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FORMAS

Towards a sustainable blue economy in Sweden

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Foreword

Climate change, biodiversity loss, increasing pollution and waste – the planetary "triple crisis" is a strong driver for change and rethinking how we use and manage our natural resources. The recent pandemic, the war in Ukraine and a changing geopolitical landscape are reshaping how we view global value chains, food and energy production. In this context, decision-makers in many parts of the world are increasingly looking towards the ocean and to various water-related or "blue" sectors as a means of diversifying economies, meeting climate goals and supporting local communities. The shift towards a blue economy therefore comes with large expectations but also uncertainties. Sustainability must be at the forefront of any change.

With this in view, Formas in collaboration with Mistra and Vinnova commissioned this forward-looking study on the potential of the blue economy in Sweden. Research and innovation will be key in realizing the potential of the blue economy and ensuring that it will be truly sustainable. The report highlights many opportunities and strengths that we can build on, as well as some barriers and incentives to progress.

The insights provided by the report will hopefully be the start of a renewed discussion in Sweden on the blue economy – on what a sustainable blue economy may look like in the Swedish context, as well as on how research, innovation and business in Sweden can contribute in an international setting. The "green transition" can indeed become a sustainable blue-green transition.

John Tumpane
Head of Environment Department, Formas

Summary

This report was commissioned by Formas in collaboration with Vinnova and Mistra and in dialogue with the Swedish Agency for Marine and Water Management (SwAM) and the Government offices of Sweden, with the purpose of providing a concise and forward-looking summary of how a transformative transition towards a more sustainable blue economy could take place in Sweden, and thereby also contribute to a more sustainable development outside Sweden. The report constitutes a basis for analysis of obstacles to and incentives for the opportunities of a sustainable blue economy, and a roadmap for the implementation of Sweden's Maritime Strategy. The analysis was also used as a basis for discussions at the UN Stockholm+50 Conference (Stockholm, 2–3 June 2022) and the UN Ocean Conference (Lisbon, 27 June–1 July 2022). Target groups for this report are politicians and economic actors.

The information presented here is based on existing data from research, government documents, industry reports and official statistics. A consultation process with key stakeholders in Sweden was carried out in 2022, including a stakeholder workshop held on 2 December 2022. The purpose of the workshop was to collectively detect the Swedish potential, pathways, and necessary enablers for transformation. Based on stakeholder inputs from the 38 participants (see Appendix) and written feedback, the report was revised and adjusted.

The report is divided into five sections: (1) an introduction setting the scene of the challenge ahead and a way forward to guide future marine spatial planning; (2) the status of maritime industries in Sweden broken down by sectors – for each industry we suggest a shift beyond a sector-based focus and towards a mission-oriented approach; (3) cross-cutting pillars of Swedish society that can contribute to the development of a sustainable blue economy; (4) final remarks; and (5) recommendations.

Four main limitations are important to mention. First, the report does not make a systematic review of all scientific literature. It is meant as a lighter type of document that can be easily communicated to politicians and economic actors. Second, some sectors have better data than others; data on the blue economy from a single source is based on the only available statistics published by Statistics Sweden (SCB) in 2017. Third, the report builds on Sweden's main marine sectors because data is tracked this way; however, a key message of this report is the need to move beyond a sector approach and towards societal missions. Lastly, while emphasis is placed on opportunities for job creation, for increasing food security and for attaining clean energy production, the report highlights the dire state of many of Sweden's marine areas and the need to ensure ocean health if we are to attain a sustainable blue economy.

Sweden's long coastline, lakes and waterways, together with a robust innovation ecosystem, provide opportunities for increased self-sufficiency, competitiveness, job opportunities and international attractiveness. In several marine sectors, the development and innovation of new businesses and products as well as new cross-sectorial alliances and partnerships are on the rise. However, a system approach that considers not only economic growth but also social and ecological sustainability is a precondition for a sustainable blue economy. A multifunctional approach to marine spatial planning will be increasingly important to ensure that the ongoing industry expansion in energy, food production, mobility and data is done in a way that at the very least ensures resource efficiency and minimizes negative social and environmental impacts, and at best contributes to the regeneration of coastal and marine ecosystems. To achieve this, Sweden's blue economy requires a national approach well connected to the European Union and international agendas, with clearer mandates and allocation of responsibilities, and a long-term strategic direction that increases confidence among Swedish actors to mobilize and dare to invest at home.

Sammanfattning

Den här rapporten har gjorts på uppdrag av Formas i samarbete med Vinnova och Mistra och i dialog med Havs- och vattenmyndigheten och Regeringskansliet i syfte att ge en kortfattad och framåtblickande sammanfattning av hur en transformativ omställning mot en mer hållbar blå ekonomi kan ske i Sverige, och därmed också bidra till en mer hållbar utveckling utanför Sverige. Rapporten ska utgöra ett underlag för analys av hinder och incitament för den hållbara blå ekonomins möjligheter och en färdplan för genomförande av Sveriges maritima strategi. Analysen användes som underlag inför FN-konferensen Stockholm + 50 (Stockholm 2-3 juni) och FN:s havskonferens (Lissabon 27 juni-1 juli). Målgruppen är politiska och ekonomiska beslutsfattare.

Informationen som presenteras här är baserad på befintlig data från forskning, officiella dokument, branschrapporter och statistik. En samrådsprocess med nyckelintressenter i Sverige genomfördes under 2022, inklusive en intressentworkshop som hölls den 2 december 2022. Syftet med workshopen var att gemensamt upptäcka Sveriges potential, vägar och nödvändiga möjliggörare för transformation. Baserat på input från de 38 deltagarna (se Bilaga) och skriftlig input från nyckelintressenter, reviderades och justerades rapporten.

Rapporten är uppdelad i fem avsnitt: (1) introduktion som beskriver utmaningar och vägar framåt som en guide för framtida planering av den marina miljön, (2) status för maritima industrier i Sverige uppdelade efter sektorer – för varje industri föreslår vi en övergång från ett sektorbaserat fokus till en missionsinriktad ansats, (3) tvärgående ansatser i svenska samhället som kan bidra till utvecklingen av en hållbar blå ekonomi, (4) slutsatser och (5) rekommendationer.

Fyra huvudsakliga begränsningar är viktiga att nämna. För det första gör rapporten inte en systematisk översyn av all vetenskaplig litteratur. Den är avsedd som en enklare typ av dokument som lätt kan kommuniceras till politiker och ekonomiska aktörer. För det andra har vissa sektorer bättre data än andra; data om den blå ekonomin baseras på den enda tillgängliga statistiken som publicerades av Statistiska centralbyrån (SCB) 2017. För det tredje bygger rapporten på Sveriges huvudsakliga marina sektorer eftersom tillgängliga data är uppbyggt på det sättet; dock är ett av huvudbudskapen i denna rapport att visa på behovet av att gå från enbart ett sektorfokus och i stället mot en tvärsektoriell systemansats. Slutligen, medan tonvikt läggs på möjligheter till jobbskapande, för till exempel ökad livsmedelssäkerhet och produktion av förnybar energi, betonar rapporten det akuta tillståndet i många av Sveriges marina områden och behovet av att säkerställa havets välmående om vi ska uppnå en hållbar blå ekonomi.

Sveriges långa kust, sjöar och vattendrag, tillsammans med en robust innovationsmiljö, skapar möjligheter för en ökad självförsörjning och konkurrenskraft, samt fler jobbmöjligheter och en internationell attraktivitet. Inom flera marina sektorer ökar utvecklingen och innovationen av nya företag och produkter, liksom nya tvärsektoriella allianser och partnerskap. En förutsättning för en hållbar blå ekonomi är en systemansats som inte bara beaktar ekonomisk tillväxt utan också social och ekologisk hållbarhet. En multifunktionell ansats inom maritim spatial planering blir allt viktigare för att säkerställa att en pågående industriell expansion inom energi, livsmedelsproduktion, mobilitet och data genomförs på ett sätt som garanterar resurseffektivitet och minimerar negativa sociala och miljömässiga påverkningar. Utöver det borde det i bästa fall bidra till regenerering av kust- och marina ekosystem. För att det ska uppnås krävs en nationell ansats för Sveriges blå ekonomi som är i linje med Europeiska unionen och internationella agendor, med tydligare mandat- och ansvarsfördelning, samt en långsiktig strategi som ökar förtroendet bland svenska aktörer att våga mobilisera och investera nationellt.

1. Introduction

The ocean – the new frontier of human activity – is being redefined by new discoveries, technologies, national strategies and ecological imperatives. Expectations about the services and resources that can be derived from our seas, and the opportunities for job creation and economic growth provided by these activities, seem to grow with every new outlook. At the same time this raises concerns over the present and future health of the ocean. This calls for a transformation of the ways we are using marine and water resources and demands new sustainable solutions and pathways for their implementation and upscaling. In other words, there is a need to move away from a blue growth approach that focuses on economic gains, towards a sustainable blue economy that includes the management, restoration and preservation of marine resources to secure ecosystem services.

The blue economy lies at the heart of Sweden's geography and culture. The country's 2400 kilometres of coastline makes it one of Europe's longest coasts, featuring sandy and rocky beaches, fjords, archipelagos and marine areas with considerably different bio-geophysical features. Over time, cultures, livelihoods and economies have developed around coastal activities throughout the country.

In Sweden, the North Sea and the Baltic Sea have long been important spaces for economic development through food supply, transport and trade. The blue economy is expected to play a vital role in the transition to a sustainable and fossil-free society. With this context in mind, it is fundamental to understand the status of – and the opportunities and risks emerging from – a growing blue economy.

1.1 The ocean we need

The ocean holds a valuable key to our future. It is critically important for regulating climate and as a food provider, hosting an unknown richness of biodiversity, biomass and genetic resources, while also providing space for energy production, transportation of people and goods, recreation and species habitat.

However, our ways of using marine space, coupled with emissions from air and land, rising carbon dioxide levels and a changing climate, are putting a huge, combined stress on marine ecosystems and their services (Heinze et al., 2021). At the same time, many of the ocean sectors are currently in a rapid phase of acceleration (Jouffray et al., 2020). A key concern with such acceleration is the history of overexploitation and unsustainable use that many industries have had towards common resources.

As countries increasingly turn their attention to the sea for diversifying their economies and ensuring the critical provision of services, there is an urgent need to radically change the way we think and use the ocean, away from a blue growth-based approach and towards a sustainable blue economy. This requires a transition that leads to net zero emissions of greenhouse gases, the recovery and restoration of habitat and biodiversity, and reduced and circular resource flows and production systems.

The High Level Panel for a Sustainable Ocean Economy estimates that the sea can supply 40 times more renewable energy, 6 times more food, 12 million new jobs, trillions in return on investment and 20% of the greenhouse gas emissions gap to limit heating to 1.5–2°C (Stuchtey et al., 2020)

The challenge is that the increased industrialization of the sea is often happening in places with already intensive economic activity and fragile but crucial ecosystems. Even activities such as physical constructions pose big challenges in coastal waters as they both pollute and change local dynamics. Along with the ambitions to reach the 30% target of conserving marine space, agreed at the Convention on Biological Diversity COP15 (IUCN, 2021), an expanding blue economy adds pressure to the governance of common resources. Competing interests over the use of marine areas increases the risk of conflict at local, national and transboundary levels. Attempts to manage the ocean sustainably must therefore take into account the multiple and complex interactions between society and the biosphere across space and time.

WHAT IS THE BLUE ECONOMY?

There are different interpretations of the blue economy. According to the World Bank (2017) there is broad recognition that a blue economy needs to entail the sustainable use of ocean resources for economic growth, improved livelihoods and jobs while restoring and preserving the health of the ocean.

For the IUCN (2022), efficiency and optimization of natural marine resources within ecological limits is paramount in the blue economy. The ocean is seen as a space for development where marine spatial planning (MSP), especially at national level, integrates the interests and needs of conservation, sustainable use, extractive activities, marine transportation and coastal tourism, and ensures that the integrity and functioning of coastal and ocean systems is maintained.

According to the UN (2022), a blue economy should be economically viable (prosperous) and environmentally sustainable, but also culturally appropriate and should foster social equity and human well-being.

For the EU (European Commission et al., 2021), a sustainable blue economy is a means to achieving the objectives of the European Green Deal and ensuring a green and inclusive recovery from the COVID-19 pandemic.

In 2015, the Swedish government decided on a national maritime strategy – for people, jobs and the environment. The strategy is an orientation document for the work required to develop the maritime industries and is based on three perspectives: balanced seas, competitive maritime industries and attractive coastal areas (SwAM, 2020).

1.2 Towards a multifunctional service-based approach

Europe's blue economy provides 4.5 million direct jobs (i.e. employment positions that are directly involved in the production or delivery of goods or services) and is a fast-growing segment of the EU economy (European Commission et al., 2021). The blue economy has modernized and diversified, and innovative sectors have evolved providing new prospects and creating jobs. Despite differences across sectors and countries, the general growth trend in marine industries is expected to follow in the rest of the world, so that by 2030 the blue economy is expected to double both in terms of value added and employment.

With such growth foreseen, it is fundamental to include the biosphere into our forecasts of a blue economy and move beyond the dominant single-use and single-sector linear paradigm in our economies. This demands a move towards approaches that can facilitate the combination of activities for multiple social, economic and environmental gains and build on circular modes of production and consumption.

Multifunctional planning is highlighted in research (Przedrzymirska et al., 2021) as well as in national policy (*Havet Och Människan*, 2020; Nyström Sandman et al., 2020; SwAM, 2020) and local management (Schubert et al., 2018) as a potential planning mechanism to ensure more sustainable marine practices. Multifunctional planning emphasizes the potential to minimize impacts to marine ecosystems and maximize socioeconomic benefits through the co-use of resources, materials and services, and the co-location of activities and infrastructures (Barquet & Green, 2022; Schupp et al., 2019; Zischg et al., 2019).

Knowledge about multifunctionality is still in an early stage and questions related to potential gains and losses from both an economic and environmental point of view remain. However, conceptually, Marine Spatial Planning (MSP) provides a clear entry point to operationalize multifunctionality, in that it is foreseen to help optimize “the use of marine space to benefit economic development and the marine environment” (European Commission, 2008). In Sweden, the first generation of Swedish MSP plans were approved by the government in February 2022 (SwAM, 2022). Second-generation plans are being prepared with a focus on offshore wind power (due in 2024), which is expected to provide an additional 90 terawatt-hours (TWh) to the already planned 30 TWh.

Multifunctionality is closely related to resource-sharing, which makes it an important instrument of the circular economy. It is also related to the ecosystem approach in the EU Marine Strategy Framework Directive, which highlights the importance of using marine areas and resources as long as this use does not compromise the health and functioning of ecosystems, and which has been the basis for planning all EU marine space.

2. Status of maritime industries in Sweden

Statistics Sweden (SCB) differentiates between the following areas: transport, maritime technology and production, the sea as a natural resource, leisure and tourism, and services (SCB, 2017). In 2015, these sectors employed over 34 000 persons, of whom women accounted for one third. The value added for coastal and marine industries amounted to SEK 27 717 million, or 1.2% of value added for enterprises, not including financial enterprises (SCB, 2018).

2.1 Businesses

Compared with relevant comparative industries, the value added in the maritime industries has shown stronger development. For the service industries and the industries linked to marine resources and space (energy extraction, fisheries and aquaculture), the value added of the maritime industries has grown by approximately 50 percentage points faster than in the comparable industries. A similar development can be observed in maritime technology industries (SwAM, 2020).

2.2 Employment

For the maritime transport industries, retail trade in leisure boats and cruises, and the maritime natural resource industries, employment development has been lower than in comparable industries. In the maritime technology industries and the service industries, however, it has been better than in comparable industries. It is important to remember that maritime tourism is narrowly defined in this indicator and does not include industries such as hotels and restaurants. This is because business statistics do not contain pure statistics for maritime tourism. Instead, other methods are required to estimate the extent of maritime tourism economically (SwAM, 2020).

2.3 Exports

When it comes to merchandise exports, it is mainly in the technology industries where significant exports can be seen. Other figures are difficult to interpret, as even small changes in absolute numbers can have large effects on the relative figures. There is a positive development for the maritime technology industry's exports of goods, which, by 2017, had increased 17 percentage points faster than exports of goods in comparative industries (SwAM, 2020).

> *The Port of Gothenburg is Scandinavia's largest and is the gateway to the world for large parts of Swedish industry. In western Sweden, there are around 3000 maritime companies with about 20 000 employees. This corresponds to 45% of the country's number of employees in maritime industries. Companies in the maritime industries are spread across municipalities in the region of Gothenburg* (Business Region Göteborg, 2022).

2.4 Outlook

Forecasts on, for instance, the potential for job generation, the creation of SMEs, the export potential of maritime activities, or what the maritime sector could imply for the provision of critical services including food, energy, water and materials are missing for Sweden. Moving forward, it is essential to understand the potential of the blue economy for a fossil-free transition. Data on maritime industries that incorporate value chains, could for instance indicate the potential that a transition away from fossil-based energy might have for service and component suppliers beyond the coastal area.

Marine transport
Shipping companies, ports and logistics companies

Marine technique and production
Shipyards, recreational boat industry, suppliers of technology and systems and other subcontractors to the maritime industries.

The sea as a natural resource
Fisheries and aquaculture, energy, minerals and bioresources

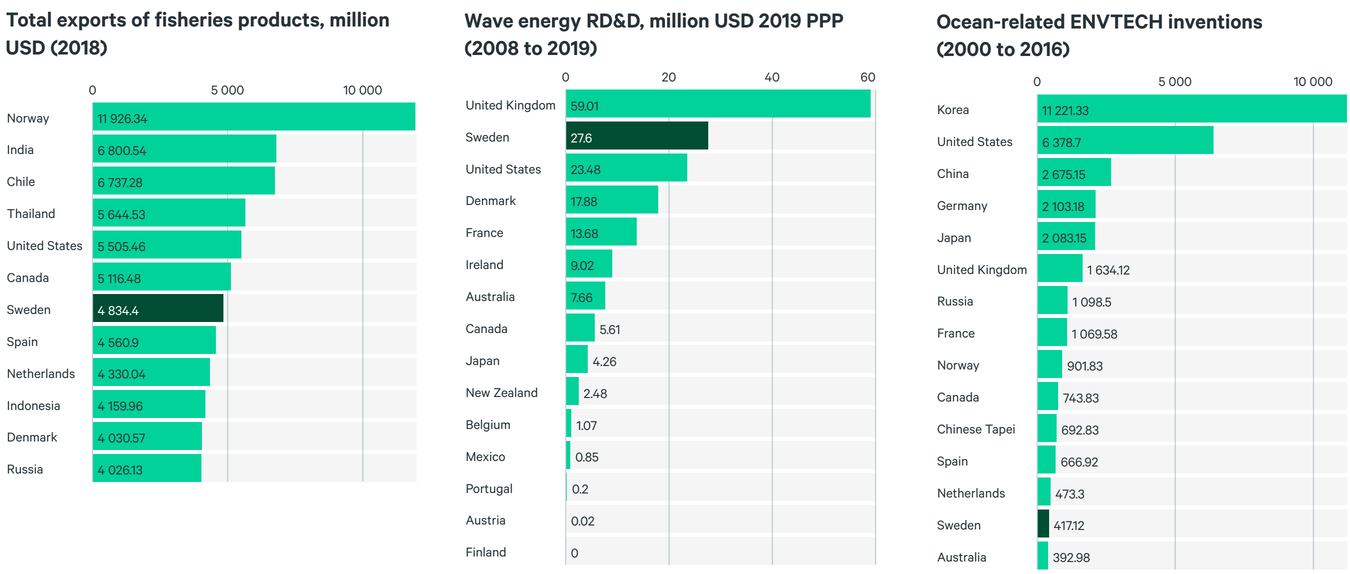
Leisure and tourism
Ferry traffic, cruise operations, archipelago tourism, recreational fishing, trade in recreational craft and marinas

Services
Ship brokerage, insurance companies, commecial sea surveying and survey services

Coherent, detailed and comparable data to track trends is needed to navigate the implementation of efficient political instruments and incentives in value chains. However, current nation-based statistics on the blue economy are not comparable across the world, as the methodologies used for collecting the data differ widely (SCB, 2017). For example, the boundaries for what constitutes a maritime industry differ from country to country, and according to a study by Statistics Sweden in 2017, Sweden applied a stricter approach than other countries concerning what to include in the blue economy. To date, there is no agreed approach to account for the blue economy internationally or the criteria that should be incorporated to show a fair forecast across sectors.

Importantly, there are different understandings of what constitutes the blue economy. While most definitions include an angle of sustainability, the extent to which the blue economy should cater for various goals – such as economic recovery, climate neutrality, circular production, preserving biodiversity, restoration, blue carbon capturing, mobility and trade – differs between the conceptualizations.

Figure 1. Sweden's position in an international context: export of fishery-related products (left); investments in wave energy research & development (middle); environmental innovation (right).



Source: Organisation for Economic Co-operation and Development (OECD, 2020a).

2.5 Blue food

Sweden's blue food heritage has formed many coastal communities around the country. It is included in Sweden's cultural identity and is also a driver for tourism.

Aquaculture

In Sweden, aquaculture takes place all over the country in seas, lakes, power plant reservoirs and on land. The most common aquaculture technique in Sweden today is floating net bags with fish. The technology is under constant development and the establishment of aquaculture with new technology is increasing in Sweden, both on land and offshore.

In Sweden, around 10 000 metric tons of fish, crustaceans and molluscs are grown for consumption annually, which is less than 1% of the total production of Norwegian salmon farming. Most production is used for food consumption. Rainbow trout, char and blue mussels account for the largest share of production based on weight (Svensk Vattenbruk, 2022) but there is also production of hatchery fish, i.e. fish to be released into natural waters. There are roughly 50 food fish farms in Sweden and just as many hatchery fish farms (Swedish Board of Agriculture, 2022).

While aquaculture is often portrayed as a more environmentally friendly alternative to commercial fishing, there are important trade-offs to consider. First, farmed predatory fish, such as salmon, require protein-rich feed. Today, up to a third of the wild-caught fish are used as feed in aquaculture instead of for direct human consumption. Second, aquaculture has a number of shortcomings, particularly in open systems where the cultivated species are in direct contact with the surrounding aquatic environment. The spread of medicines and pesticides as well as the spread of nutrients from feed and faeces can have local effects on the surrounding water and other aquatic organisms.

Commercial fishing

Over 90% of the world's fish stocks are estimated to be maxed out or too heavily fished. According to an assessment by SwAM concerning the environmental objective of a Balanced Marine Environment, only 40% of the Swedish and EU-joint fish stocks are used sustainably (Sveriges Miljömål, 2021).

Swedish coastal fisheries in the east have been deemed as unsustainable in terms of the status of their main fish, their economic profitability, and even as a source of secure employment (Jagers et al., 2012; Johansson, 2021). Although fishing in the North Sea has declined since the reform of the EU Common Fisheries Policy (EU CFP) in 2002, its marine ecosystems are still in a perturbed state and there has been a shift from pelagic to benthic production (Johansson, 2021).

According to recent statistics (SwAM, 2021), catches in commercial fishing in the sea in 2021 amounted to just over 153 000 t of live weight. This is a reduction by about 18 000 t or 10% compared with 2020. Reduced catches are noted primarily for sand eel and herring, which is largely due to a reduced quota. It is worth noting that even cod catches remain at very low levels due to the measures that prohibit fishing for cod in the Baltic Sea,as stocks have collapsed under the EU CFP. The value of the landings in 2021 amounted to approximately SEK 767 million – a reduction of approximately SEK 69 million or 8.2% compared with 2020 (SwAM, 2021).

Fish for fodder in 2021 was just over 103 000 t, compared with approximately 119 000 t in 2020. In 2021, fish for fodder accounted for approximately 76% of the total catch with a value of approximately SEK 243 million (SwAM, 2021).

Catches in commercial freshwater fishing in 2021 slightly and generally increased in volume compared with the previous year, amounting to a total of 1710 t (1571 t in 2020), but decreased in value by 1 million SEK. The most economically significant fish in commercial freshwater fishing in 2021 were crayfish and zander. The value of crayfish increased to SEK 36.7 million (SEK 36.2 million in 2020) while the value for zander decreased to 33.8 million (SEK 38.9 million in 2020). The catch of crayfish in 2021 amounted to 267 t (255 t in 2020); zander amounted to 481 t (527 t in 2020) (SCB, 2021).

Recreational fishing attracted 1.5 million persons in 2021, and the total catch landed was estimated to be 12 400 t, of which 6500 t was from lakes and streams and 5900 t was from along the coast and in the sea. Additional released catch was estimated at 11 500 t (SCB, 2021).

The real gains today

The stronger economic gains in Swedish fisheries are based on the value chains and services developed around the fishing sector, which are primarily based on refining fish imported from Norway. Fish imports have increased 258% since 2004, reaching 751 000 t in 2018. Consequently, Swedish exports of fishery-related products have also more than doubled since 2008, reaching USD 4.8 million in 2018 (Figure 1). The export of Norwegian-imported fish is what places Sweden among the top 10 largest exporters of fishery-related products in the world and the second-largest in the EU (OECD, 2020a). This growth, however, implies that the processing sector in Sweden may be heavily affected by policy decisions and imports from the fishery sector in Norway.

Beyond fisheries and towards a blue food supply

The global food demand is projected to increase to 50–70% by 2050. Research shows that the ocean could provide over six times more food than it does today – more than two-thirds of the animal protein that will be needed to feed the future global population. With such an expected increase, the sustainable production of blue food will depend on factors such as policy reforms, technological innovation and the extent of future shifts in demand (Costello et al., 2020).

An increase in the primary production of seafood is crucial for food and nutrition security and for resilience in periods of crisis, but also to create economic prosperity and reduce transport needs. A very traditional seafood consumption pattern in Sweden – clean fillets, few species, primarily white fish and salmon – combined with poor technological development in the past has contributed to shaping a narrow view on what seafood entails (Appelqvist & Lindegarth, 2019). However, recent investments in R&D are starting to change this picture and are contributing to a more diverse view of what seafood can look like. This change comes following a government decision to increase production of food including seafood in the country (Government of Sweden, 2006).

The greatest potential to increase the production of blue food in Sweden is found among farmed seafood, such as mussels or algae, but also land-based aquaculture. Farmed seafood is an underexploited source of protein but is expected to become 36–74% higher than current global yields by 2050. Aquaculture holds great potential to contribute to the Swedish diet and reduce the over-70% seafood imports (Borthwick et al., 2019), but there is a need for careful assessments of potential impacts in order to mitigate harm to ecosystems.

The development of new restructured seafood products as burgers/balls/spreads from mince or protein ingredients retrieved from underutilized species and side streams embodies great opportunities. Research and industry is currently exploring alternative seafoods in order to create better conditions for the cultivation of mussels, oysters, shellfish, algae and other edible species as a way to expand the sea-based sources of protein, reduce the climate footprint for food production and make better use of underutilized species (Blue Food Consortium, 2022).

To realize this potential while ensuring the health of our waters and seas, there are important Swedish technical and biological developments to draw on, including advanced circular water treatment techniques for water- and land-based production systems, non-fed aquaculture such as algae, but also bivalves and other filter feeders and detritivores. There are clear opportunities for transferring knowledge and value chains from one sector (e.g. water treatment) to another (e.g. aquaculture) (Blue Food Consortium, 2022). The greatest barrier is related to the regulatory framework, which is not adapted to these new industries (SwAM & Swedish Board of Agriculture, 2021).

2.6 Offshore renewable energy[1]

During 2020, around 28 TWh of wind power was produced in Sweden (compared to 3.5 in 2010), of which around half a TWh was made up of offshore wind power from Lillgrund, Kårehamn, Vindpark Vänern and Bockstigen. The last offshore wind power installation was deployed in 2013. There are currently eight licensed wind farms at sea (or in large inland lakes), but none of these have yet been put into use. There are several projects at different stages of the planning process, both for anchored and floating wind structures, in more than 40 locations (Westander et al., 2022).

Table 1. The first Swedish marine spatial plan (MSP) includes areas for 20–30 TWh offshore wind, and there is an ongoing assignment from the Swedish government to Swedish authorities to find areas and update the second Swedish MSP with the location of an additional 90 TWh.

Phase	Twh	Presumed time in process	Commissioned earliest
Construction phase	0	24–36 months	
Procured/projected	0	12–18 months	
Permit examination	67	18–180 months	2028–2041
Consultation	125	12 months	2029–2042
Early stage	174	18–24 months	2032–2044
Total	366		
Total process time 12.5–17.5 years			

Source: Adapted from the Swedish Wind Energy Association (Kinning, 2022).

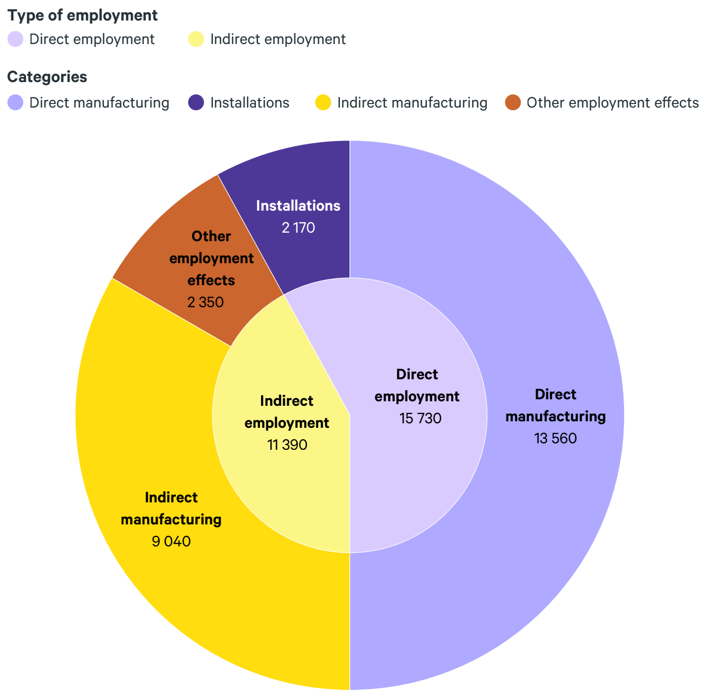
Offshore wind power can supply 45% of electricity needs by 2050. A tenfold increase in offshore wind power in Sweden is forecasted by 2030. By 2050, an extension to 167 TWh of offshore wind power is estimated to be the most cost-effective way to meet the increased electricity demand (Svensk Vindenergi, 2021b).

Jobs

The Swedish Wind Association (Svensk Vindenergi, 2021b) calculates that offshore wind power can create 1500 to 4000 annual jobs in Sweden by 2030, and up to 10 000 annual jobs by 2050. For the period 2025–2050, there is an expectation that offshore wind power can generate 165 000 jobs. An expansion of offshore wind power also means increased demand for products along the value chain, including foundations, cables, vessels, monitoring services, food and accommodation for staff. The value of these goods and services in Sweden can amount to between 2 and 7 billion SEK annually by 2030, and between 7 and 17 billion SEK annually by 2050, depending on the share of national production as against imports.

1 The term "offshore renewable energy technology" encompasses several clean energy technologies, offshore wind, floating solar panels and ocean energy (wave and tidal).

Figure 2. Based on OECD statistics, number of jobs created if Sweden installs capacity of 1808 megawatts (MW) between 2022 and 2030.



Source: Blanco & Kjaer (2009) and BASREC (2012)

The Swedish Wind Energy Association identified that a 10-fold increase in installed capacity would put Sweden on path to address expected increased demand of electricity originated by hydrogen production and transport electrification (Svensk Vindenergi, 2021a). Based on OECD statistics, the necessary 1808 megawatts (MW) to be installed between 2022 and 2030 could be allocated to a yearly increase. This would imply the creation of about 27 120 jobs: 13 560 in direct manufacturing, 9040 in indirect manufacturing, 2170 in installations and 2350 through other indirect employment effects. A prolonged expansion of offshore wind capacity after 2030 could guarantee long-term employment.

Beyond energy efficiency and towards sustainable energy planning

Forecasts for 2050 show that the global electricity demand will almost double. The Swedish Energy Agency forecast expects an increase from 140 TWh in 2022 to 280 TWh by 2035, and 370 TWh by 2045 (Swedish Energy Agency, 2022). The EU's goal is that by 2030, 32% of all electricity production will originate from renewables, and Sweden is aiming at 100% fossil free electricity production by 2040. This will require better technology that allows for more effective and cleaner sources of energy, less intrusive and more flexible structures that reduce impacts to ecosystems and societies, but also better planning that considers regional differences in energy production and demand.

The expansion of offshore wind energy will need to account for the unknown consequences of larger wind turbines that will be installed at greater depths. A recent report commissioned by SEPA shows that current depths range between 5 and 40 metres but new installations are expected to expand to depths of 40 to 60 metres (Bergström et al., 2022). Clean wind energy affects the local fauna and flora at every phase of the production, not only due to the physical changes in the seabed required to set up the structures (Petruny et al., 2016), but also due to the noise pollution generated in the construction and operation of the installations (Bergström et al., 2022).

> *Marine spatial planning will play a key role in guaranteeing that clean energy production at the very least does not interfere with the interests of other marine activities, and at best is placed to positively contribute to ecosystems and existing industries such as fishing and tourism.*

Several positive effects have been identified as well, though conclusions are not clear cut and are highly dependent on the specific location (Bergström et al., 2022). These include the potential for wind structures to act as artificial reefs for the expansion of marine flora and fauna (De Mesel et al., 2015). The installations could be attractive for species such as cod during the months where they seek fodder and shelter (Reubens et al., 2014). Wind installations can also build so-called stepping stones – small islands that provide suitable habitats – and can contribute to species proliferation, thereby increasing habitat connectivity (Bishop et al., 2017; De Mesel et al., 2015). Wind parks can also hinder destructive fishing activities such as trawling, as they act as natural barriers (Bergström et al., 2022).

Moreover, the physical and material characteristics of the structures also define the impacts on species and ecosystems (Bergström et al., 2022). Aspects such as salinity and biodiversity of the marine areas play a role. It is therefore important to identify species that can benefit from offshore wind power. If wind turbines are to provide appropriate grounds for habitat formation, it is important to adapt their structures in such a way that they can mimic natural components and characteristics so they can help achieve the environmental effect desired.

Swedish investments in other offshore energy globally

The Swedish state-owned Vattenfall invests heavily in floating platforms of wind farms in Scotland (800 MWh), Norway and France. Vattenfall will also invest in Denmark, the United Kingdom, the Netherlands and Germany. Beyond Vattenfall, there are three Swedish companies with emerging floating wind technologies in pre-commercial joint projects in the North Sea, Celtic Sea, South Korea, Skagerrak, Baltic Sea, Scotland and the Iberian Peninsula. One of them is already listed on the Nasdaq stock exchange.

Sweden has been at the forefront regarding R&D investments in ocean energy (wave, tidal). Between 2005 and 2019, Sweden invested more than USD 56 million on multiple forms of ocean energy, excluding offshore wind (OECD, 2020a). The share of the total energy research, design and development budget on ocean and offshore wind energy was 2.4% in 2019, similar to France and the UK. Since 2010, Sweden has invested USD 27.6 million on wave energy research, design and development, second only to the UK among countries in the OECD dataset.

Hydrogen production and infrastructure integrated in offshore energy sites are under development. Among others, Vattenfall (Vattenfall, 2019) is aiming to be first with hydrogen electrolysers placed directly on offshore wind turbines at the plant in Aberdeen Bay. The Swedish company OX2 is in the joint project “the Baltic Sea Hydrogen Collector” (OX2, 2022) to investigate possibilities for a hydrogen infrastructure connecting countries around the Baltic Sea.

2.7 Tourism and recreation

Tourism is one of the world’s largest economic sectors, creating jobs for people of all ages and skill levels, in major cities, but also in remote, rural and coastal areas and in other, often economically fragile, places where alternative opportunities may be limited (OECD, 2020b). In Sweden, tourism normally corresponds to about 10% of both GDP and employment (WTTC, 2022). The OECD (2020b) reported around 172 000 employees in the tourism sector for Sweden in 2018. According to Statistics Sweden, 40 000 of these jobs are connected to maritime tourism, where Baltic Sea locations represent around three-quarters of the labour market (SCB, 2018).

There is no official definition of marine tourism, hence statistics are lacking. Studies suggest that though recreational activities take place almost everywhere along the coast and near coastal waters, there is a concentration around larger cities, such as Gothenburg (Skriver Hansen et al., 2021). A similar pattern can be seen around harbours. A total of 301 000 boat nights (one boat a night) were registered in Swedish guest harbours in 2020, which corresponds to a decrease of about 17% compared with 2019, largely attributed to the pandemic. However, the total number of guest nights in guest harbours in Sweden increased in 2020 to just over 900 000. The largest number of boat nights usually takes place in counties with big cities, the vast majority in Västra Götaland County with 123 000 boat nights in 2020, followed by Stockholm County (18%) and Skåne County (11%) (Tillväxtverket, 2021).

Västra Götaland was Scandinavia's most visited tourist region after Stockholm in 2017. Of all overnight stays in leisure boats in Sweden, 41% took place in western Sweden (Tillväxtverket, 2021). Close to 3 million or 90% of all overnight stays in a leisure boat are made along the Gothenburg–Strömstad coastline (Tillväxt Norra Bohuslän, 2017).

While tourism – particularly foreign tourism – was seriously impacted by the pandemic, one of the segments that benefited from increased Swedish holidays at home ("staycations") is nature tourism. Even before the pandemic, there was an increased demand for nature experiences. A likely development is that the demand for this type of tourism has intensified and been pushed forward by the pandemic, as this has probably also been perceived as a relatively safe form of tourism, where it is easier to keep a distance from other people (Tillväxtverket, 2021).

Beyond tourism and towards resilient coasts

In March 2021, the European Parliament adopted a resolution establishing an EU strategy for sustainable tourism adapted to the Digital Agenda, the European Green Deal and the UN Sustainable Development Goals (European Parliament, 2021). The resolution stresses "the need to respect the marine ecosystem, promote dialogue between Member States, regional and local authorities, stakeholders and civil society and promote the sustainable development of coastal and maritime tourism".

Around 80% of global tourism is coastal, which potentially brings economic growth and jobs, but also socioeconomic trade-offs and environmental impacts (UN-Habitat, 2018). The Global Sustainable Tourism Council provides a set of objective criteria to evaluate sustainable practices of businesses in the tourism industry (GTSC, 2016). In Sweden, this process is handled by Nature's Best. The certification assists tour operators that provide, for instance, fishing, kayaking or diving experiences to promote sustainability and obtain brand visibility to eco-conscious travellers.

The OECD (2021) *highlights the pandemic as an opportunity to reconsider the tourism system and move towards stronger, more sustainable models for tourism development that accelerate the transition to a more inclusive and greener sector. Here, companies have a key role to play, and coastal and marine areas have much to offer.*

The digital transformation of the tourism sector is also an important development as it changes the way we travel and experience places (OECD, 2020b). Several Swedish companies have developed sea-based applications, targeting for example leisure boats and sportfishing, where recommendations for sustainable activities are provided. These companies participate in co-creation activities with both researchers and authorities, further adding to information exchange and strengthening private-public-research collaboration.

The 2020-2025-2030 report, produced by the World Tourism Organization for the European Commission (UNWTO, 2014), forecasts an annual average growth of 1.4% for the EU northern countries during 2020–2030 in the number of international tourists. If a similar growth is expected in the labour market across all sectors of touristic activities, Sweden has the potential to add around 6500 new jobs in maritime tourism to the ones already existing. This would bring the figure to around 46 600 employees in the maritime tourism industry by 2030.

Multifunctional offshore platforms can also contribute to job creation and coastal and cruise tourism. The development of a framework to guide multipurpose licensing procedures in the EU would facilitate exploring boat tours within offshore energy and aquaculture facilities (van den Burg et al., 2020). Even though tourism cannot be integrated with some offshore solutions due to safety concerns, it has the potential to serve as an educational tool to promote acceptance and understanding among multiple sectors, accelerate the combination of industries, move recreational activities further offshore and lengthen the tourist season beyond the summer (van den Burg et al., 2019).

Tourism activities in the coastal and marine areas could also be integrated with climate adaptation and resilience interventions. In Sweden, 95% of the coastal municipalities are already involved in adaptation measures to mitigate natural hazards such as sea level rise and erosion (Matschke Ekholm et al., 2021). Nature-based solutions increase ecological value and create opportunities for recreational activities such as hiking and photography. For instance, the LIFE Coast Adapt project is an initiative to restore sandy beaches, develop eelgrass, create artificial reefs and construct coastal wetlands at multiple sites in Skåne County (Länsstyrelsen Skåne, 2021).

2.8 Shipping

The Swedish shipping sector has a turnover of SEK 85 billion per year. It directly employs about 30 000 people (indirectly more than 100 000 people) in shipping companies, marine technology companies, ports, authorities and academia. Shipping transports just over 170 million tonnes of cargo and around 67 million passengers per year (NRIA Sjöfart, 2021). Shipping is also an important part of marine tourism in Sweden, as indicated in the OECD's Sustainable Ocean Economy Report (OECD, 2022). Pre-pandemic (in 2018), international sea passenger transport receipts grew from USD 45 million in 2008 to USD 205 million.

However, shipping is estimated to account for 2–3% of the annual global CO_2 emissions. We know that energy efficiency is strongly dependent on the type of ship, type of goods transported, the fill rate, and commercial interests of, for example, the cargo owner. Besides CO_2 emissions, shipping also causes a range of direct environmental pressures on the marine environment, such as pollution from antifouling, scrubber wash-waters and noise, as well as the spread of invasive species. "*Projections through 2050 for the Baltic Sea indicate that shipping could be the major source of strong acid addition to surface waters, particularly if wet scrubber systems become widely used.*" (Turner et al., 2018 Projections through 2050 for the Baltic Sea indicate that shipping could be the major source of strong acid addition to surface waters, particularly if wet scrubber systems become widely used).

To reach the International Maritime Organization's greenhouse gas targets of cutting CO_2 emissions by half by 2050, a palette of measures is being investigated, ranging from alternative energy carriers (fuels) to improved energy efficiency. While Swedish ship owners have been forerunners in the transition to a sustainable shipping industry, Swedish ships (even counting Swedish-controlled ships) account for only 1–2% of the annual fleet in the entire Baltic Sea (Trosvik et al., 2019).

NEW GENERATION OF COMMERCIAL SHIPS

Oceanbird is a collaboration between Wallenius Marine, the KTH Royal Institute of Technology and SSPA/RISE and is largely financed by the Swedish Transport Administration. The project is developing wind-assisted car-carrying ships, with the goal of reducing emissions to air by 90%. The first ship will sail in 2024. The project is a good example of an effective triple helix collaboration.

ForSea operates the world's largest battery-powered ferries, on the Helsingborg–Helsingør route, thanks to part-financing from the EU and long-term cooperation between shipping companies, electricity companies and industry, such as ABB.

Northern Offshore Services has designed and launched a ship series with hybrid operation for service of offshore wind power facilities. The ships have batteries that can be charged from land and are also prepared to be charged directly from the wind farm.

Rederi AB Gotland, through its subsidiary Gotland Tech Development, is participating in a new research project developing fossil-free solutions for ship propulsion and a reliable supply chain of hydrogen for Gotland's marine traffic.

A future circular shipping economy

There are other unexploited opportunities to innovate, in the field of the circular economy. In 2022, the Nordic Innovation Panel's assessment of the circular economy revealed that "the maritime value chain is complex with a large group of heterogeneous players with varying circular maturity levels...inefficiencies occur in all parts of the maritime value chain"(Nordic Innovation, 2022). The panel identified several areas with opportunities to improve the system and increase efficiency. With regard to shipping, opportunities arise by taking a life cycle approach to the materials used; by fostering the sharing of multifunctional platforms; by repurposing ships to extend their lifetime; and by exploring new value chains with alternative service provision.

Table 2. Innovation opportunities to promote a circular economy.

Inefficiency	Opportunities
Unsustainable materials	Life cycle approach: most input materials in ships are recyclable and durable (e.g. steel or aluminium). On average, 96% of ship materials can be recycled or reused. More focus on the use of sustainable indirect materials (and not only on optimizing the safety and energy efficiency of the ship during its operation) would significantly improve the sustainability of ships.
Underutilized capacities	Underutilized capacities: one of the largest inefficiencies in the maritime industry. Many ships are left unused for long periods of time, have long idle times when in port, or operate with limited use of available capacity, creating significant unnecessary costs and emissions.
Premature scrapping	Repurposing: while most ships are built to last up to 30 years, many of these are dismantled earlier. There are opportunities to repurpose or upgrade ships, but the cost efficiency due to non-standardized components is often a blocker.
Unexploited value chains	Servicing: new business models that focus on service provision through monitoring and subscription types of services are already reducing maintenance costs for companies and expanding the life length of ships.

Source: Adapted from the Nordic Innovation Playbook (Nordic Innovation, 2022).

Beyond shipping, the use of materials in and from the marine environment is a competence area that supports all the blue economy sectors with sustainable, cost-efficient and reliable materials. As activities in the marine space increase, there is a need to ensure that “circularity by design” is built in, to optimize resource use and support the marine ecosystems, during operation and at the end of the product’s life (Nordic Innovation, 2022).

The European Commission’s Directorate-General for Maritime Affairs and Fisheries and Directorate-General for Environment have highlighted how important it is for the offshore renewable and aquaculture sector to apply a circular design approach to increase resource efficiency, design long-lasting, resilient and recyclable materials and ultimately minimize waste generation, in line with the EU Circular Economy Action Plan and connected to the 2022 Proposal for Ecodesign for Sustainable Products Regulation (European Commission, 2022b).

Beyond shipping and towards mobility

According to the World Bank’s Global Mobility Report (2020), global freight volumes are projected to grow by 70% from 2015 to 2030. Passenger traffic is expected to increase by 50%, which is estimated to correspond to an additional 1.2 billion vehicles on the earth’s road network – which is already congested. Shipping will handle a significant portion of the growing volumes. According to figures from the International Transport Forum, maritime transport is expected to increase by almost 430% globally by 2050. At a national level, regardless of the above increase, Sweden is completely dependent on functioning import and export routes. As much as 90% of our imports and exports are done by sea at some point (NRIA Sjöfart, 2021).

Greenhouse gas emissions from all modes of transport, including maritime, should be reduced by 90% under the European Green Deal (European Commission, 2021). Decarbonizing maritime transport – including fishing operations, freight, passenger traffic, defence operations, and all related infrastructure such as electric charging stations and circular sources of fuel can open up new economic opportunities while reducing climate-changing emissions, air and water pollution, and underwater noise..

There is great potential for Swedish technology and engineering and innovation to contribute to a sustainable blue economy as well as creating new sources of employment. Substantial investments in Swedish research and development are helping advance technologies for renewable methanol (Ellis & Svanberg, 2018); to integrate renewable energy systems in small and large ships (Ghenai et al., 2019); and to mainstream hybrid and electric propulsion systems (Tarkowski, 2021). Moreover, research is exploring the possibilities of using biogas for ships. Most land-based public transport in the larger cities currently runs on biogas but in the near future is likely to be electrified leaving a surplus of biogas capacity that could potentially be absorbed by marine transport (Jivén et al., 2022). Green hydrogen is considered to be the future fuel for shipping. Research is currently exploring the feasibility of such a transition (Fagerström & Anderson, 2019).

Lighthouse is a neutral collaboration platform gathering leading maritime stakeholders through a triple helix collaboration between industry, society and academia and institutes for research, development and innovation within the maritime shipping sector. It works in close collaboration with the Swedish Maritime Technology Forum, *including the* Sargasso Platform*, an open innovation platform building on maritime skill, needs and competencies. It is a free of charge service that matches those with a challenge or an idea to those with a solution.*

Low-carbon waterborne mobility options – for instance through the electrification of boats for sports, patrolling or mobility – is an area that could experience rapid development. Although commuting by boat accounts for a remarkably small proportion of the total amount of travel in Sweden, there are discussions about increasing the use of inland water and marine spaces to reduce pressure on terrestrial public transport. Recent pilot projects suggest that electrifying boats for passenger transportation may not only be a sustainable transport solution, but its lower operation costs could facilitate its penetration of densely populated coastal and river cities where conventional public transport systems are reaching their full capacity (Campillo et al., 2019).

3. Cross-cutting areas in Swedish society that can enable a sustainable blue economy

While targeted policies and interventions are undeniably necessary for a sustainable blue economy, countries start from different standpoints and with different strengths. These are decisive for the type of development envisaged and supported.

An enabling welfare state reproduces a virtuous circle between economic development, welfare, equality and democracy. The Nordic welfare model enhances learning and local experimentation in hybrid communities and networks, and extends democracy by mobilizing well-educated professionals and practitioners in all spheres of society to innovate (Miettinen, 2013). Two particular strengths in Swedish society can be highlighted here: an innovation ecosystem and an embedded ecosystem-based approach in the strategy for governing marine areas.

3.1 Innovation ecosystem

Sweden has a well-connected innovation ecosystem, consistently ranking in the top three on the Global Innovation Index (GII, 2021) and in the European Innovation Scoreboard (EIS, 2021). After Silicon Valley, Stockholm produces the second-highest number of so-called "unicorns" per capita (SI, 2022). Over time, Sweden has generally been considered an innovation leader in the EU, albeit with mixed results when it comes to entrepreneurship (Paulsson, 2019).

When looking at Sweden's marine innovation index, in 2018 there was a rapid growth of the maritime industries. The Maritime Innovation Index moved from 100 (base year 2016) to over 200 for 2018 (SwAM, 2020). The development of the indicator is largely explained by the rapid increase in innovation expenditure in the maritime industries. However, these results need to be interpreted with caution, as expenditure on maritime industry innovations is small in both absolute and relative terms, compared with many other industries.

The success of Sweden's innovation capacity in the blue economy is also reflected in the OECD's fractional counting method, which takes into account the proportion of the nationality of the innovators. From 2000 to 2016, Sweden registered 230 ocean renewable energy inventions, 93 ocean pollution abatement inventions and 44 coastal adaptation inventions. In total, 417 ocean-related environmental technologies were accredited to Swedish inventors, which placed the country in the 14th position out of 121 countries (OECD, 2020a).

In recent years, several important initiatives have been linked to maritime industries and their ability to innovate through regional marine innovation clusters. In a cluster, the idea is that innovation work is run as a collaborative project between customers and suppliers or between different suppliers in collaboration instead of in competition. Other projects have tried to establish different types of local innovation arenas, where smaller companies can receive support through business developers, innovation advisors and researchers in a continuous development work. Along with generally improved conditions for innovations in the maritime industries, this type of initiative can have a positive impact in defined industries and regions.

Incubators and science parks form a central part of Sweden's ecosystem and national infrastructure for innovation. There are over 40 generic incubators and 30 science parks with different specializations, including marine technology and the blue economy (Swedish Incubators & Science Parks, n.d.). Sweden has a well-developed value chain for research infrastructure, tests and demonstrations at various scales of technological maturity, enhanced by collaboration with complementing facilities worldwide. Additionally, the current landscape of physical and digital research infrastructures in the country is a powerful base to boost marine innovation in the future.

There is scope for further fostering marine innovation in regional development agendas, particularly through the Smart Specialization Strategies (S3), where nine regions in Sweden have objectives linked to agendas in the marine sector. Beyond national collaboration, the S3 platform is increasingly fostering transnational innovation partnerships for sustainable business development in emerging blue markets (Morf et al., 2021).

The S3 platform connects regions around Sweden and Europe. One of the foundations of S3 is that environmental challenges should be transformed into opportunities. Blekinge is the only region in Europe that today has merged the two funding instruments Missions and Smart Specialization. The region, together with Vinnova, is part of the trans-European project TRAMI, which aims to develop a mission methodology in Europe.

Internationally, Sweden has substantial experience in facilitating and promoting sustainability, also at sea (e.g. lighthouses). For example, the country is one of the founding partners in the Blue Action Fund (BAF, 2022) – one of the world's largest public funders promoting marine conservation and sustainable coastal livelihoods. Around the globe, Sweden is facilitating inclusive ideation and co-creation initiatives supporting entrepreneurs, industry, research, cities and communities, such as Hack for Earth and the Climate Smart Cities Challenge. This ecosystem has been developed over time by ensuring policy and infrastructure conducive to its innovation.

Marine sciences

Sweden has a long-standing tradition in marine natural sciences and the country has today the third-highest density of marine scientists in the world (Intergovernmental Oceanographic Commission & UNESCO, 2020). Swedish marine research builds on the work carried out at 13 marine research stations, and 5 research vessels > 35 m (compared with 220 worldwide), currently being bridged by coordinating actions (European Marine Biological Resource Centre, JERICO and ship-coordinating activities).

EXAMPLES OF DATA INFRASTRUCTURE

The Swedish Biodiversity Data Infrastructure (SBDI, 2022) – provides data and analysis services that offer rich opportunities for innovative, interdisciplinary research on biodiversity and ecosystems. The Swedish National Data Service (SND, 2022) has a primary function to support the accessibility, preservation and reuse of research data and related materials. Together with a network of around 40 universities and public research institutes, SND forms a national infrastructure for open access to research data.

Transforming data to knowledge is a central aspect in the transition towards smart maritime governance. For instance, SwAM's report for marine spatial planning in Skagerrak and Kattegat highlighted that better knowledge of cumulative effects on ecosystem values are found near the coast due to higher data availability (SwAM, 2018). Incorporating mapping results of marine values and involving academic actors are priorities to increase knowledge generation and reduce uncertainty in the marine spatial planning process (Karlsson, 2019).

In line with the Green Deal, the Destination Earth Initiative is the EU's next step to develop a Digital Twin of the Ocean. The Digital Twin Ocean's ambition is to make ocean knowledge readily available to citizens, entrepreneurs, scientists and policymakers to design the most effective ways to restore marine and coastal habitats, support a sustainable blue economy and mitigate and adapt to climate change. Sweden has advanced marine ecosystem knowledge and already includes human activities in digital monitoring and digital ocean twins.

3.2 Ecosystem-based approach

The journey towards an ecosystem-based approach in management and planning will demand a greater understanding of the complexity of marine ecosystems, including the human social economical system. Despite being adopted by many management organizations in principle, operationalizing ecosystem-based management has been a challenge globally. A mismatch in institutional arrangements, created by the traditional sectoral focus of marine environmental and resource management, is a main factor acting against implementation (Alexander & Haward, 2019). A second challenge refers to the lack of thresholds-based reference points for achieving good environmental status for coastal and marine waters. There is thus a need, through international collaboration, to develop indicators that will facilitate management in marine ecosystems used by multiple countries (Tam et al., 2017).

In Sweden, SwAM has the broad tasks to protect, restore and ensure sustainable use of freshwater resources and seas, including fisheries management. SwAM has developed the marine spatial planning (MSP) tool Symphony, to assess cumulative impacts from human activities and support the implementation of the Source to Sea approach, which includes the relationship between upstream pressures and downstream effects. Sweden is the first country to use cumulative impact assessments integrated with national MSP for marine management (Hammar et al., 2020).

Symphony, the digital tool supporting ecosystem-based marine spatial planning, was a Swedish–US joint agreement in the first UN Ocean Conference. Symphony is used within national marine planning as well in international projects worldwide. WIO Symphony for the Western Indian Ocean has been developed by the Nairobi Convention, its 10 member states and Sweden.

The close collaboration between SwAM, different government agencies, and research and innovation actors, provides a strong foundation for cross-sectoral collaboration countrywide. Internationally, SwAM supports governments, international conventions, organizations and processes. The initiative SwAM Ocean seeks to address the challenges pertaining to poverty alleviation through the sustainable use of marine ecosystem services, with a focus on coastal areas in least-developed countries and small island developing states.

Collaboration in the Baltic Sea

Successful ecosystem-based management in the Baltic Sea requires better modelling of multi-scale ecosystem processes, geographical and cross-sectoral collaboration between stakeholders, and innovative tools and methods that integrate both ecological and socioeconomic processes (Dahlbäck et al., 2021). In Sweden, this is carried out within the framework of MSP together with other cross-cutting processes and instruments nationally.

Nationally, SwAM is coordinating MSP through a process that brings together multiple users of the ocean to make informed and coordinated decisions about the use of marine resources. Internationally, SwAM coordinates Swedish efforts with regard to two intergovernmental organizations that unite the Baltic Sea region: the Baltic Marine Environment Protection Commission (HELCOM) (1974), which primarily focuses on the environment; and Visions and Strategies Around the Baltic Sea (VASAB) (1992), which focuses on planning and development issues. In 2010, HELCOM and VASAB joined forces and, since then, there has been a formal HELCOM-VASAB Marine Spatial Planning Working Group for the Baltic Sea region.

The joint working group has developed:

- MSP principles
- a Regional Baltic MSP roadmap
- guidelines for the implementation of the ecosystem approach in MSP
- guidelines on transboundary consultations, public participation and cooperation.

THE SEA AND HUMANITY

The environmental status in the seas surrounding Sweden has still not reached the targets set out in national and international regulatory frameworks (primarily the EU's Marine Strategy Framework Directive and Water Framework Directive). HELCOM holistic assessments conclude that the Baltic Sea still has a poor environmental status both with respect to eutrophication and hazardous substances. In response to this, "The sea and humanity" (Havet och människan), published in January 2021, by the Swedish Cross-Party Committee on Environmental Objectives (Havet Och Människan, 2020) proposed nearly 100 measures to achieve healthy ecosystems and sustainable use of marine resources. It also suggests facilitating a holistic approach by introducing a dedicated marine environmental law.

The ambition is that this joint effort will lead to up to 10 functional, coherent national marine spatial plans based on an ecosystem approach. Here, Sweden has taken a leading role in transboundary collaboration in the Baltic Sea, where SwAM has organized several intergovernmental consultations from 2013 to 2019 to bring together countries around the Baltic Sea (Zervaki, 2018). Much of this collaboration has focused on the greatest challenge for the region: reducing eutrophication (Murray et al., 2019).

Despite progress in many of the contributing basins in the region, there is a need to improve the clarity of the regulations to match environmental conditions and ensure compliance, which requires monitoring of ecological data and dynamic transfer of scientific knowledge (Bohman, 2018). Connecting vague ecosystem goals in the legislation with ecosystem indicators such as concentration of nutrients or turbidity and defining clear targets can improve the effectiveness of marine management. This is in line with the European Commission's proposal for an EU regulation on restoration of nature. Such regulation would introduce legally binding requirements to ensure that marine ecosystems covered by the EU nature directives do not deteriorate any further (European Commission, 2022a)

Beyond environmental criteria, an ecosystem-based management of the ocean can help address the lack of inclusion of the human dimension in marine governance. This would in turn contribute to increasing awareness of ocean inequality – defined as the way marine resources are distributed and the distribution of rights and capacity for participation in decision-making (Belgrano & Villasante, 2021) – and ensure the integration of socioeconomic values in future MSP.

4. Final remarks

This report has provided an overview of the current state of Sweden's marine industries as well as a forward-looking assessment of areas that could enable a transition to a more sustainable blue economy in Sweden.

There are strong indications of progress, particularly in blue energy and food. However, there is an urgent need to find solutions to common challenges and break away from sectoral thinking. Such an approach requires a fundamental shift in how our ocean is valued and exploited, and an integrated and adaptive ecosystem-based management of our seas. This is highly ambitious as such an approach demands better alignment of regulations, planning and monitoring criteria with ecosystem boundaries. It demands a fundamental shift in how we organize and utilize marine space that goes beyond solely prioritizing economic growth, to ensuring a more effective delivery of multiple gains for society, the environment and biodiversity. However, Swedish regulations, planning and monitoring criteria are not adapted to new and emerging solutions. This can result in unnecessary hindrances and delays to implementation of solutions, and risks the country experiencing a brain drain and/or missing out on investments.

The table below synthesizes the status of Sweden's blue economy today, and key trends identified in this report for Sweden tomorrow.

Table 3. Sweden's current and future blue economy.

Blue economy	Sweden today	Sweden tomorrow
Sustainable food supply	Seafood consumption is based on a few traditional products. High level of exports but reliant on raw-product imports.	Diversified seafood production and consumption. Increased aquaculture production. Increased processing of rest streams. Transfer of knowledge and infrastructure in service provision.
Energy planning and development	Investments in offshore wind. R&D investments in wave energy. National plans to expand areas for offshore energy. Export of technologies.	100% renewable electricity production. More mature technologies in hydrogen and wave energy. Expansion of offshore wind energy in areas of lowest impact on valuable ecosystems. Potential for generating over 25 000 jobs. Linking intermittent wind power to the regulatory capacity of hydropower through system design. Generation of offshore wind power and ecosystem services on site (biodiversity and oxygen).
Resilient coastal governance	Around 40 000 coastal and marine-based jobs.	Continued increase of staycations with strong focus on nature-based experiences. Digital transformation to change or enhance the tourist experience.
Transport and mobility	New generations of commercial ships are under development. Substantial investments in R&D to develop alternative fuels.	Standardized shore-side electricity and scrubber wash-water discharge regulation and separation.

5. Recommendations

The following recommendations are provided, based on insights from the report and the stakeholder workshop:

1. **There is a strong need for national coordination of marine spatial planning** where the state takes a more active planning and coordinating role for a unified systems perspective. Additionally, agencies and particularly municipalities are in urgent need of resources (financial, capacity, time) to be able to cope with complex challenges from multiple and often conflicting goals.

2. **Set a new net-zero emissions goal for the maritime transport system** that accounts not only for the contribution to net-zero emissions from air emissions (climate impact) but also emissions polluting water. Move beyond shipping to include the entire maritime transport system and landscape of actors (including the International Maritime Organization), which means working with sustainable development along the entire chain from shipping of the raw material/goods to the actual ships, the ports, logistics and interconnections with other modes of transport, including the industries that rely on them.

3. **Move from concept to practice in ecosystem approaches.** Connect vague ecosystem goals in the legislation with clear ecosystem indicators, such as concentration of nutrients or turbidity. Define clear targets to improve the effectiveness of marine governance and connect ecosystem indicators with socioeconomic ones. Agree on threshold-based reference points for achieving Good Environmental Status. International collaboration is required to develop indicators that will facilitate management in marine ecosystems used by multiple countries.

4. **Establish a new co-benefit model that fosters multifunctional use** of our seas and guides the combinations of services that are technically possible and financially feasible. Create incentives for regenerative multifunctionality and smooth the regulatory processes. Here, there is an urgent need to modernize our regulatory systems, including the environmental code (miljöbalken), to allow for more flexibility and create some space for sustainable interventions, including circular and fossil-free technologies and processes. Practically, this could translate into benefits for the actors willing to take the lead in deploying multifunctional solutions (e.g. shorter lead times in permit applications, or specific procurement processes designed for multifunctional interventions).

5. **Put numbers on the value of our blue economy.** Forecasts are outdated in Sweden and need to be revised. Update data on the potential for job generation, the creation of SMEs, the export potential of maritime activities, or what the maritime sector could imply for the provision of critical services, including food, water and materials. Moving forward, it is important for the government and industry to understand the potential of the blue economy for a fossil-free transition. Research could complement future official statistics with additional data that incorporate value chains. This will show the potential that a transition away from fossil-based energy might have for service and component suppliers beyond the geographic delimitations of coastal and marine areas.

6. **Offshore wind energy – Sweden failed to be the first but it can be the best** when it comes to offshore wind energy if it adopts a system approach where multiple criteria weigh in to the concession-granting process. This perspective means taking a planning-first approach, identifying multiple criteria that make areas suitable and desirable for offshore wind energy. This is preferable to a “get-there-first” approach, where the first offer of an area is given precedence and the choice of technology and exact placement is often decided in a later phase of the process. A “best-price” approach is also insufficient to guarantee a sustainable expansion of energy infrastructure, as other impacts and potential benefits over the long term are not considered in such models.

7. **Enable cross-sectoral platforms** to connect value chains and foster cooperation between different industries. Having a clear aim to increase resource efficiency and circular use aligns well with companies' efforts to reduce capital and operational expenditure through more-efficient production, transport and services (e.g. maintenance) and sharing costs on, for example, impact assessments. This could also reduce the administrative burden on agencies reviewing applications by reducing the total bulk of studies submitted in applications.

8. **Reconnect people, places and resources.** Offshore installations facing local opposition should explore the potential to create acceptance by providing local gains for both ecosystems and societies. There are indications that opposition to, for example, offshore wind, is due to the fact that the impacts are felt locally but the benefits are dispersed. Dialogue with coastal communities and the private sector is needed to understand perceptions, address concerns and create acceptance.

9. **Increase self-sufficiency** of food and energy by investing in developing national primary production where the blue economy has an important role to play. This requires continued efforts to diversify blue food and the use of biomass beyond fisheries.

10. **Force research away from silo science.** Much of the marine research is happening within the natural sciences disciplines. However, there is a need to connect studies on biodiversity, ecosystems and climate with socioeconomic and political studies that inform marine spatial planning processes. For example, aspects related to acceptance for offshore energy, tourism seasons and their services, and citizen observations are necessary to complete data. Cross-sectoral research could also contribute to improved ocean literacy.

11. **Invest in system testbeds** that make use of the various geographical opportunities and diverse coastal and marine landscapes across the country. There is currently no testbed able to cope with entire value chains for offshore innovations. Most testbeds focus on technical efficiency of individual components, but there is a need to explore technical transfer across sectors vis-a-vis social and economic innovation, and capture service and production chains. Moreover, knowledge of and access to testbeds needs to be more clearly accessible to potential users from industry, research and municipalities.

12. **Improve open data sharing and accessibility** through dialogue. Today, we spend considerable amounts of time searching for data. Some of it exists but is stored in different places, much of it is not open or free, and much still needs to be collected. Different actors will increasingly need to collect the same type of data for different purposes. For example, seabed maps are needed for offshore wind expansion as well as in research and for navigation. There are many difficulties today to sharing data, including security issues and lack of dialogue across agencies and researchers. A first step is to create a common understanding through dialogue of what is possible to share and what is not and why.

13. **Improve knowledge exchange** with other EU countries particularly our neighbours. Most EU member states are well under way with their marine spatial plans. All countries need similar information, particularly for the upcoming industries, such as energy, mineral extraction, new types of marine foods, etc. While networks at different levels have been useful to bring actors together and discuss common challenges, the sharing of data (e.g. country reports and assessments) could be improved. For example, many of these assessments are often written in national languages and shared within a limited sphere of national actors; however, these are of international interest and could be a low-hanging fruit for enhancing existing collaboration or taking leadership in creating new spaces for knowledge exchange and collaboration.

References

Alexander, K. A., & Haward, M. (2019). The human side of marine ecosystem-based management (EBM): 'Sectoral interplay' as a challenge to implementing EBM. *Marine Policy*, *101*, 33–38. https://doi.org/10.1016/j.marpol.2018.12.019

Appelqvist, C., & Lindegarth, S. (2019). *Scary Seafood – den nya maten från havet* (p. 52). Göteborgs universitet.

BAF. (2022). *Blue Action Fund | Safeguarding Marine Biodiversity*. Blue Action Fund. https://www.blueactionfund.org/

Barquet, K., & Green, J. (2022). Towards multifunctionality: Adaptation beyond the nature–society dichotomy. *Stockholm+50 Background Paper Series*.

BASREC. (2012). *Conditions for Deployment of Wind Power in the Baltic Sea Region*. The intergovernmental Baltic Sea Region Energy Co-operation (BASREC). http://basrec.net/wp-content/uploads/2013/09/BASREC-wind-2_strategic-outline_120424.pdf

Belgrano, A., & Villasante, S. (2021). Linking Ocean's Benefits to People (OBP) with Integrated Ecosystem Assessments (IEAs). *Population Ecology*, *63*(1), 102–107. https://doi.org/10.1002/1438-390X.12064

Bergström, L., Ohmän, M. C., Berkström, C., Isaeus, M., Katusky, L., Koehler, B., Sandman, A. N., Ohlsson, H., Ottvall, R., Schack, H., & Wahlberg, M. (2022). *Effekter av havsbaserad vindkraft på marint liv*. Vindval. https://www.naturvardsverket.se/globalassets/media/publikationer-pdf/7000/978-91-620-7049-6.pdf

Bishop, M. J., Mayer-Pinto, M., Airoldi, L., Firth, L. B., Morris, R. L., Loke, L. H. L., Hawkins, S. J., Naylor, L. A., Coleman, R. A., Chee, S. Y., & Dafforn, K. A. (2017). Effects of ocean sprawl on ecological connectivity: Impacts and solutions. *Journal of Experimental Marine Biology and Ecology*, *492*, 7–30. https://doi.org/10.1016/j.jembe.2017.01.021

Blanco, I. & Kjaer, C. (2009). *Wind at Work, Wind Energy and Job Creation in the EU*. European Wind Energy Association. https://www.ewea.org/fileadmin/files/library/publications/reports/Wind_at_work.pdf

Blue Food Consortium. (2022). Blue Food—Centre for future seafood. *Blå mat*. https://www.bluefood.se/in-english/

Bohman, B. (2018). The Ecosystem Approach as a Basis for Managerial Compliance: An Example from the Regulatory Development in the Baltic Sea Region. In D. Langlet & R. Rayfuse (Eds.), *The Ecosystem Approach in Ocean Planning and Governance* (pp. 80–116). Brill | Nijhoff. https://doi.org/10.1163/9789004389984_004

Borthwick, L., Bergman, K., & Ziegler, F. (2019). *RISE - Jordbruk och livsmedel* (p. 26). Research Institutes of Sweden AB.

Business Region Göteborg. (2022). *Branschfakta maritima näringar—Business Region Göteborg*. https://www.businessregiongoteborg.se/fordel-goteborg/fordel-goteborg/branscher-i-fokus/maritima-naringar/branschfakta-maritima-naringar

Campillo, J., Dominguez-Jimenez, J. A., & Cabrera, J. (2019). Sustainable Boat Transportation Throughout Electrification of Propulsion Systems: Challenges and Opportunities. *2019 2nd Latin American Conference on Intelligent Transportation Systems (ITS LATAM)*, 1–6. https://doi.org/10.1109/ITSLATAM.2019.8721330

Costello, C., Cao, L., Gelcich, S., Cisneros-Mata, M. Á., Free, C. M., Froehlich, H. E., Golden, C. D., Ishimura, G., Maier, J., Macadam-Somer, I., Mangin, T., Melnychuk, M. C., Miyahara, M., de Moor, C. L., Naylor, R., Nøstbakken, L., Ojea, E., O'Reilly, E., Parma, A. M., … Lubchenco, J. (2020). The future of food from the sea. *Nature*, *588*(7836), 95–100. https://doi.org/10.1038/s41586-020-2616-y

Dahlbäck, B., Doelle, M., Hill, C., & Sousa Pinto, I. (2021). *Ecosystem approach to enhance resilience in Swedish offshore marine areas and contribute to a sustainable blue economy* [Scoping study]. MISTRA. https://www.mistra.org/wp-content/uploads/2021/10/mistra-bp-sustainable-blue-economy-2021.pdf

De Mesel, I., Kerckhof, F., Norro, A., Rumes, B., & Degraer, S. (2015). Succession and seasonal dynamics of the epifauna community on offshore wind farm foundations and their role as stepping stones for non-indigenous species. *Hydrobiologia: The International Journal of Aquatic Sciences*, *756*(1), 37–50. https://doi.org/10.1007/s10750-014-2157-1

EIS. (2021). *Den europeiska resultattavlan för innovation* [Text]. Europeiska kommissionen - European Commission. https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_sv

Ellis, J., & Svanberg, M. (2018). *SUMMETH – Sustainable Marine Methanol Deliverable D5.1 Expected benefits, strategies, and implementation of methanol as a marine fuel for the smaller vessel fleet* (p. 47).

European Commission. (2008). *Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU* [Communication from the Commission]. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0791:FIN:EN:PDF

European Commission. (2021). Communication on a new approach for a sustainable blue economy in the EU Transforming the EU's Blue Economy for a Sustainable Future. European Commission COM/2021/240 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN

European Commission. (2022a). *Proposal for a Nature Restoration Law*. https://environment.ec.europa.eu/publications/nature-restoration-law_en

European Commission. (2022b). *Proposal for Ecodesign for Sustainable Products Regulation*. https://environment.ec.europa.eu/publications/proposal-ecodesign-sustainable-products-regulation_en

European Commission, Directorate-General for Maritime Affairs and Fisheries, Addamo, A., Calvo Santos, A., Carvalho, N., Guillén, J., Magagna, D., Neehus, S., Peralta Baptista, A., Quatrini, S., & Schinasi Romeu, Y. (2021). *The EU blue economy report 2021*. Publications Office. https://doi.org/10.2771/8217

European Parliament. (2021). *European Parliament resolution of 25 March 2021 on establishing an EU strategy for sustainable tourism*. https://www.europarl.europa.eu/doceo/document/TA-9-2021-0109_EN.html

Fagerström, A., & Anderson, S. (2019). *The contribution of Advanced Renewable Transport Fuels to transport decarbonization in Sweden—2030 and beyond*. 44.

Ghenai, C., Bettayeb, M., Brdjanin, B., & Hamid, A. K. (2019). Hybrid solar PV/PEM fuel Cell/Diesel Generator power system for cruise ship: A case study in Stockholm, Sweden. *Case Studies in Thermal Engineering*, *14*, 100497. https://doi.org/10.1016/j.csite.2019.100497

GII. (2021). *Global Innovation Index 2021: Which are the most innovative countries?* https://www.wipo.int/global_innovation_index/en/2021/index.html

Government of Sweden. (2006). *Strategic Challenges: A Further Elaboration of the Swedish Strategy for Sustainable Development* (Government Communication 2005/06:126). Regeringskansliet. http://www.government.se/contentassets/a321458d6c6b407388aac5590ce0fdea/strategic-challenges---a-further-elaboration-of-the-swedish-strategy-for-sustainable-development-comm.-200506126

GTSC. (2016). *GSTC Industry Criteria with Suggested Performance Indicators for Tour Operators*. https://www.gstcouncil.org/wp-content/uploads/GSTC-Industry-Criteria-for-Tour-Operators-with-indicators-Dec-2016.pdf

Hammar, L., Molander, S., Pålsson, J., Schmidtbauer Crona, J., Carneiro, G., Johansson, T., Hume, D., Kågesten, G., Mattsson, D., Törnqvist, O., Zillén, L., Mattsson, M., Bergström, U., Perry, D., Caldow, C., & Andersen, J. H. (2020). Cumulative impact assessment for ecosystem-based marine spatial planning. *Science of The Total Environment*, *734*, 139024. https://doi.org/10.1016/j.scitotenv.2020.139024

Havet och människan (SOU 2020:83). (2020). https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2021/01/sou-202083/

Heinze, C., Blenckner, T., Martins, H., Rusiecka, D., Döscher, R., Gehlen, M., Gruber, N., Holland, E., Hov, Ø., Joos, F., Matthews, J. B. R., Rødven, R., & Wilson, S. (2021). The quiet crossing of ocean tipping points. *Proceedings of the National Academy of Sciences*, *118*(9), e2008478118. https://doi.org/10.1073/pnas.2008478118

Intergovernmental Oceanographic Commission & UNESCO. (2020). *Global Ocean Science Report: The current status of ocean science around the world*. United Nations.

IUCN. (2022). *Towards Partnerships and Collaboration on the Blue Economy*. https://www.iucn.org/sites/dev/files/import/downloads/towards_partnerships_and_collaboration_on_the_blue_economy.pdf

Jagers, S. C., Berlin, D., & Jentoft, S. (2012). Why comply? Attitudes towards harvest regulations among Swedish fishers. *Marine Policy*, *36*(5), 969–976. https://doi.org/10.1016/j.marpol.2012.02.004

Jivén, K., Hjort, A., Malmgren, E., Persson, E., Brynolf, S., Lönnqvist, T., Särnbratt, M., & Mellin, A. (2022). *CAN LNG BE REPLACED WITH LIQUID BIOMETHANE (LBM) IN SHIPPING?* https://www.ivl.se/press/pressmeddelanden/2022-03-10-svensk-biogas-kan-ersatta-stora-mangder-fossilt-fartygsbransle.html

Johansson, S. (2021). *Scoping study on Research in Swedish Offshore Marine Areas*. MISTRA. https://www.mistra.org/wp-content/uploads/2021/10/mistra-ss-offshore-marine-areas-2021.pdf

Jouffray, J.-B., Blasiak, R., Norström, A. V., Österblom, H., & Nyström, M. (2020). The Blue Acceleration: The Trajectory of Human Expansion into the Ocean. *One Earth*, *2*(1), 43–54. https://doi.org/10.1016/j.oneear.2019.12.016

Karlsson, M. (2019). Closing marine governance gaps? Sweden's marine spatial planning, the ecosystem approach to management and stakeholders' views. *Ocean & Coastal Management*, *179*, 104833. https://doi.org/10.1016/j.ocecoaman.2019.104833

Kinning, L. (2022). *Sammanställning över planerad havsbaserad vindkraft i Sverige*. Svensk Vindenergi. https://svenskvindenergi.org/wp-content/uploads/2022/05/Sammanstallning-over-planerad-havsbaserad-vindkraft-2022-05-03-1.pdf

Länsstyrelsen Skåne. (2021, October 11). *LIFE Coast Adapt | Klimatanpassningsåtgärder för att minska effekterna av erosion*. LIFE Coast Adapt. https://lifecoastadaptskane.se/klimatanpassningsatgarder-for-att-minska-effekterna-av-erosion/

Matschke Ekholm, H., Nilsson, Å., & Isaksson Lantto, F. (2021). *Klimatanpassning 2021—Så långt har Sveriges kommuner kommit* (No. C601; C-Rapport). IVL Swedish Environmental Research Institute.

Miettinen, R. (2013). *Innovation, Human Capabilities, and Democracy: Towards an Enabling Welfare State*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199692613.001.0001

Morf, A., Sandsten, J., Prutzer, M., & Lindroth, N. (2021). *Blue Economy and Coastal Development – Sharing Swedish Experiences*. (Report no. 2021:5). Swedish Institute for the Marine Environment.

Murray, C. J., Müller-Karulis, B., Carstensen, J., Conley, D. J., Gustafsson, B. G., & Andersen, J. H. (2019). Past, Present and Future Eutrophication Status of the Baltic Sea. *Frontiers in Marine Science*, *6*, 2. https://doi.org/10.3389/fmars.2019.00002

Nordic Innovation. (2022). *Nordic Circular Economy Playbook*. https://pub.nordicinnovation.org/Nordic-Circular-Economy-Playbook/#51752

NRIA Sjöfart. (2021). *NRIA Sjöfart 2021 | Lighthouse*. https://lighthouse.nu/verksamhet/nria/

Nyström Sandman, A., Christiernsson, A., Gidhagen Fyhr, F., Lindegarth, M., Kraufvelin, P., Bergström, P., Nilsson, P., Fredriksson, R., Bergström, U., & Hogfors, H. (2020). *Grön infrastruktur i havet: Landskapsperspektiv i förvaltningen av Sveriges marina områden*. http://urn.kb.se/resolve?urn=urn:nbn:se:naturvardsverket:diva-8498

OECD. (2020a). *Sustainable Ocean Economy Database*. https://stats.oecd.org/index.aspx?datasetcode=OCEAN

OECD. (2020b). *OECD Tourism Trends and Policies 2020*. OECD. https://doi.org/10.1787/6b47b985-en

OECD. (2021). *Managing tourism development for sustainable and inclusive recovery*. https://doi.org/10.1787/b062f603-en

OECD. (2022). *Sustainable ocean economy*. https://www.oecd-ilibrary.org/content/component/1f798474-en

OX2. (2022). *OX2 to investigate the possibility to develop offshore hydrogen pipeline in the Baltic Sea*. https://www.ox2.com/newsroom/press-releases-news/2022/ox2-to-investigate-the-possibility-to-develop-offshore-hydrogen-pipeline-in-the-baltic-sea/

Paulsson, D. (2019). *Report on the implementation of smart specialisation in Sweden*. 37.

Petruny, L., Wright, A., & Smith, C. (2016). Renewables, Shipping, and Protected Species: A Vanishing Opportunity for Effective Marine Spatial Planning? In A. Popper & A. Hawkins (Eds.), *EFFECTS OF NOISE ON AQUATIC LIFE II* (WOS:000370000900100; Vol. 875, pp. 815–820). https://doi.org/10.1007/978-1-4939-2981-8_100

Przedrzymirska, J., Zaucha, J., Calado, H., Lukic, I., Bocci, M., Ramieri, E., Varona, M., Barbanti, A., Depellegrin, D., de Sousa Vergílio, M., Schultz-Zehden, A., Onyango, V., Papaioannou, E., Buck, B., Krause, G., Schupp, M., Läkamp, R., Szefler, K., Michałek, M., … Lazić, M. (2021). Multi-Use of the Sea as a Sustainable Development Instrument in Five EU Sea Basins. *Sustainability*, *13*(15), 8159. https://doi.org/10.3390/su13158159

Reubens, J. T., De Rijcke, M., Degraer, S., & Vincx, M. (2014). Diel variation in feeding and movement patterns of juvenile Atlantic cod at offshore wind farms. *Journal of Sea Research*, *85*, 214–221. https://doi.org/10.1016/j.seares.2013.05.005

SBDI. (2022). *Swedish Biodiversity Data Infrastructure*. Swedish Biodiversity Data Infrastructure. https://biodiversitydata.se/

SCB. (2017). *Redovisning av regeringsuppdraget att utveckla statistiken kring de maritima näringarna* (N2016/08065/MRT). https://www.scb.se/contentassets/930201cc060d402180862db287e89f58/redovisning-av-regeringsuppdraget-att-utveckla-statistiken-kring-de-maritima-naringarna-januari-2017.pdf

SCB. (2018). *Statistics are now available on maritime industries*. Statistiska Centralbyrån. http://www.scb.se/en/finding-statistics/statistics-by-subject-area/business-activities/structure-of-the-business-sector/maritime-industries/pong/statistical-news/maritime-industries/

SCB. (2021). *Det yrkesmässiga fisket i havet 2021. Definitiva uppgifter*. Statistics Sweden. https://www.scb.se/contentassets/b506c8ec29804e119b96f515328d48c8/jo1101_2021m03_sm_jo50sm2105.pdf

Schubert, P., Ekelund, N. G. A., Beery, T. H., Wamsler, C., Jönsson, K. I., Roth, A., Stålhammar, S., Bramryd, T., Johansson, M., & Palo, T. (2018). Implementation of the ecosystem services approach in Swedish municipal planning. *Journal of Environmental Policy & Planning*, *20*(3), 298–312. https://doi.org/10.1080/1523908X.2017.1396206

Schupp, M. F., Bocci, M., Depellegrin, D., Kafas, A., Kyriazi, Z., Lukic, I., Schultz-Zehden, A., Krause, G., Onyango, V., & Buck, B. H. (2019). Toward a Common Understanding of Ocean Multi-Use. *Frontiers in Marine Science*, *6*, 165. https://doi.org/10.3389/fmars.2019.00165

SI. (2022). *International experts meet the Swedish innovation ecosystem*. Svenska Institutet. https://si.se/en/international-experts-meet-the-swedish-innovation-ecosystem/

Skriver Hansen, A., Glette, V., & Arce, J. F. (2021). Mapping recreational activities in coastal and marine areas – PPGIS findings from western Sweden. *Ocean & Coastal Management*, *205*, 105567. https://doi.org/10.1016/j.ocecoaman.2021.105567

SND. (2022). *Swedish National Data Service*. https://snd.gu.se/en

Stuchtey, M., Vincent, A., Merkl, M., & Bucher, M. (2020). *Ocean Solutions That Benefit People, Nature and the Economy.* World Resources Institute. www.oceanpanel.org/ocean-solutions

Svensk Vattenbruk. (2022). *Sveriges vattenbruksproduktion.* https://www.svensktvattenbruk.se/46/om-vattenbruk/vattenbruket-i-sverige/sveriges-vattenbruksproduktion.html

Svensk Vindenergi. (2021a). *Färdplan 2040. Vindkraft för klimatnytta och konkurrenskraft.* https://svenskvindenergi.org/wp-content/uploads/2021/01/Fa%CC%88rdplan-2040-rev-2020.pdf

Svensk Vindenergi. (2021b). *Havsbaserad vindkraft – en nyckel till industrins omställning.* https://svenskvindenergi.org/wp-content/uploads/2021/12/Policyrapport-Havsbaserad-vindkraft-en-nyckel-till-industrins-omstallning.pdf

Sveriges Miljömål. (2021). *Hållbart nyttjade fisk- och skaldjursbestånd i kust och hav.* https://www.sverigesmiljomal.se/miljomalen/hav-i-balans-samt-levande-kust-och-skargard/hallbart-nyttjade-fisk--och-skaldjursbestand-i-kust-och-hav/

SwAM. (2018). *Strategic Environmental Assessment of the Marine Spatial Plan proposal for Skagerrak and Kattegat.* https://ym.fi/documents/1410903/38439968/sea-skagerrak-kattegat-swedish-consultation-msp-90A30BC3_82CA_44C7_B095_B27D20B041B3-138633.pdf/f1c6a14d-67ea-b25c-0066-dd5c30d53558/sea-skagerrak-kattegat-swedish-consultation-msp-90A30BC3_82CA_44C7_B095_B27D20B041B3-138633.pdf?t=1603262101135

SwAM. (2020). *Uppföljning av den maritima strategin.* Swedish Agency for Marine and Water Management. https://www.havochvatten.se/planering-forvaltning-och-samverkan/program-projekt-och-andra-uppdrag/maritima-strategin/uppfoljning-av-den-maritima-strategin.html

SwAM. (2021). *The Swedish approach to MPA Network Design & Management: Framework and step-by-step guidance.* (2021:12). Swedish Agency for Marine and Water Management.

SwAM. (2022). *Uppdrag om nya områden för energiutvinning i havsplanerna (2022).* Swedish Agency for Marine and Water Management. https://www.havochvatten.se/om-oss-kontakt-och-karriar/om-oss/regeringsuppdrag/regeringsuppdrag/uppdrag-om-nya-omraden-for-energiutvinning-i-havsplanerna-2022.html#

SwAM, & Swedish Board of Agriculture. (2021). *Handlingsplan för utveckling av svenskt vattenbruk.* Swedish Agency for Marine and Water Management and Swedish Board of Agriculture. https://www.havochvatten.se/download/18.406b761e1798a7d1e39a57b6/1622471740372/ru-framtidens-fiske-handlingsplan-vattenbruk.pdf

Swedish Board of Agriculture. (2022). *Vattenbruk.* https://jordbruksverket.se/utveckla-foretagande-pa-landsbygden/vattenbruk-och-fiske/vattenbruk

Swedish Energy Agency. (2022). *Sveriges elbehov kan dubblas redan till år 2035.* Energimyndigheten. https://www.energimyndigheten.se/nyhetsarkiv/2022/vagen-mot-en-eldriven-framtid/

Swedish Incubators & Science Parks. (n.d.). *Innovationsmanifestet—SISP.* https://www.sisp.se/public-affairs/innovationsmanifestet

Tam, J. C., Link, J. S., Rossberg, A. G., Rogers, S. I., Levin, P. S., Rochet, M.-J., Bundy, A., Belgrano, A., Libralato, S., Tomczak, M., van de Wolfshaar, K., Pranovi, F., Gorokhova, E., Large, S. I., Niquil, N., Greenstreet, S. P. R., Druon, J.-N., Lesutiene, J., Johansen, M., … Rindorf, A. (2017). Towards ecosystem-based management: Identifying operational food-web indicators for marine ecosystems. *ICES Journal of Marine Science, 74*(7), 2040–2052. https://doi.org/10.1093/icesjms/fsw230

Tarkowski, M. (2021). Towards a More Sustainable Transport Future—The Cases of Ferry Shipping Electrification in Denmark, Netherland, Norway and Sweden. In W. Leal Filho, E. V. Krasnov, & D. V. Gaeva (Eds.), *Innovations and Traditions for Sustainable Development* (pp. 177–191). Springer International Publishing. https://doi.org/10.1007/978-3-030-78825-4_11

Tillväxt Norra Bohuslän. (2017). *Kluster Maritim Turism och Rekreation.* Tillväxt Norra Bohuslän. https://www.tillvaxtbohuslan.se/maritim-naringslivsstrategi/wp-content/uploads/sites/20/2017/01/Marin-Turism.pdf

Tillväxtverket. (2021). *Fakta om svensk turism 2020.* https://tillvaxtverket.se/download/18.361cfdb517c0c1bd7cc80cca/1634191360297/Fakta%20om%20svensk%20turism%20TA_Slutleverans.pdf

Trosvik, L., Vierth, I., & Andersson-Sköld, Y. (2019). *Maritime transport and air emissions in Sweden and business-as-usual scenarios for 2030 and 2045.* VTI. http://vti.diva-portal.org/smash/get/diva2:1420777/FULLTEXT02.pdf

Turner, D. R., Edman, M., Gallego-Urrea, J. A., Claremar, B., Hassellöv, I.-M., Omstedt, A., & Rutgersson, A. (2018). The potential future contribution of shipping to acidification of the Baltic Sea. *Ambio, 47*(3), 368–378. https://doi.org/10.1007/s13280-017-0950-6

UN-Habitat. (2018). *UN-Habitat background paper on Blue Economy and Cities | UN-Habitat.* https://unhabitat.org/un-habitat-background-paper-on-blue-economy-and-cities

United Nations. (2022). *Making waves for a blue economy.* United Nations; United Nations. https://www.un.org/en/desa/making-waves-blue-economy

UNWTO. (2014). *International tourism trends in EU-28 member states—Current situation and forecasts for 2020-2025-203*. http://www.eufed.org/binary/uploads//UNWTO_TT2030_EU28.pdf

van den Burg, S. W. K., Aguilar-Manjarrez, J., Jenness, J., & Torrie, M. (2019). Assessment of the geographical potential for co-use of marine space, based on operational boundaries for Blue Growth sectors. *Marine Policy*, *100*, 43–57. https://doi.org/10.1016/j.marpol.2018.10.050

van den Burg, S. W. K., Schupp, M. F., Depellegrin, D., Barbanti, A., & Kerr, S. (2020). Development of multi-use platforms at sea: Barriers to realising Blue Growth. *Ocean Engineering*, *217*, 107983. https://doi.org/10.1016/j.oceaneng.2020.107983

Vattenfall. (2019). *World's first hydrogen-producing offshore wind turbine gets £9.3million funding boost*. https://group.vattenfall.com/uk/newsroom/pressreleases/2022/aberdeen-hydrogen

Westander, H., Risberg, J., & Henryson, J. (2022). *På uppdrag åt Svensk Vindenergi. Statistik om land- och havsbaserad vindkraft 2014 till 2021, Samråd, ansökningar, beslut, avslagsanledningar.* . https://svenskvindenergi.org/wp-content/uploads/2022/06/Statistik-om-vindkraft-2014-2021-Svensk-Vindenergi.pdf

World Bank. (2017). *What is the Blue Economy?* [Text/HTML]. World Bank. https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy

World Bank. (2020). *Global Mobility Report: Measuring Progress Toward Safe, Clean, Efficient, and Inclusive Transport*. https://www.worldbank.org/en/results/2020/11/11/global-mobility-report-measuring-progress-toward-safe-clean-efficient-and-inclusive-transport

WTTC. (2022). *Economic Impact Reports*. World Travel and Tourism Council. https://wttc.org/research/economic-impact

Zervaki, A. (2018). The Ecosystem Approach and Public Engagement in Ocean Governance: The Case of Maritime Spatial Planning. In D. Langlet & R. Rayfuse (Eds.), *The Ecosystem Approach in Ocean Planning and Governance* (pp. 223–255). Brill | Nijhoff. https://doi.org/10.1163/9789004389984_009

Zischg, J., Rogers, B., Gunn, A., Rauch, W., & Sitzenfrei, R. (2019). Future trajectories of urban drainage systems: A simple exploratory modeling approach for assessing socio-technical transitions. *Science of The Total Environment*, *651*, 1709–1719. https://doi.org/10.1016/j.scitotenv.2018.10.061

Appendix

List of participants invited to the workshop on 2 December 2022

Anders Hermansson, Svensk Sjöfart
Anders Odell, FOI
Anders Werner, Skärgårdsredarna
Andrea Morf, Havsmiljöinstitutet & Nordregio
Andreas Bryhn, SLU
Andreas Hansen, GU
Anna Christiernsson, SU
Anna Hammarstedt, IVL svenska miljöinstitutet
Anna Jöborn, Mistra
Anna Lindstedt, Utrikesdepartementet
Anna Waxin, Skärgårdsstiftelsen
Anne Gunnäs, Viable Seas/Lysekils kommun
Anneli Kuusisto, Härnösands kommun, Bothnia Sweden
Anton Paulrud, Pelagic
Åsa Burman, Chalmers
Åsa Pettersson, Energiföretagen
Åsa Romson, IVL
Astrid Burhöi, Västra Götalandsregionen
Björn Bolund, Vattenfall AB
Björn-Ola Linnér, Linköping universitet
Carl Norsten, Business Sweden
Cecilia Strokirk, SMTF Svenskt marintekniskt forum
Charlotte Berkström, SLU
Christina Thulin, SKR Sveriges Kommuner och Regioner
Christine Hanefalk, Maritimt forum
Ellen Bruno, Stockholms universitet Östersjöcentrum
Eric Tedesjö, Transportföretagen
Erik Lundberg, Handels GU
Erika Augustinsson, Region Blekinge
Fredrik von Elern, Rise
Georgia Destouni, Stockholms universitet
Gunilla Rosenqvist, Uppsala Universitet, Blått Centrum Gotland
Gunnel Göransson, SGI
Gustaf Almqvist, Länsstyrelsen
Gustav Kågesten, SGU
Helen Lindahl, Tillväxtverket
Inge Vierth, VTI
Inger Näslund, WWF
Ivan Stenius, KTH, SMaRC
Ivar Stenius, KTH
Jakob Granit, Havs- och vattenmyndigheten
Jennie Larsson, Sjöfartsverket
Jessica Hjerpe Olausson, Chalmers Industriteknik
Johan Penner, Jordbruksverket
John Tumpane, Formas
Jonas Siljhammar, Visita
Kajsa Tonnesson, GU
Karin Lexen, Naturskyddsföreningen
Karl Hallding, Vinnova
Kerstin Eriksson, Sweden Food Arena
Klas Cullbrand, Resource-sip
Krishan Kent, Marenor
Kristina Sundell, GU
Kurt Bratteby, SI
Lars Josefsson, Johannebergsciencepark
Lars Werke, SCB
Lena Bergstrom, SLU
Lena Gipperth, Göteborgs universitet Centrum för hav och samhälle
Lillemor Lindberg, Innovatum Science Park
Linus Hammar, Havs och vattenmyndigheten
Lisa Almesjö, Vinnova
Lotten Hjelm, Skärgårdarna
Louise Staxäng Torbäck, Symbioscentrum, Sotenäs kommun
Magnus Andersson, Näringsdepartementet
Malin Price, Tillväxtverket
Marie Gidlund, Sweden food arena
Marmar Nekoro, Läkemedelsverket
Mats Djurberg, Statens maritima och transporthistoriska museer
Mattias Blomberg, Formas
Mattias Rust, Infrastrukturdepartementet
Max Troell, Kungliga Vetenskapsakademien
Michael Palmgren, Marint Kunskapscenter
Nick Kamenos, Umeå universitet
Olga Kordas, Viable cities
Örjan Östman, Sveriges Lantbruksuniversitet
Ottilia Thoreson, Sida
Patrick Gorringe, SMHI
Paul Westin, Energimyndigheten
Per Danielsson, SGI
Peter Johansson, Teknikföretagen
Peter Ronelöv Olsson, Sveriges Fiskares Producentorganisation
Petra Wallberg, Svenskt Vatten
Pierre Ingmarsson, RISE
Remy Kolessar, Energimyndigheten
Robin Teigland, Chalmers
Roger Berg, Saab group
Stina Gottlieb, Sotenäs kommun
Stina Tano, Naturskyddsföreningen
Tina Elfwing, SU
Torsten Linders, Göteborgs Universitet
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