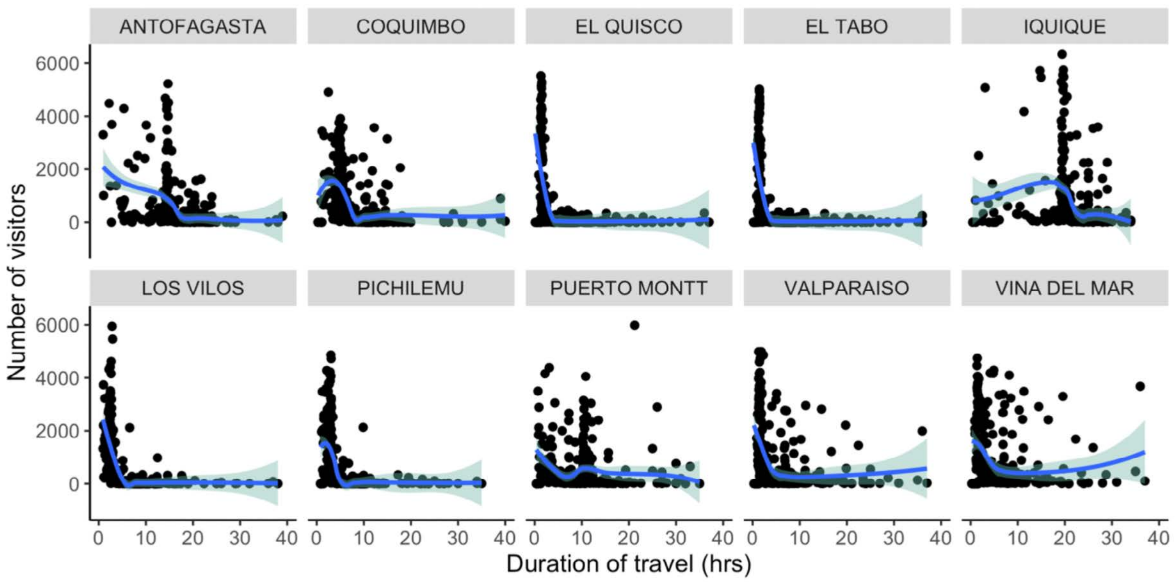


Figure 5. Duration of travel and number of visitors to selected municipalities. Note: each dot corresponds to a municipality of origin. Source: Own elaboration using data from Google Maps.

The calculation of travel costs is then completed with a few additional inputs. Fuel costs are calculated based on the distance, and an average fuel efficiency of 20 km/l. We take values for the average passengers per vehicle and the opportunity cost of inter-urban travel from "Precios Sociales", a publication of the Ministerio de Desarrollo Social that contains several inputs to be used for cost-benefit analysis of public programs.

Other relevant inputs for our estimation are the share of people that rent housing when in holidays, the average number of nights spent during high and low season (Encuesta Nacional de Turismo, 2016), and the average spending in housing per person (Surfonomics, 2014). The main inputs to the estimations of the value of tourism are shown in Table 6.

Table 6. Main inputs for the calculation of the value of tourism.

Input	Value	Source
Value of time	7995 CLP	Ministerio de Desarrollo Social
Exchange rate	860 CLP/$	Central Bank of Chile
Fuel price	1100 CLP/l	Comisión Nacional de Energia
Average spending in lodging	$45.28/night/person	Surfonomics
Number of nights (high season)	9	SERNATUR
Number of nights (low season)	4.5	SERNATUR

6. Results

This section outlines our main results for the current and potential economic value of the three coastal ecosystem service bundles estimated along the Chilean coastline. We present our results per bundle and per municipality, and explore their correlation with a GINI index for fisheries, population and other relevant socio-economic variables. Values per municipality are also available in an **interactive map that can be found here.**

A. Estimation per Bundle

Table 7 shows our main results per ecosystem service bundle aggregated across all coastal municipalities. Our estimates suggest tourism ($19,711 MM) provides the largest value. In total, it provides around 50% more than fisheries ($12,195 MM) and almost 20 times the value that wetlands provide ($1,095 MUSD). The aggregated value of all ecosystem services bundles is estimated to be $33,001 MM, in our most conservative scenario.

In terms of management potential, (calculated as the difference between NPV and the no loss scenarios for fisheries and wetland bundles) results show fisheries have a value of $263 MM followed by wetlands with $188 MM. This adds up to $451 MM across municipalities.

Table 7. Overall results of NPV and management potential per ecosystem service bundle. (All values expressed as USD of 2020).

Bundle	NPV ($ MM)	Management Potential ($ MM)
Fisheries	12,195	263
Wetlands	1,095	188
Tourism	19,711	-
TOTAL	33,001	451

Note: this table shows the sum across municipalities of the Net Present Value (NPV) of Fisheries, Wetlands and Tourism (1st column). For the case of tourism, the NPV is calculated using the most conservative estimate of GDP growth (scenario C). For fisheries and wetlands, the NPV is calculated under the business-as-usual scenario. The management potential is the difference between the business-as-usual scenario and the No Loss scenario for Fisheries and Wetlands.

Bahía Mansa Chile

B. Estimation per municipality

Fisheries

For fisheries, our results show great variability for the net present value generated in each municipality (Table 8). The municipalities with the highest NPV were Coronel, Lebu, Talcahuano, Caldera, and Coquimbo. Lebu is also one of the municipalities with the greatest potential, followed by Iquique. Per capita, Caldera has the highest NPV value, showing the importance of fishing activities for this municipality. Gini indexes also show great variability, ranging from 0,24 (Fresia) to 1 in Litueche (an analysis of this index is provided below). Moreover, in general, more populated municipalities have higher NPV values coming from fisheries (Figure 6).

Table 8. Fisheries bundle estimation per municipality, showing GINI Index, NPV, No loss scenario, NPV per capita and potential (difference between NPV and no loss) un 2019. (All values expressed as USD of 2020).

Municipality	GINI	NPV ($)	No Loss	NPV per Capita ($)	Fisheries Potential
ALGARROBO	0,49	1.663.202	1.972.683	120	309.482
ANTOFAGASTA	0,67	48.992.029	55.287.949	135	6.295.920
ARAUCO	0,70	92.383.677	92.383.734	2.548	-
ARICA	0,85	509.078.649	509.078.649	2.300	-
CALBUCO	0,82	184.573.498	184.573.519	5.431	-
CALDERA	0,93	822.590.239	822.589.400	46.574	-
CAMARONES	0,82	1.480.049	1.696.929	1.179	216.880
CANELA	0,79	31.279.452	31.280.381	3.440	929
CARAHUE	0,47	444	7.212	0	6.768
CASABLANCA	0,69	5.345.879	5.345.885	199	-
CHANARAL	0,67	11.357.930	15.103.543	930	3.745.613
CHANCO	0,64	4.495.932	4.495.974	504	-
COBQUECURA	0,62	949.261	5.449.969	189	4.500.708
COELEMU	0,39	22.626	22.626	1	-
CONCON	0,55	3.208.406	3.208.367	76	-
CONSTITUCION	0,74	90.551.510	90.551.514	1.966	-
COQUIMBO	0,91	693.806.391	693.810.544	3.047	4.153
CORONEL	0,84	1.400.899.098	1.400.899.231	12.050	-
CORRAL	0,91	294.723.401	294.723.439	55.587	-
EL QUISCO	0,59	5.658.690	5.797.840	355	139.150
EL TABO	0,49	8.495	8.767	1	273
FREIRINA	0,65	43.735.862	44.039.554	6.212	303.693
FRESIA	0,24	144.870	154.148	12	9.278
HUALPEN	0,69	494.938	494.938	5	-
HUARA	0,67	3.470.061	3.535.268	1.271	65.208
HUASCO	0,74	15.197.305	15.197.167	1.497	-
IQUIQUE	0,79	171.576.663	229.915.461	896	58.338.797
LA HIGUERA	0,87	63.072.078	63.069.117	14.872	-
LA LIGUA	0,60	10.755.009	10.754.635	304	-
LEBU	0,74	1.086.480.214	1.176.270.081	42.570	89.789.867
LICANTEN	0,64	66.609.446	69.338.211	10.012	2.728.764
LITUECHE	1,00	480.241	480.816	76	576
LOS MUERMOS	0,55	13.309.528	13.308.907	780	-
LOS VILOS	0,77	30.635.997	30.799.559	1.433	163.562
LOTA	0,85	509.089.090	509.089.099	11.694	-
MARIQUINA	0,70	16.285.248	16.285.360	765	112
MAULLIN	0,69	72.878.811	72.877.955	5.127	-
NAVIDAD	0,68	3.039.566	3.039.652	458	-
OVALLE	0,73	68.990.153	74.971.267	620	5.981.114

PAPUDO	0,54	3.245.241	3.245.238	511	-
PAREDONES	0,62	5.503.837	7.353.358	889	1.849.522
PELLUHUE	0,67	89.730.308	89.730.314	11.852	-
PENCO	0,73	1	6.080.662	0	6.080.661
PICHILEMU	0,71	10.937.024	10.936.983	667	-
PUCHUNCAVI	0,63	3.306.403	3.306.625	178	222
PUERTO MONTT	0,81	73.759.012	77.775.905	300	4.016.893
PURRANQUE	0,68	67.465	67.459	3	-
QUINTERO	0,73	36.756.270	38.271.683	1.151	1.515.413
SAN ANTONIO	0,66	127.269.662	127.269.662	1.393	-
SAN JUAN DE LA COSTA	0,65	2.403.597	2.410.250	320	6.653
TALCAHUANO	0,83	919.251.934	919.251.939	6.058	-
TIRUA	0,72	15.325.681	16.969.288	1.471	1.643.607
TOCOPILLA	0,68	14.610.600	16.324.084	580	1.713.484
TOLTEN	0,67	41.061.150	41.061.151	4.224	-
TOME	0,79	58.390.192	58.390.191	1.063	-
VALDIVIA	0,76	92.963.502	92.963.455	560	-
VALPARAISO	0,60	24.039.825	24.039.825	81	-
VICHUQUEN	0,59	8.823.745	8.823.745	2.042	-
VINA DEL MAR	0,67	24.040	24.040	0	-
ZAPALLAR	0,71	212.116	212.116	29	-
TOTAL: 60 Municipalities	**-**	**7.906.826.633**	**8.096.393.283**	**208.248**	**189.071.272**

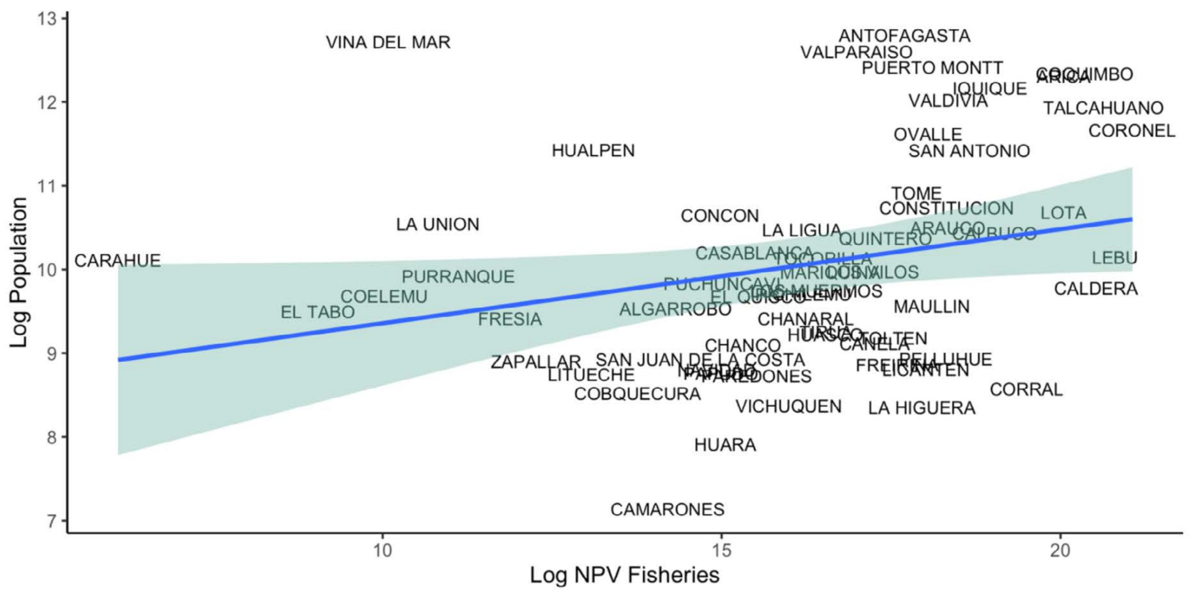


Figure 6. Plot of log NPV from fisheries and population, showing a slight positive correlation.

Wetlands

For wetlands, we found that municipalities in the south of the country usually have higher NPV values (Table 9). For instance, the municipalities with the highest values (Maullin, Valdivia, Mariquina and Carahue) are all located south of the Araucanía region. There is a general relation between NPV and potential, as we used the same loss rate for all municipalities, therefore the greatest NPV, the greatest potential there is as the difference with the no loss scenario is higher. For the NPV per capita, there are some municipalities that, even though they don't rank high for NPV, have high NPV per capita values (e.g., Tolten and Camarones). We found no significant correlation between NPV and population (Figure 7).

Table 9. Wetland bundle estimations per municipality, showing NPV, No loss scenario, potential (difference between NPV and no loss), and NPV per capita. (All values expressed as USD of 2020).

Municipality	NPV ($)	No Loss ($)	Potential ($)	NPV per Capita ($)
ALGARROBO	1.285.542	1.507.074	221.532	93
ANTOFAGASTA	180.914	212.091	31.176	-
ARAUCO	54.187.669	63.525.617	9.337.948	1.495
ARICA	13.289.981	15.580.191	2.290.210	60
CALBUCO	2.307.965	2.705.688	397.723	68
CALDERA	3.221.435	3.776.572	555.137	182
CAMARONES	10.753.052	12.606.083	1.853.031	8.568
CANELA	10.057.635	11.790.827	1.733.193	1.106
CARAHUE	68.742.962	80.589.166	11.846.204	2.802
CASABLANCA	719.082	842.999	123.917	27
CHANARAL	3.198.132	3.749.254	551.122	262
CHANCO	3.434.190	4.025.990	591.800	385
COBQUECURA	2.164.632	2.537.655	373.023	432
COELEMU	7.769.846	9.108.794	1.338.947	486
CONCON	1.697.333	1.989.828	292.495	40
CONSTITUCION	33.786.770	39.609.110	5.822.341	733
COQUIMBO	16.985.051	19.912.018	2.926.967	75
CORONEL	15.109.464	17.713.219	2.603.755	130
CORRAL	36.768.215	43.104.336	6.336.122	6.935
EL QUISCO	154.679	181.334	26.655	10
EL TABO	456.979	535.728	78.749	34
FREIRINA	3.523.322	4.130.482	607.160	500
FRESIA	3.116.762	3.653.861	537.099	254
HUARA	692.217	811.504	119.287	254
HUASCO	5.850.530	6.858.729	1.008.199	576
IQUIQUE	970.244	1.137.442	167.198	5
LA HIGUERA	350.999	411.485	60.486	83
LA LIGUA	6.480.588	7.597.362	1.116.774	183
LA SERENA	6.488.592	7.606.746	1.118.154	26
LEBU	3.217.538	3.772.004	554.466	126
LICANTÉN	5.088.668	5.965.578	876.910	765
LOS MUERMOS	18.270.448	21.418.923	3.148.474	1.070
LOS VILOS	3.219.511	3.774.317	554.806	151
LOTA	198.527	232.739	34.212	5
MARIQUINA	82.104.780	96.253.573	14.148.793	3.859
MAULLÍN	155.213.974	181.961.387	26.747.413	10.918
NAVIDAD	3.438.040	4.030.503	592.464	518

OVALLE	8.376.246	9.819.692	1.443.446	75
PAPUDO	4.987.857	5.847.394	859.538	785
PAREDONES	18.617.267	21.825.507	3.208.240	3.009
PELLUHUE	2.053.424	2.407.283	353.859	271
PENCO	2.545.800	2.984.508	438.708	54
PICHILEMU	49.619.827	58.170.616	8.550.789	3.027
PUCHUNCAVÍ	3.379.281	3.961.619	582.338	182
PUERTO MONTT	26.768.783	31.381.742	4.612.959	109
PURRANQUE	1.711.035	2.005.891	294.856	84
QUINTERO	3.741.105	4.385.794	644.690	117
RÍO NEGRO	3.985.034	4.671.759	686.725	283
SAN ANTONIO	6.171.881	7.235.457	1.063.576	68
SAN JUAN DE LA COSTA	8.928.713	10.467.363	1.538.650	1.189
SANTO DOMINGO	43.867.338	51.426.823	7.559.486	4.025
TALCAHUANO	13.501.048	15.827.631	2.326.583	89
TIRÚA	44.479.748	52.144.767	7.665.020	4.270
TOCOPILLA	1.460.485	1.712.165	251.680	58
TOLTÉN	95.455.844	111.905.374	16.449.530	9.819
TOMÉ	1.756.708	2.059.435	302.727	32
VALDIVIA	126.573.850	148.385.823	21.811.973	762
VALPARAÍSO	310.209	363.666	53.457	1
VICHUQUÉN	41.524.130	48.679.819	7.155.690	9.608
VIÑA DEL MAR	289.275	339.124	49.850	1
ZAPALLAR	470.917	552.068	81.151	64
TOTAL: 61 Municipalities	**1.095.072.073**	**1.283.781.529**	**185.687.373**	**-**

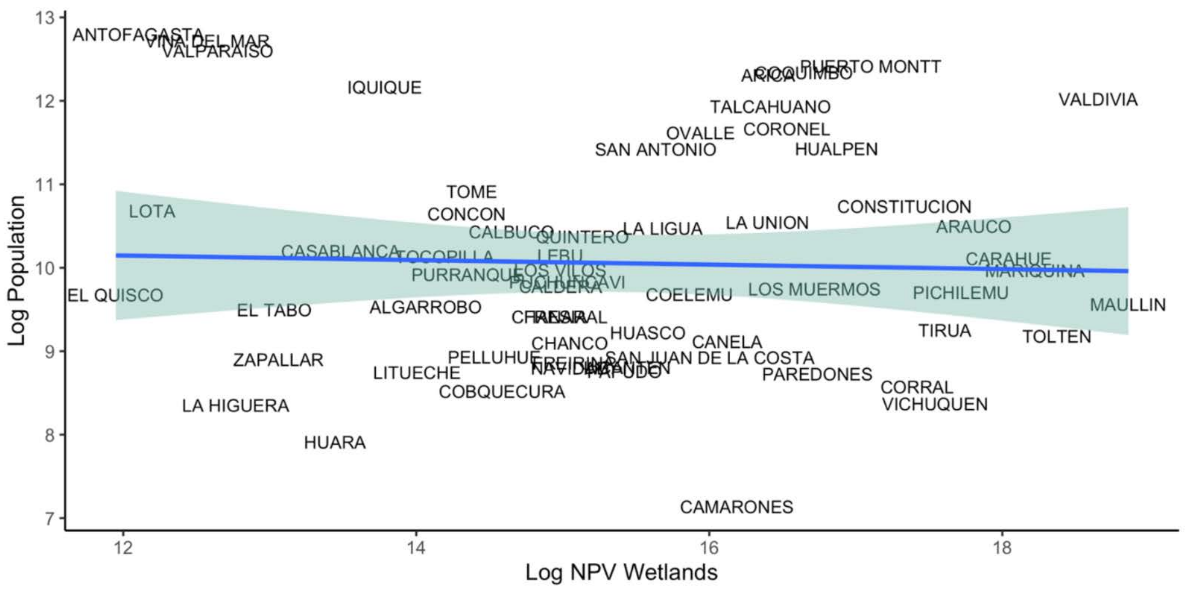


Figure 7. Plot of log NVP from fisheries and population per municipality, showing no significant correlation.

Tourism

Of the three bundles examined in this project, tourism has the largest economic value as measured by the travel costs method. According to our calculations, in 2019, the total coastal tourism-related travel costs in Chile where around $1,070 Million, resulting in a net present value associated with tourism (in the most conservative scenario) of around $19,700 Million. On average, the value in 2019 for each municipality was around $ 14 Million, while the average NPV was of around $260 Million, in the most conservative scenario (scenario C). The municipality with the largest value is Iquique with an NPV close to $2500 Million, while ten municipalities do not derive value from the coast. Within those with positive value, the municipality with the lowest value is Copiapó, with an NPV of around $3.6 Million.

Figure 8 shows there is a positive and significant correlation between the number of visitors and the net present value of tourism (b=0.996, p=0.000). The estimates suggest that a 1% in the number of tourists increases the value of tourism in almost 1%. This points out to a stable relationship between the distance travelled and the destinations across all municipalities in the sample and that the driving force of the results is the number of visitors rather than the distance travelled by them to different municipalities.

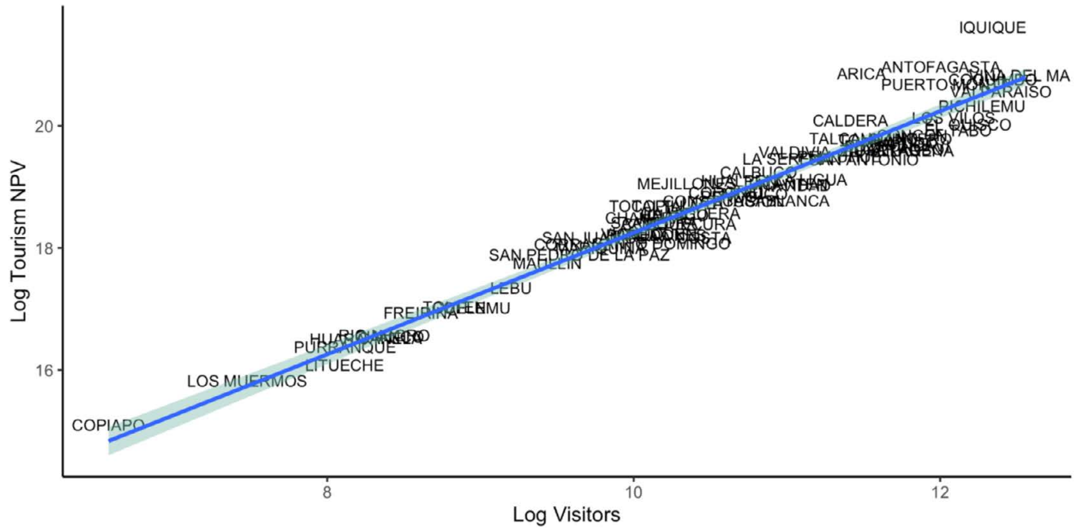


Figure 8. Log of number of visitors in 2019 and net present value of tourism (scenario C), showing a positive correlation.

Figure 9 shows there is also a positive relationship between the population at destination and the number of visitors (in 2019) (b=0.412, p=0.001). In general, larger coastal cities receive more tourists. Naturally, we cannot determine causality from this relationship. It can be that coastal cities have grown because of tourism or that they are able to accommodate more tourists because they have a larger population. Also, there is great variability in the results. Some municipalities such as Los Muermos or Purranque receive significantly lower visitors than what their population would suggest. Others, such as Pichilemu, el Tabo, El Quisco, receive significantly more coastal tourists than the average given their population size. All in all, we also observe a positive and significant relationship between the number of visitors and value of tourism per capita at the destination (b=0.605, p=0.000). This is shown in Figure 10. Municipalities that receive more tourists are, in general, able to obtain more value per habitant than the ones that receive less tourists. Note that this is not obvious given the positive relationship between size of population at destination and the number of visitors. It is noticeable that Copiapo, receive a very small number of coastal tourists. We cannot rule out that this is a construct of our measure of infrastructure and that it is not capable of capturing particular elements of this city and its relation to coastal tourism. Table 10 shows the main results for tourism per municipality.

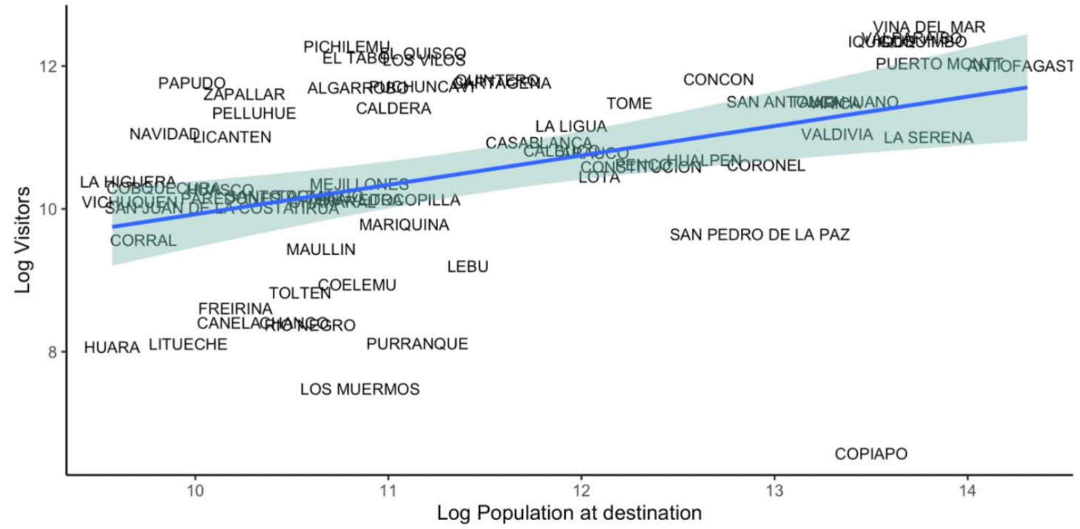


Figure 9. Log population at destination and number of visitors in 2019, showing a positive relationship.

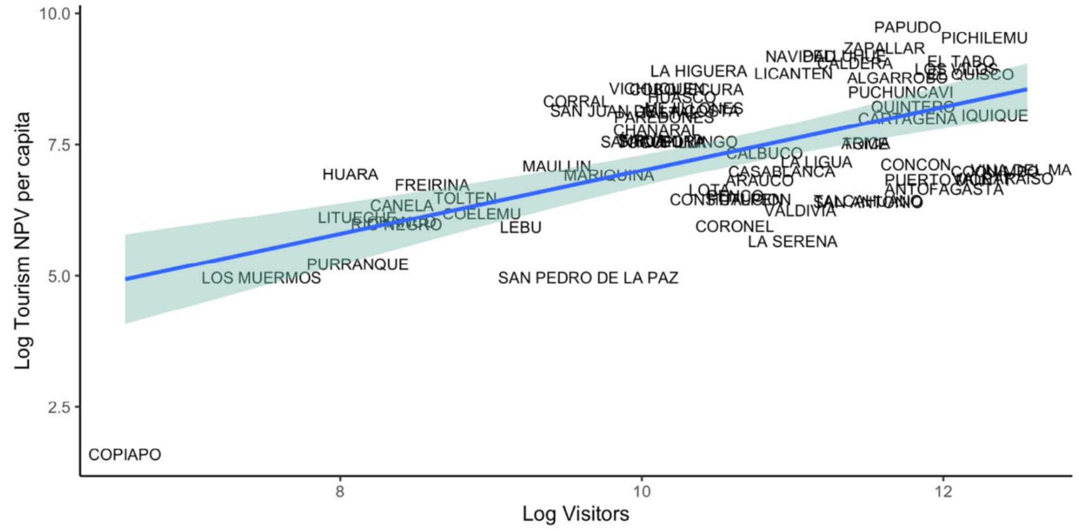
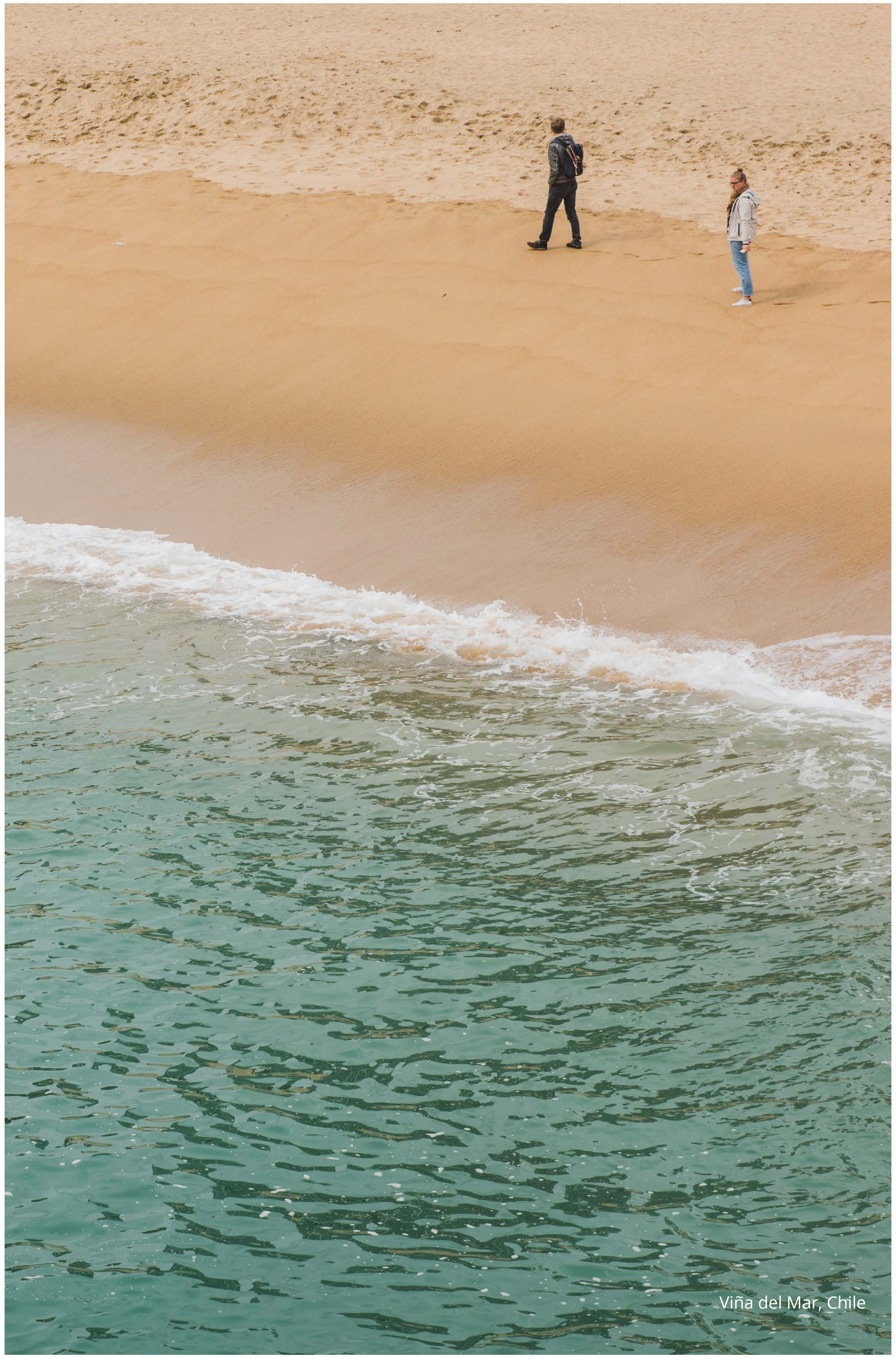


Figure 10. Log of number of visitors in 2019 and NPV per capita (conservative scenario C), showing a positive relationship.

Table 10. Main results for tourism showing number of visitors in 2019, net present value under different scenarios (A,B AND C) and NPV per capita (under scenario C). (All values expressed as USD of 2020).

Municipality	Visitors in 2019	NPV A ($MM)	NPV B ($MM)	NPV C ($MM)	NPV per capita ($)
ALGARROBO	120.367	388	360	331	6450
ANTOFAGASTA	163.813	1.494	1.387	1.274	778
ARAUCO	48.208	187	174	160	914
ARICA	97.379	1.341	1.244	1.144	1872
CALBUCO	49.764	267	248	227	1546
CALDERA	90.683	620	576	529	8590
CAMARONES	0	0	0	0	0
CANELA	4.493	18	16	15	574
CANETE	0	0	0	0	0
CARAHUE	0	0	0	0	0
CARTAGENA	128.758	378	351	323	2992
CASABLANCA	55.776	167	155	142	1088
CHANARAL	24.342	126	117	108	2400
CHANCO	4.482	18	17	15	417
COBQUECURA	29.629	114	106	97	5180
COELEMU	7.631	29	27	25	484
CONCEPCION	0	0	0	0	0
CONCON	135.793	486	451	415	1251
CONSTITUCION	39.693	166	154	141	637
COPIAPO	716	4	4	4	5
COQUIMBO	229.598	1.215	1.127	1.036	1085
CORONEL	40.820	191	177	163	383
CORRAL	14.285	82	76	70	4135
CUREPTO	0	0	0	0	0
EL QUISCO	195.207	584	542	498	6952
EL TABO	183.072	530	492	452	8916
FREIRINA	5.492	27	25	23	837
FRESIA	0	0	0	0	0
HUALPEN	43.812	231	214	197	640
HUARA	3.196	17	16	15	1030
HUASCO	28.804	132	122	113	4491
IQUIQUE	229.525	2.878	2.671	2.455	3180
LA HIGUERA	32.224	136	126	116	7439
LA LIGUA	70.316	237	220	202	1309
LA SERENA	60.086	333	309	284	289
LA UNION	0	0	0	0	0
LEBU	9.895	40	37	34	376
LICANTEN	60.409	220	204	187	7016
LITUECHE	3.340	11	10	10	453
LOS ALAMOS	0	0	0	0	0
LOS MUERMOS	1.771	9	8	7	144
LOS VILOS	177.801	651	604	555	7692
LOTA	34.545	160	148	136	763
MARIQUINA	17.755	77	72	66	1011
MAULLIN	12.558	60	56	51	1209
MEJILLONES	31.212	221	205	188	3650
NAVIDAD	63.280	216	200	184	9753
OVALLE	0	0	0	0	0
PAPUDO	128.625	435	403	371	17097
PAREDONES	25.575	95	88	81	3067

PELLUHUE	84.563	346	321	295	9850
PENCO	41.072	179	166	153	681
PICHILEMU	214.076	786	729	670	13864
PUCHUNCAVI	122.907	411	381	350	4921
PUERTO MONTT	168.474	1.124	1.043	959	920
PURRANQUE	3.354	15	14	13	186
QUINTERO	133.538	460	427	392	3729
RIO NEGRO	4.331	18	17	16	394
SAAVEDRA	25.163	116	108	99	1927
SAN ANTONIO	99.008	327	303	279	607
SAN JUAN DE LA COSTA	22.473	91	85	78	3465
SAN PEDRO DE LA PAZ	15.469	69	64	59	144
SANTO DOMINGO	26.428	83	77	71	1915
TALCAHUANO	98.886	465	431	396	624
TALTAL	26.377	153	142	131	3336
TEODORO SCHMIDT	0	0	0	0	0
TIRUA	22.242	94	87	80	1957
TOCOPILLA	25.160	153	142	131	1891
TOLTEN	6.843	29	27	25	657
TOME	97.248	451	419	385	1844
TREGUACO	0	0	0	0	0
VALDIVIA	63.062	372	346	318	518
VALPARAISO	242.065	1.001	929	853	947
VICHUQUEN	24.376	97	90	82	5249
VINA DEL MAR	283.820	1.302	1.209	1.111	1124
ZAPALLAR	110.095	379	352	324	11375
TOTAL: 77 Municipalities	**828.411**	**23.112**	**21.448**	**19.714**	**-**



Viña del Mar, Chile

Región de los Lagos, Chile

C. Fisheries income distribution

Figure 11 shows a histogram of the frequency of municipalities for each fisheries Gini Index value bracket. We found that for fisheries there is great income inequality between boat owners, showing concentration of resources in each municipality. Indeed, most municipalities are above the national average Gini Index value (0.47, vertical line).

Moreover, we found a significant and positive correlation between NPV and Gini Index (b= 1.99e-10, SD= 5.73e-11), p<0.0005), but a poor model fit (r2=0.17) (Figure 12). As such, results suggests that the more value fisheries provide for a municipality, the larger the gap in income distribution from it.

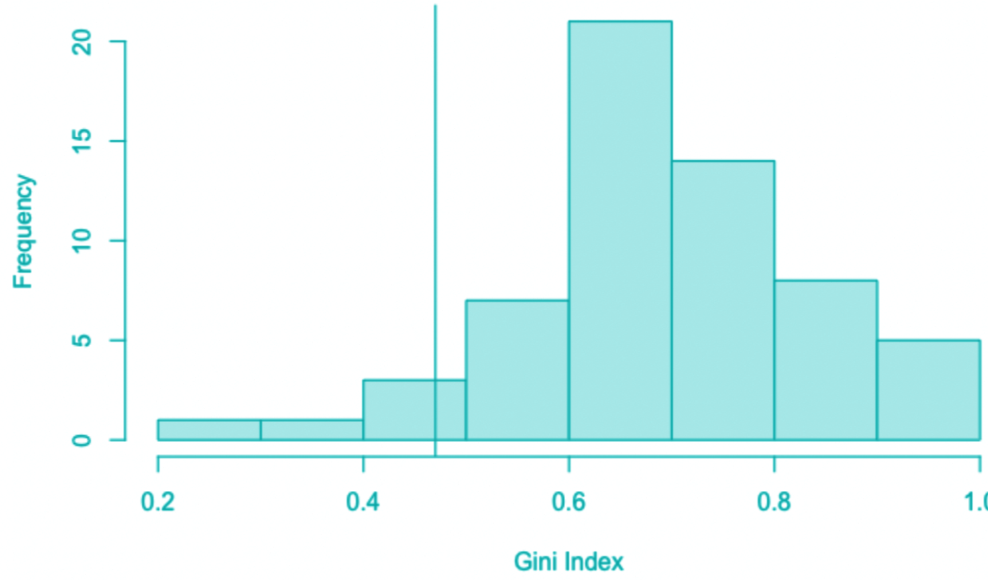


Figure 11. Histogram of GINI Index values for fisheries.

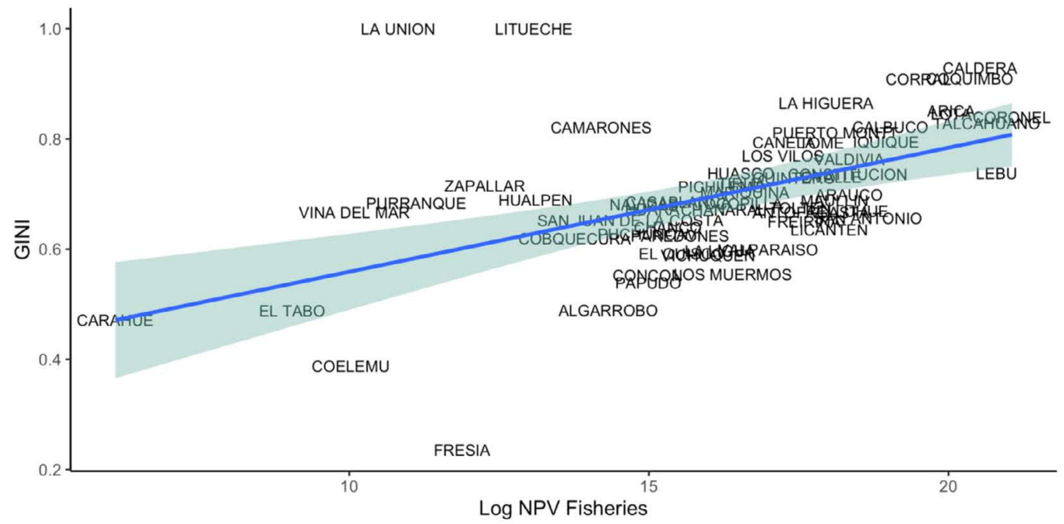


Figure 12. Log of fisheries NPV and GINI, showing a positive correlation.

D. Aggregated results

Aggregated results across bundles allow to identify trends that can shed light of the global situation of coastal municipalities in Chile. Figure 13 shows show a positive, but non-significant, correlation (b=0.0971.36, p=0.155) between the value that fisheries and tourism provide per municipality. In general, municipalities that bring high tourism and fisheries revenue are those that are bigger in terms of population (such as Arica, Iquique or Coquimbo). But there are also municipalities that clearly fall outside this relationship, such as Viña del Mar, one of the most important touristic destinations in Chile, that has low levels of fisheries landings.

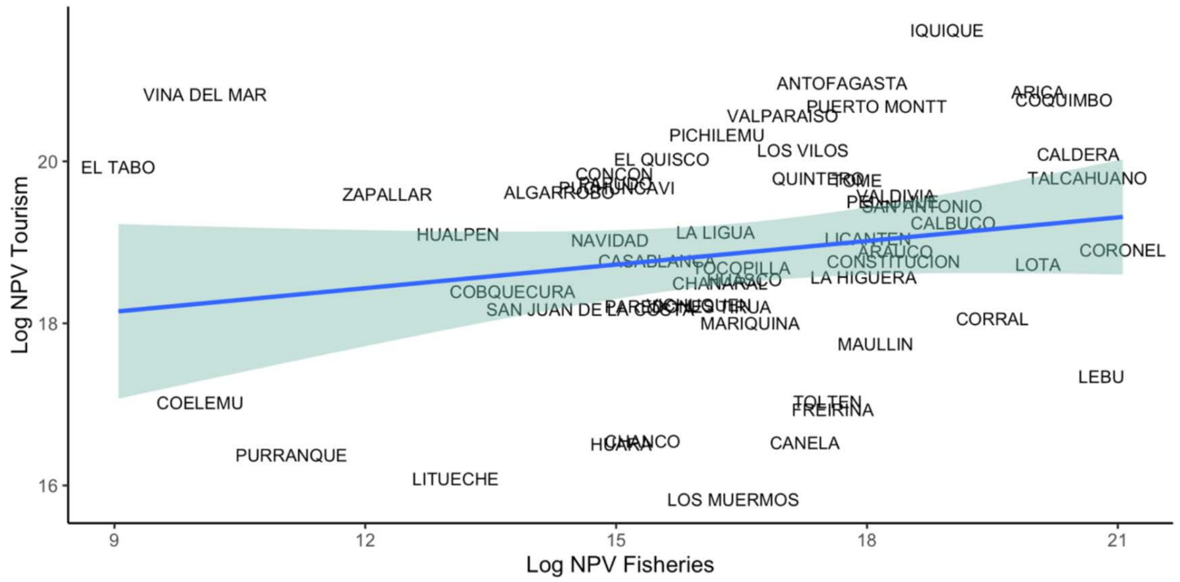


Figure 13. Log fisheries NPV and tourism NPV, showing a positive correlation.

We found a negative, but non-significant (b=-0,172, p=0.102) correlation between wetlands and tourism NPV values (Figure 14). This correlation is very low, which prevents drawing strong conclusions about the relationship between these two variables. However, the negative sign could be partly explained by geography: while some key coastal touristic attractions are in the centre and north due to good weather conditions (i.e., Antofagasta, Iquique, Viña del Mar), these are also places with low extent of wetlands due to lower precipitations.

Highly attractive touristic municipalities are also well developed with competing uses between spaces, which can further shrink wetland area. Moreover, the plot between fisheries and wetland shows a very weak positive correlation (b=0,079, p=0.282) (Figure 15). While there are key municipalities that are both high in wetland and fisheries (i.e., Maullin, Valdivia), these are a subset and do not represent a general trend in which these two variables grow together.

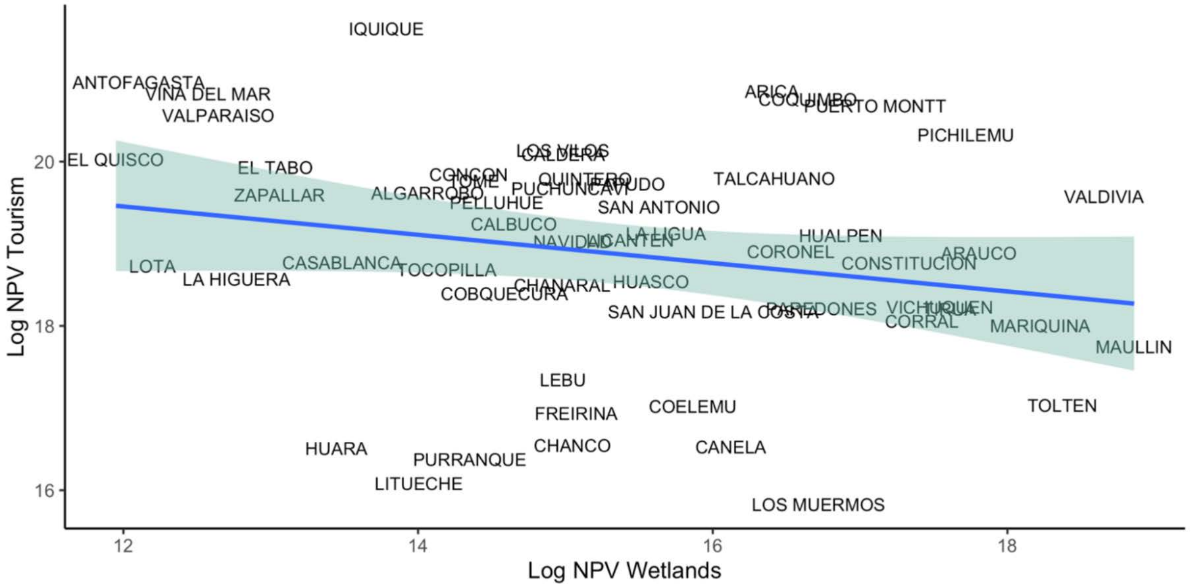


Figure 14. Log wetlands NPV and tourism NPV, showing a negative correlation.

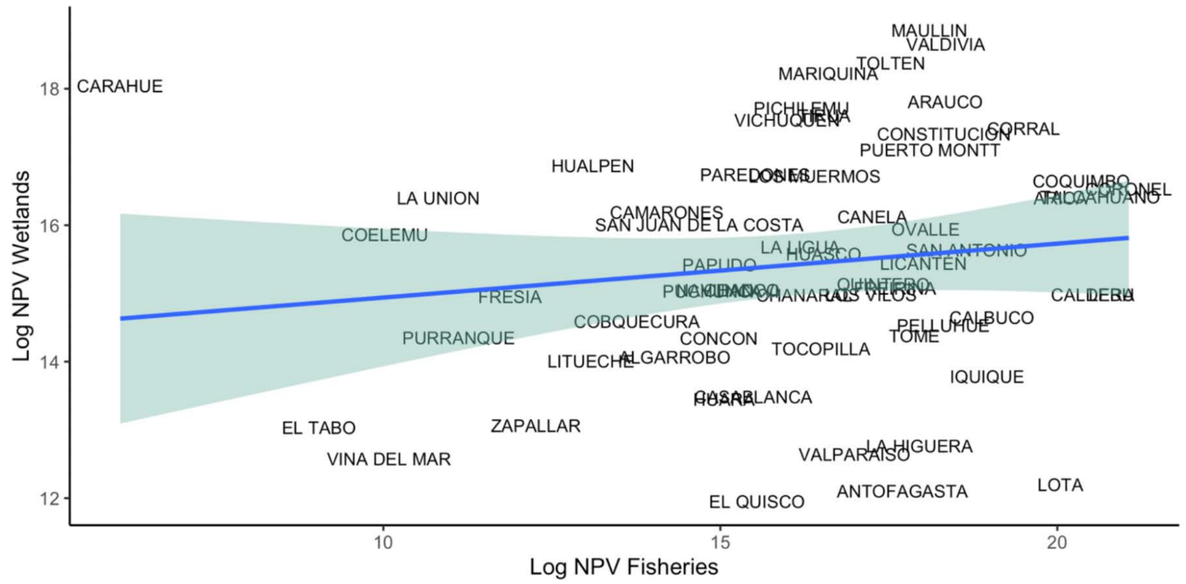
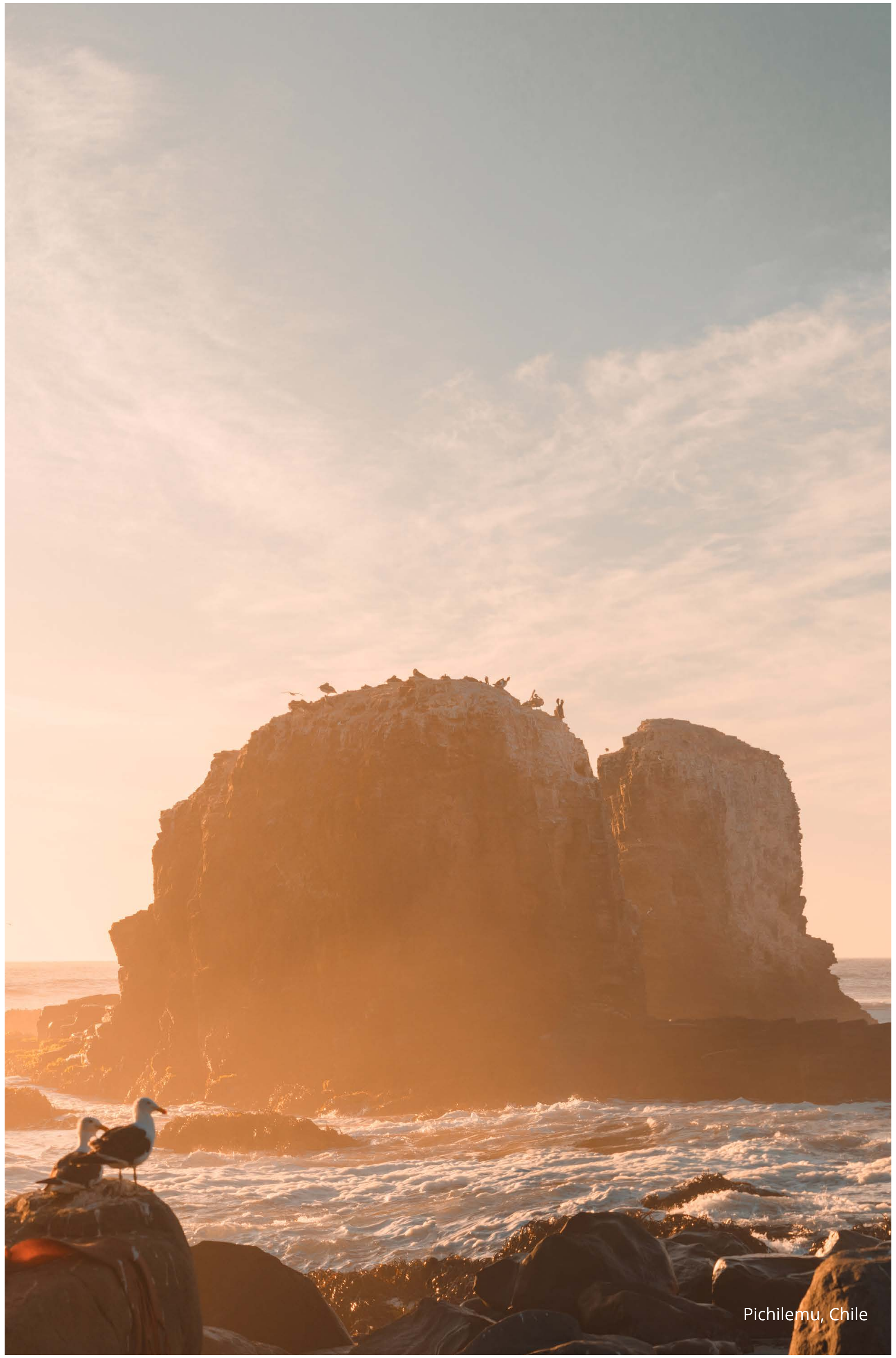


Figure 15. Log fisheries NPV and wetland NPV, showing a weak positive correlation.



Pichilemu, Chile

7. Discussion

Valuating coastal ecosystem services

Assessing the economic value that natural ecosystems provide to humans is an important step for better managing them [16,18,21].

Estimating a monetary value on the contributions of nature can help putting into perspective the different ways humans benefit from natural systems and inform the consequences of alternative management strategies by providing estimations of their impacts on a common (monetary) metric[9]. In this study, we have taken a first stab, with a diverse set of methods and datasets, at assessing the value of coastal ecosystems in Chile. Our results should be seen as a first approximation to the orders of magnitude of the value of some coastal ecosystem services, their trends, and potential future paths rather than precise calculations.

Given data limitations, we restricted our attention to three bundles: wetlands, tourism and fisheries. In general, we find that tourism provides the largest source of economic value, and our estimates (in conservative scenarios) suggest its value is more than 50% the value for fisheries, the second most valuable service. Wetlands are an order of magnitude smaller than the other two bundles that we estimate. For all bundles, we find great diversity in the values across municipalities, which is expected given their sizes, resource endowments, populations and development strategies. Moreover, our results show poor correlation between bundles across municipalities, which could indicate the necessity for considering the potential trade-offs and synergies between bundles at the local level. Indeed, our results show that drawing system-scale conclusions about how these bundles interact in Chile is of little use. This is senseful as Chile's coast is diverse, so the relative value provided by the different bundles at the local level is going to be unique to each context.

Pichilemu, Chile

Wetlands

For wetlands, the results are driven entirely by wetland area, as we used the same per-hectare reference value for all of them. Because we use a global average to understand trends in this ecosystem service bundle, the value is higher in the no-loss scenarios for all wetlands (as all wetlands are assumed to decrease in area with time). The overall gap we calculated between NPV and the no loss scenario (management potential) for wetlands is $188 MUSD. Wetlands are sometimes overlooked in coastal and conservation dialogues, but these provide key ecosystem services. While some services are directly linked to local livelihoods (such as fishing, salt harvest, or tourism), other services (such as CO2 sequestration) are not captured directly by local communities living in the fringe of wetland area. As such, wetland degradation puts several livelihoods at risk, both at the local level and at regional-national and global levels, and should be given attention in conservation strategies not only for their local benefits but for their impacts in global ecological dynamics. Wetlands can be secured on the long-term if their threats (mainly from land-use change and pollution) are halted. This is of course a multi-dimensional issue and coordination between agencies and key stakeholders is needed.

Fisheries

For fisheries, results show that this bundle contributes considerably to coastal economies. Municipalities such as Coronel, Lebu, Talcahuano, Caldera, and Coquimbo have key ports where thousands of tons are landed. While these municipalities lead the estimations in terms of NPV, there are several other municipalities where fisheries contribute considerably, especially when considering the size of the municipality and the NPV per capita value. We have tried to consider the value that fisheries contribute not only at the landing point by using economic multipliers [29]. Economic multipliers try to capture the overall value that an activity provides, as the product travels through supply chains. Future work, and more data, would be needed to capture the heterogeneity of these multipliers depending on the fishery, the opportunities for added value, and the different markets. This could shed light on where investment in infrastructure, governance and better market channels might be needed to better derive value from catch. A rather worrying result, however, is the negative trend seen for many municipalities' landings in the time span. These trends, in contrast to results in wetlands, are constructed from data for each municipality and represent a good estimate since it's an extrapolation from twenty years of data. Reversing these trends is then crucial for fisheries so they can continue to contribute to local economies. Later in this discussion we comment on ways of doing this based on successful cases that integrate fisheries management with other potential management tools.

Tourism

Tourism has the largest value among the three bundles. It is more than 50% greater than the calculated value of fisheries and is greater than wetlands by an order of magnitude. Non-surprisingly, we find great heterogeneity in the results. Iquique, in the north of the country, has the largest tourism value. This is not completely driven by the number of visitors, but also because of the distance travelled.

It is interesting to note the heterogeneity in NPV per capita and number of visitors. Some municipalities, such as Papudo or Zapallar draw a significantly higher than average NPV per capita given the number of visitors they receive, while other municipalities such as Vina del Mar, draw very small NPV per capita. While this result is in part due to the larger population of the latter, it is important to note, as it can signal development paths taken by the different municipalities that are not necessarily consistent with the maximum levels of benefits for the local populations. A deeper look into the reasons of why different municipalities are able to obtain different levels of NPV per capita is an interesting avenue for future research.

Our scenarios for tourism clearly show the relevance of projecting into the future. With Scenario A, the value per year value (the flow of services) almost doubles in the 30 years, while for Scenario C the increase is lower. As we discuss earlier, without sectorial projections, we generate these scenarios based on GDP growth. Given the historical relative constant contribution to GDP of the tourism industry, pairing tourism to GDP growth is a reasonable exercise. However, as the country moves from extractive to service-based economies, it is likely that the contribution of tourism to GDP will increase.

We highlight two key points when analyzing these trends. First, **while tourism values might seem overwhelmingly important in comparison to fisheries and wetlands, the three values are linked[33,34]**. Coastal tourism is dependent, at least partially, on a healthy coastal ecosystem. The possibility of enjoying nature is one of the reasons why these places are visited. Indeed, we know that wetlands are an important tourism destination, for instance in Cahuil, VI Region. This relationship is not embedded in our calculations, but it is important to acknowledge it. This means that, while wetlands and fisheries might not show up as representing a large fraction of the value of the coastal ecosystem, these are important indicators of ecosystem health and could also be drivers for coastal tourism, which forms the largest fraction of total value. Note that this does not necessarily bias our calculations for the total value coastal ecosystem services, since the cultural value of fisheries and wetlands is included in the value of tourism but might hide the links between the ecosystem service bundles and artificially show a lower value for wetlands and fisheries. Without better information on the reasons for visiting a site and/or more granularity in the data it is not feasible to assign a fraction of tourism value to a particular component of the ecosystem bundles. An important point here is that destroying coastal natural systems might also translate in a reduction of tourism, and potentially vice-versa, healthier ecosystems might increase the value of tourism. Assessing how much of the growth in tourism can be realized with poor coastal ecosystems management is beyond the scope of this study, and more data would be needed to approximate this relation. While there are cases where tourism grows independently of ecosystem health (and on its way destroying coastal ecosystems), there are other cases as well where tourism has been halted by a lack of conservation initiatives, which have decreased destination's values[35].

The second key point to consider when analyzing these results has to do with the broader socio-economic impacts of these growth trajectories. **There isn't a direct translation between economic value, as calculated in this study, and social welfare.** This parallels the limitations of GDP as a metric of welfare, a topic that has been extensively discussed.

This is important to highlight. For instance, fishers might be highly vulnerable to reductions in catches, and the economic impact of this might be suffered mostly by them[36] . **Increases in the tourism industry might not reach this specific group and therefore generate, or increase, inequalities[37].** Similarly with wetlands, those who depend on this ecosystem can potentially benefit from increases in tourism, but a transition towards a tourism-based livelihood might not be possible for those with lower adaptive capacity[38]. As such, it is important to remember that broader evaluations of social wellbeing need to consider not only the overall economic value generated, but also its distribution, among other relevant indicators. Living in a socially sustainable economy needs to consider not only the aggregated ability of producing goods and services in the future, but also the heterogeneity in how benefits and costs are distributed among those living by the coast[39]. It is only through a long-term and socially fair perspective that coastal ecosystems should be seen with development eyes. Otherwise, there is an intrinsic risk of alienating coastal communities, with potentially large negative consequences.

Indeed, here we were able to partially analyze not only aggregated value provided by ecosystem services but also proxies for their distribution. For fisheries for instance, we constructed a GINI index based on how value provided by landings is distributed amongst boat owners. **Results show very unequal distribution, with the majority of municipalities with very high GINI value. Pretty much all municipalities are above the overall GINI index of the country.** While the comparison between our calculations and the GINI index of the country is not direct, as these are measuring slightly different things, it does help to understand what our calculations mean in the Chilean context. Indeed, our results are also high in comparison with more direct cases in which the same index been measured in other fisheries[40]. Moreover, we show that there is a positive and significant relation between GINI index and NPV, indicating that the more value a municipality produces in terms of fisheries, the less equal the value is distributed. This is very worrying because it suggests that fisheries recovery might actually increase the concentration of resources, rather than the other way around.

Study limitations

The economic valuation performed here has many limitations that we separate into two main categories. First, limitations related to the approach and methodology, and second, limitations related to the available data.

Regarding the ecosystem valuation approach, there a few important points to consider. First, we were only able to valuate ecosystem services where methodologies and previous estimates are available. For instance, we could not valuate key ecosystem services such as the protection against storms and swells that sandy beaches can provide, or the carbon sequestration by coastal kelp forests because these are still poorly understood and are fundamentally difficult to evaluate[41,42]. Here, the key issue is not whether these ecosystem services should be evaluated or not, but how poor current methods for approximating their value are. Second, since we do not perform primary research, we rely on estimates made by others to inform the values of some of the services along the Chilean coast. There are limits to the value-transfer methodology and the ability to adapt estimates in one place to the reality of another. This trade-off is inevitable without performing primary research. Third, by focusing on the three bundles we assessed, our valuation is a severe underestimation of the total value of coastal ecosystem services. There are many ecosystem services that are not included in this project that should be the subject of study in the future (e.g., coastal protection by sandy beaches, kelp forest as providers of raw material, etc). We were not able to include estimations for other ecosystem services because there is simply no data available to do so.

Second, there are particularities of the sub-methodologies that also limited our ability to provide accurate estimations. For wetlands, we only had one reference study to perform the transfer methodology. Therefore we are entangled with any biases or miscalculations that might exist in that study[26,43]. This is a common issue for value transfer approaches. For tourism, the travel cost methodology suffers from a few problems. First, the value is assigned if the sites are visited. In this sense, the existence value is not included in the calculation. A related problem is that it might suffer from large socio-economic biases. People with higher incomes can travel more and pay more travel costs to reach a destination. This biases the value in favor of places preferred by people with higher incomes. Fundamentally, willingness and ability to pay are indistinguishable in the demand. Regarding the value of fisheries, the main limitation in the approach is that for capturing the whole value of fisheries along the supply chain, we had to use an "industry multiplier" that came from a meta-analysis and might not be representative of the heterogeneity in value that different fisheries produce along supply chains[29].

The second category of limitations is related to the lack of data. There are specific pieces of data that are missing and could have improved our estimates significantly. For wetlands, while we had data on the area of each one (provided by the government) we did not have enough granularity on the data of its uses. Because the valuation of wetlands is highly sensitive to its uses, this lack of data prevents better calculations on the value of those wetlands that are under-researched. Moreover, for wetlands we did not have a local estimate of the trend in area cover for Chile. For building the scenarios, we had to use a global estimate from coastal wetland that is not necessarily a good representation of the situation in Chile. There is an urgent need for better monitoring coastal wetland extensions in Chile as to better target conservation efforts.

For tourism, the data available provided by SERNATUR, while innovative, does not provide information about multiple destinations, which is a common problem with origin-destinations data sets. Considering all trips to be single-destined could in principle over-estimate the value associated to a destination. To counter this risk of over-estimation, we have not considered travels that are labeled as "frequent" tourist visits in the SERNATUR dataset. These actually represent a greater number than "non-frequent" visits. Since these two data sets are not complementary, total visits is less than the sum of the two. Selecting only one of the datasets surely puts us on a conservative side of estimates, but a better categorization of the data would be useful. The data also does not contain information on the duration of stay, which could significantly improve our estimates. Without this data, we relied on information from surveys to estimate the average time people spend in their destination. We also believe there is value in updating available surveys that collect information on expenses and other characteristics of tourism in the country. Finally, we have not included international tourism, as there is no information on the destination of international visitors. International visitors are significant and excluding them certainly puts us on the conservative side of the final estimates.

For fisheries, the main problem with data has to do with unreported or illegal fishing. Several estimates suggest that, for artisanal fisheries, legal landings record represent only a portion of total landings[44,45]. Moreover, price data was not always available for the each region and therefore we had to rely on data from other regions, which can introduce distortions in the evaluations as these are subject to variation. Moreover, for fisheries we were not able to add cost values, as we didn't have information on the gear used to fish. In fisheries, cost can account for an important fraction of the total catch value, but this is highly variable[46]. Finally, with current data available it is not possible to estimate credible gaps between current catches and maximum sustainable yields and thus we are restricted to assume an optimistic scenario is one where there are no further losses in catches.

Generally, the availability and readiness of data concerning fisheries, tourism and wetlands (and other aspects of coastal management and conservation) is key for better understanding and managing coastal ecosystems. In this project, we used a variety of data sources. Improving estimations such as ours would greatly benefit from better availability of data (e.g., fish price data at a more local level) but also from better integration between sources. Monitoring coastal ecosystems in an integrated way, as a combined effort between government agencies, academics, and civil society organizations, could provide an important baseline from where to build from. In the same way, feeding data collection processes in an adaptive way as findings become available, would help to produce data that is more relevant for governance and decision-making processes. Filling crucial data needs and monitoring are much required steps for proper and long-lasting management of the coastal ocean.

Looking forward: successful and informative case studies of coastal protection

While beyond the scope of this project, **moving forward towards integrated and sustainable coastal management requires looking at other successful cases in how they manage their coastal areas.** There are two cases that we believe can shed light on this: California and Colombia.

The California Case

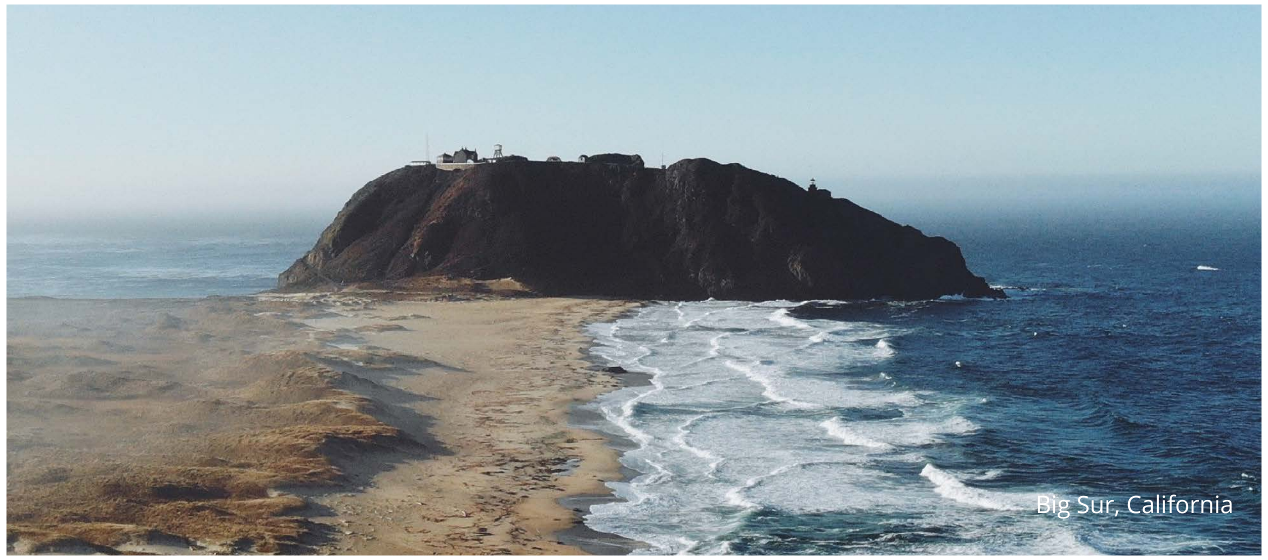
California is an interesting case because of its efforts to protect coastal areas with two key policy pieces and its geographical and climatic similarities with parts of the Chilean coast (Murray & Hee, 2019). The Coastal Act of 1976 created the California Coastal Commission to implement state coastal protection policies in partnership with local governments, which has since been recognized as one of the world's most successful coastal-marine management policies (Saarman & Carr, 2013). Then, the California Marine Life Protection Act (MLPA) of 1999 created the most significant coastal Marine Protected Areas (MPAs) network globally, with 124 MPAs under different management programs, resulting from a science-based public-private, and participatory process that took ten years to implement. By doing so, **California has been able to cope with a significant increase in tourism while maintaining and even recovering the very natural assets that support the touristic industry, along with its fisheries (Murray & Hee, 2019; Ovando et al., 2021).** In doing so it has also entrenched its coastal economy with conservation efforts, for instance, by increasing tourism and diving activities in marine protected areas. As such, California presents a potentially good example of the necessary processes and outcomes to secure a sustainable management of coastal areas for promoting the diverse values these can provide.

The Colombia Case

Colombia presents a smaller scale but very interesting example. In 1999, CORALINA (Corporación para el Desarrollo Sostenible del Archipiélago de San Andrés, Providencia y Santa Catalina) was legally established as an autonomous administrative and financial entity corporation to guarantee the sustainable development of the San Andres and Santa Catalina archipelago. CORALINA is a much more concentrated effort than the California case, as it only considers an archipelago, but its administrative structure can provide important lessons. It is the entity in charge of all environmental issues, from tourism to protection and management of natural resources. As such, it can implement coordinated actions to booster the supply of several ecosystem services, such as tourism and fisheries, avoiding intricate agency coordination problems, as it happens in other settings. CORALINA also has a community engagement and education component which brings the community, and specially the youth, into understanding the importance of properly managing marine natural resources.

Learnings for Chile

Chile suffers from overlapping, dispersed, and ineffective governance structures for the coast. Because the coastline is dynamic and complex, many governmental agencies deal with its management, usually lacking appropriate tools. This creates inefficiencies as agencies' responsibilities overlap, interact, and even contradict each other. As such, Chile can learn from these two examples for better managing its coastal natural resources. From California, there are important lessons regarding the extent of its initiatives: California is the sixth largest economy in the world, with a large tourism industry. It has transitioned from over-exploitation and degradation of natural systems to relatively healthy and productive ones through a mix of large-scale public policies supported by science. Chile, with similar coastal ecosystems could be inspired by this large-scale effort and move towards integrated management of coastal systems, in which the contributions of different ecosystem services are combined. Here, the case of CORALINA and its governance system can provide insights into how to organize management around all areas that are affected by coastal activities. Providing a common decision-making arena to manage the diversity of ecosystem services coastal systems provide is key to ensure integrated management, so that growth in the supply of one service is not linked to reductions in another.


Big Sur, California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Closing remarks

We have developed an approach to provide a comprehensible measure of economic value of coastal ecosystem services, using the VI region of Chile as a case study.

Our results are management-relevant and show the importance of these ecosystems to local economies, and the potential value that could be lost if current degradation trends continue. The main advantage of this methodology is its scalability: the marginal effort of including another region is vastly reduced as more regions are included. We hope that better understanding the value that coastal ecosystems provide can spark a renewed interest in coastal management, which Chile greatly needs. Learning from the institutional and governance processes from other contexts can aid in this task. But, most importantly, we need to better value our ecosystems, understand its threats and the diversity of ways people derive benefits from it. While we have taken a limited approach by only assessing monetary value, coastal systems provide key livelihoods and the base for cultural expressions that are irreplaceable. As such, monetary valuations should serve as a starting point and not an end: a discussion opener that can ignite other themes, bring more people into the table, and put Chile in the path for a more sustainable future.


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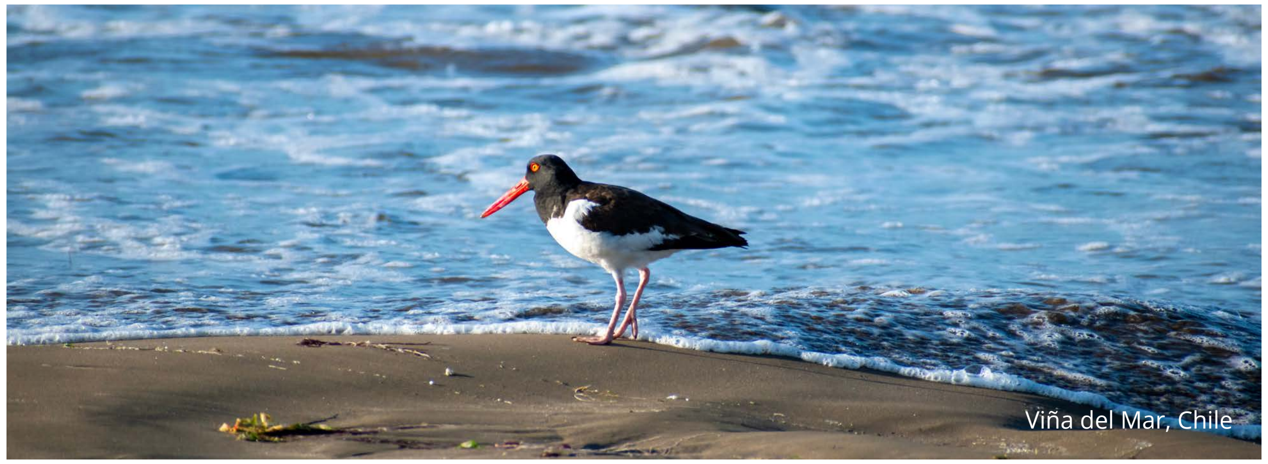
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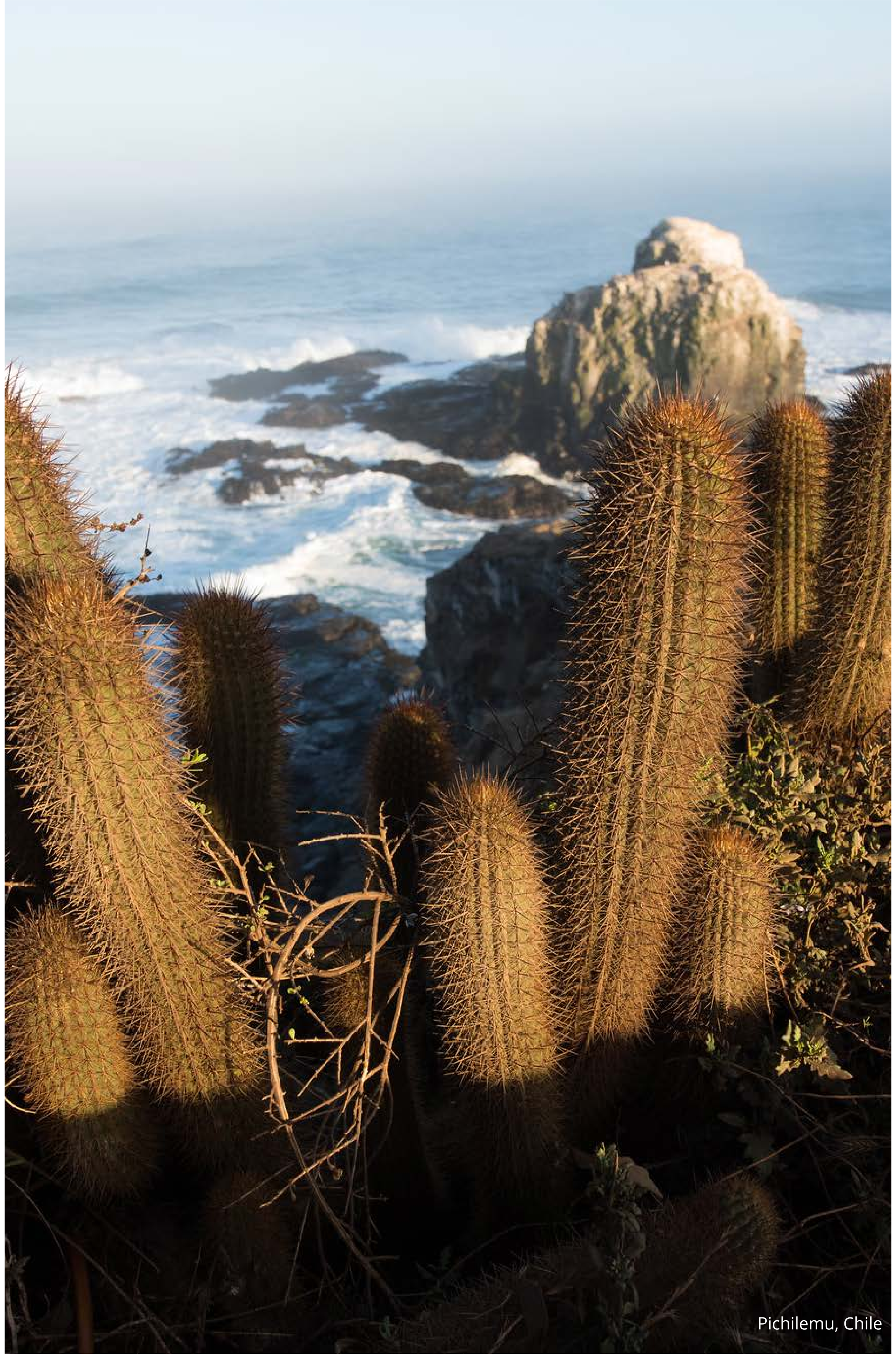
Pichilemu, Chile

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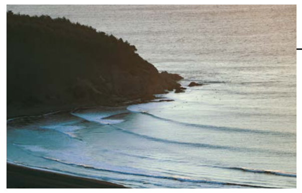

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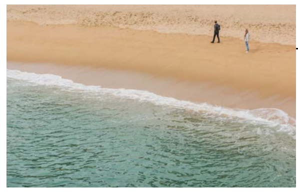

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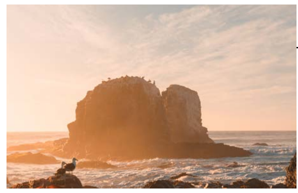

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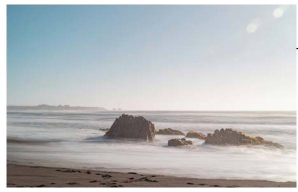

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Assessing the economic potential and distribution of Chile's coastal ecosystem services

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