Natural capital accounting for Clew Bay, Ireland

Synthesis report

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Key findings

- Sustainable ocean management is complex. There are multiple dimensions which need to be considered, including environmental, economic, and social dimensions. Further, the global context is continually changing, and the seafood sector needs to be flexible and adaptive to respond to global needs.
- The concept of multiple capitals, which includes natural capital, produced capital, human capital and social capital, provides an approach to integrating the environment into economic and social decision making.
- Information is central to any decision-making process. Natural capital accounting adds value to current monitoring approaches by organising existing data into an integrated and coherent narrative across multiple dimensions (environmental, social and economic).
- Historically, bespoke data collection processes and missing information have impeded integration from occurring. This project provides a framework for future data collection including areas that should be targeted to generate value for money from investments in data and information.
- The outcomes from the project demonstrate how ocean accounting can be used in policy, management and planning. The information resulting from the project can be used by BIM, the local CLAMS groups and statutory authorities, to inform ongoing management of Clew Bay and marine and coastal areas in Ireland generally.
- Using publicly available data, the project estimated the extent of ecosystems in Clew Bay, assessed the services and benefits provided by those ecosystems, and identified some potential human induced pressures on the ecosystems and the Bay.
- There were many datasets available. However, many datasets are collected for a single purpose without consideration of wider applications. The data collected was deficient in some combination of the following - time limited, spatially limited, data gaps, recording units. Consistent data collection across space and time is needed to evaluate management interventions.
- Creating a single data repository for Clew Bay was a useful exercise and can be built upon over time and be used to respond to different issues and challenges within the region.
- The project provides the foundation for future investments in regularly updated ocean accounts to enable evidence-based policy, including planning and strategy, regulation, management decisions and return on investment analysis.
- The project demonstrates that ocean accounting can be scaled up to the national level using existing data and leveraging the knowledge gained during this project. However, changes in scale and location are likely to change the purpose and use of the accounts.
- The authors recommend any further application of the approach be accompanied by targeted investment in data collection, capacity building and research. Wherever possible, data collection should align with environmental-economic accounting guidelines and standards.
- For accounting to be successful, there is a need for the development of consistent national methods for the collection of marine environmental data so the data can be integrated and readily incorporated into environmental-economic accounts for analysis and reporting.

1 Introduction

The management of the world's oceans requires achieving a balance between protecting the marine environment and developing opportunities for sustainable use and enjoyment that promote social wellbeing and equitable prosperity. A sustainable ocean economy, one that maintains the resilience and health of the ocean, while providing socio-economic benefits to diverse groups of people, is central to building a better future for people and the planet.

Sustainable ocean management is complex. Challenges include coordination across whole of government, private and public sector dynamics, different management ideals across disciplines (for example, ecology and economics), and missing and fragmented information. This is further complicated by a complexity of management levers that can be applied at different scales including protection, regulation (licensing) of use, restoration, and behaviour change.

The concept of natural capital provides an approach to integrating the environment into economic and social decision making. Clew Bay on Ireland's Atlantic west coast was chosen as the study area for trialling a natural capital approach. The bay hosts a strong and connected aquaculture sector, with an active Coordinated Local Aquaculture Management System (CLAMS) group supported by both BIM and the Marine Institute. It hosts a range of inshore fishing activity, and the Clew Bay Oyster Co-op actively manages the Native Oyster fishery alongside competent authorities. The area is a popular tourist destination and hosts a wide variety of marine leisure activities

The overarching purpose of this project was to explore how Natural Capital approaches can support the Irish seafood industry in the sustainable management of ocean resources, and to support seafood industry operators to create value.

The project had three objectives:

1) test and demonstrate the application of Natural Capital Accounting for the Irish Seafood sector, using the United Nations System of Environmental-Economic Accounting
2) improve the understanding of the complex relationship between seafood sector activities and the natural environment, and
3) contribute to the sustainable management of the seafood sector and the marine environment

Economic, social and environmental policy in the region requires good information be founded on solid evidence. The United Nations System of Environmental Accounting (SEEA) (henceforth Natural Capital Accounting) provides an approach to creating an agreed set of information that can be used by managers and users of the ocean. Natural Capital Accounting establishes a set of principles and processes to organise social, economic, and environmental data, ensures the information is spatially and temporally comparable, and generates outputs.

This report, compiled by IDEEA Group for BIM, is a synthesis of the project findings and recommendations. The synthesis report is the third in a series of 3 reports:

1. Use case assessment – framing natural capital from the perspective of a number of different users and potential applications of natural capital information

2. Clew Bay Natural Capital Profile – which focusses on the provision of structured information on natural, produced, human and social capital in Clew Bay
3. Synthesis report – this report, which is an assessment of the information against the objectives of the project, and the priority applications, and recommendations for improvement in the future.

The project synthesis report provides an overview of:

- Ireland's seafood sector in Clew Bay
- How adopting a Natural Capital framing can support the Irish seafood industry
- Findings from the study
- Lessons learned from the project
- Recommendations for advancing Natural Capital Accounting

2 Ireland’s seafood sector

Ireland has a large, diverse, and complex seafood sector which consists of many operators all around the coast of Ireland. The seafood sector is a primary driver of rural economies around the coastline of Ireland and acts as an anchor in these locations which other supporting service sectors develop. In 2020, the volume of seafood produced by the Irish seafood sector surpassed 220,000 tonnes with a value of €394m. While less than 20% of this volume was produced by the aquaculture sector it contributed 46% of the total value.

Each seafood operator, from sole trader to large employers, must overcome their own challenges and grasp their own opportunities to earn an economic return. Each seafood operator, by choosing to employ and invest in different types of capital, has a unique response to their specific challenges and opportunities. Their response is unique because of unique/ differing environmental (for example, weather), economic (for example, existing levels/types of grant support available) and social conditions (for example, personal health and wellbeing). These responses may be organic, and developed by seafood operators themselves, or be mandated through regulation or market demand. An operator’s response will also depend on the location’s historical events and assumptions about future prospects.

Because of the unique conditions that seafood operators face, a bottom-up approach that recognises the intricacies of a particular context is required to balance economic, social and environmental objectives. An example of a recently developed local approach to management is Marine Spatial Planning.

All management approaches require information, whether qualitative or quantitative. Information is useful for identifying the challenges and opportunities that elicit a response, and then in telling a story about the outcomes that result from that response. Yet, information about the environment that connects to the economy and society in a meaningful way, is lacking. Further, environmental information is rarely described within the context of a broader area, which is fundamental for providing context. We created a natural capital profile for Clew Bay.

2.1 Clew Bay

Clew Bay is part of the Irish maritime area, which extends over 490,000km^2 (approximately 7 times its terrestrial landmass) (see Figure 1). Clew Bay is a sheltered bay on the west (Atlantic) coast of County Mayo, Ireland. The Bay is open to westerly swells off the Atlantic Ocean and is 25km long, 12.5km wide and covers an area of 31,250 hectares. The bay is bounded on both north and south by mountains–Croagh Patrick (795 metres) on the south and the Nephin Beg range on the north.

It has been said that the bay has 365 islands, one for every day of the year. A distinctive feature of the inner end of the bay is the archipelago of small islands formed by drumlins, or long oval mounds of glacial origin (Britannica, 2018). Achill Island and the Corraun Peninsula form western extensions of the northern shores and Clare Island, which is the biggest island, guards the entrance of the bay and is home to some 130 people.

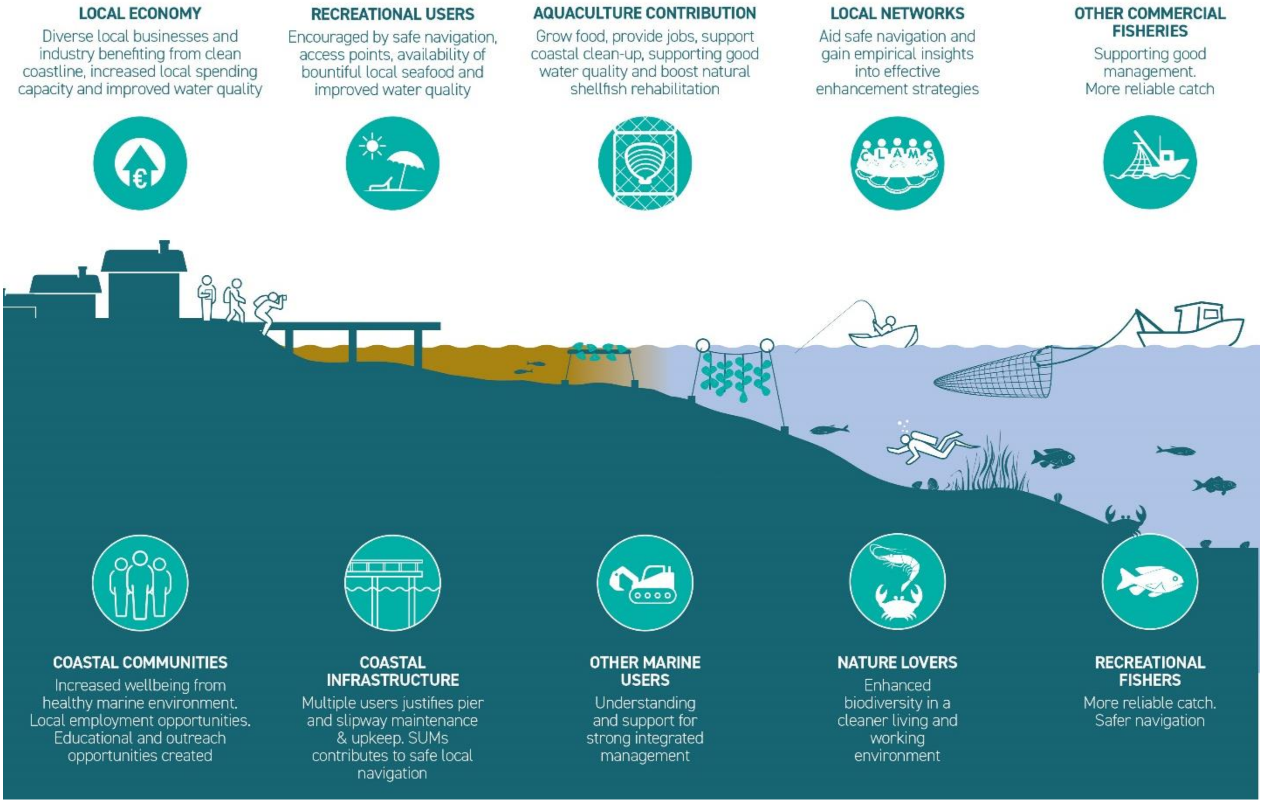
Figure 1 Clew Bay, Ireland

The Bay's multitude of islands and complex series of interlocking bays provides both shelter and oxygen enriched waters, making Clew Bay an excellent location for the cultivation and capture of both shellfish (crustacean and bivalves) and finfish. The bay is highly productive, and the unique geomorphology provides shelter allowing for fishing activities to take place over extended periods throughout the year.

Westport, which is the main town adjacent to Clew Bay, is County Mayo's premier tourist destination and is known for the scenery, the pubs and restaurants in the town, blue flag beaches, and Croagh Patrick. Westport's proximity to Connemara, Achill, Clew Bay and Croagh Patrick, and its hotels and guest houses, make it a base for holidaymakers to tour the region, which also forms part of the Wild Atlantic Way. Finally, there is a strong link between tourism, local seafood produce in shops and restaurants, and the seafood sector primary producers, which is recognised in the Taste the Atlantic initiative.

The seafood sector is engaged in Clew Bay in many ways and contributes to environmental, economic and social outcomes (see Figure 2). For example, commercial and recreational fishers depend on healthy ecosystems to provide habitat for a number of species which are caught. Oyster habitat filters the water, providing a place for people to swim and providing amenity for tourists. Coastal communities have improved health and wellbeing from being connected with the marine environment, which is part of local fabric.

Figure 2 The seafood sectors engagement in Clew Bay



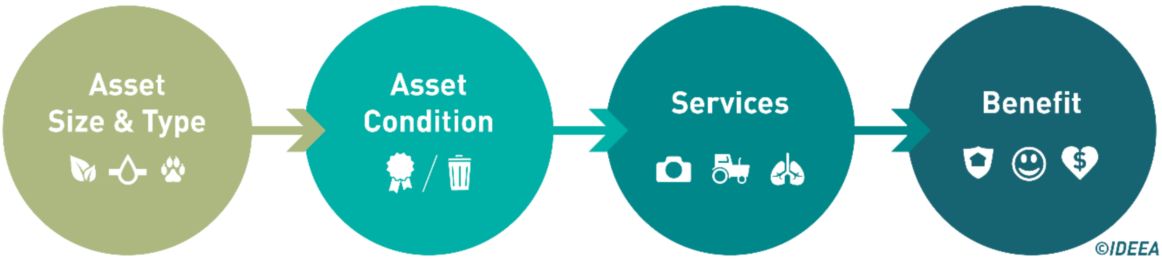
3 Adopting a Natural Capital framing to support the Irish seafood industry

3.1 A Natural Capital Framing

A natural capital framing can be applied to the seafood industry to demonstrate the links between the environment and the economy and hence support more informed decision making. A natural capital framing can be used to improve the understanding of the complex relationships between seafood sector activities and the natural environment, by describing the contribution of the environment to the benefits associated with the seafood sector (see Figure 3).

A natural capital framing describes the ocean as a set of assets, with a size and type (for example, extent or area of seagrass meadows) and condition (for example, characteristics such as seagrass density assessed against a reference condition) that produce a set of services (for example, fish for food or a pleasant location for tourism). These assets and services have economic, social, cultural and intrinsic values that are experienced by various users and beneficiaries of services, whether a business, government, household, or community. In this project, we test and demonstrate the application of a natural capital framing for the Irish Seafood sector.

Figure 3 Core Ecosystem Accounting Framework

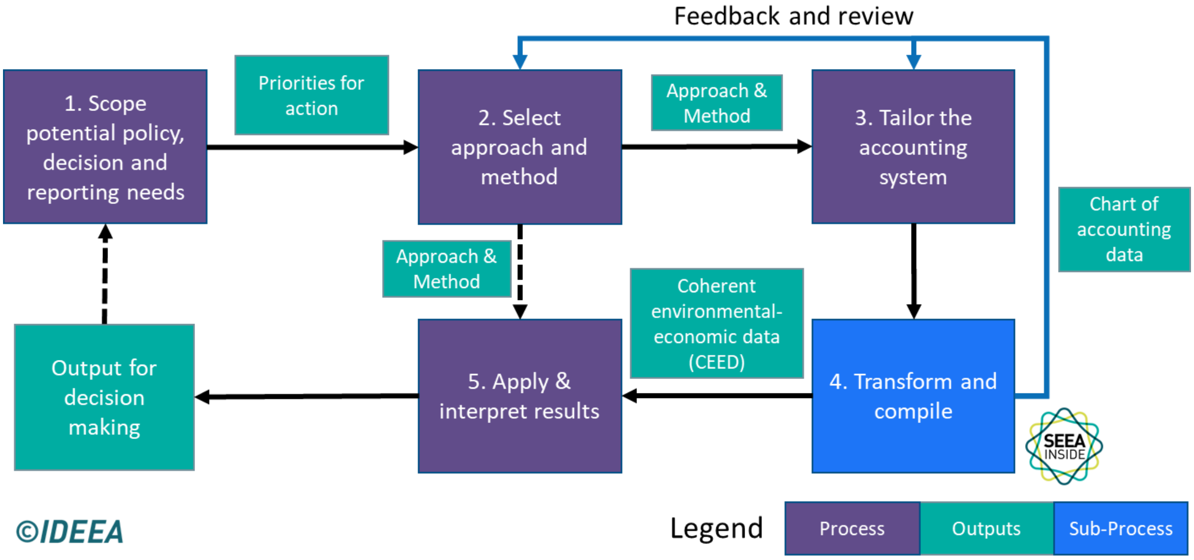


A natural capital framing also provides the entry point for the discussion of multiple capitals including produced, human and social capital. The capitals are interdependent and should be managed jointly. The Coordinated Local Aquaculture Management System (CLAMS) group is an example of social capital which has evolved to support sustainable development in CLEW Bay.

3.2 Natural Capital Design and Implementation Protocol

Information is an input into decision making. To drive the use of natural capital information in decision making, IDEEA Group have developed a five-step Natural Capital Design and Implementation Protocol (NC-DIP) (Figure 5) which underpins the production of a coherent environmental-economic database (CEED) and is used to deliver on the information needs of an organisation. This section describes the NC-DIP and its use in this project.

Figure 4 Process to compile environmental-economic data for decision-making



The process in Figure 4 consists of a design phase (steps 1-3), a data compilation phase (step 4) and an application phase (step 5). The design phase ensures that the data compilation phase results in meaningful and interpretable information for the application phase. Each step is described in Table 1. The process described can be readily aligned with other natural capital approaches including the Natural Capital Protocol[1]. By way of example, the Natural Capital Protocol Frame and Scope stages are equivalent to steps 1 and 2; the Measure and Value stage is equivalent to steps 3 and 4 and finally the Apply stage is reflected in steps 5. This process is also amenable to considering multiple capitals. In this project, the integration of natural and produced capitals is the focus but the conceptualisation can be extended to the integration of human and social capital following the same process.

[1] https://capitalscoalition.org/project/combining-forces-on-natural-capital/
https://capitalscoalition.org/wp-content/uploads/2017/11/NCP-SEEA-Toolkit-Sep-2017-IDEEA-Group-1.pdf

Table 1: Five steps of the NC – Design and Implementation Protocol

Step	Title	Explanation
1	Scope potential policy, decision and reporting uses	This step involves listing and describing the potential uses for CEED. In this step, organizations identify the potential uses of CEED across the organization and within respective business units. A description of the uses of CEED (the what) should be accompanied with a description of why it is important (the why), and teams involved (the who). The outputs from step 1 help to identify priorities and guide the design of CEED, the collection of data and focus on use.
2	Select approach and method	The link between a potential use and CEED is made explicit in order to target the design of a CEED. For this purpose, both an analytical approach and methods should be specified. Thus, it is not sufficient to identify an objective such as understanding the social and economic benefits of investments in native vegetation or calculating a return on investment. What is required is a more complete description of the methods to be used to calculate or demonstrate the benefits and returns. In particular, consideration should be given to how changes in the environmental variables being considered, e.g. rainfall, vegetation cover, relate to particular environmental and economic outcomes such that the effects of policies and investments can be understood. Approaches include cost-benefit analysis, standard accounts, scenario analysis, impact evaluation, return on investment and sustainability reporting
3	Tailoring the accounting system	Tailor an accounting system to support implementation of the analytical approaches and methods identified in step 2. The tailoring process leads to the development of a chart of accounting data.
4	Transform and compile	This step includes the compilation and assessment of both data and methods to populate the chart of accounts and to produce the CEED.
5	Apply and interpret results	This step involves using the CEED to employ the approach and methods described in Step 2. There will be a series of outputs that will be used to support the priorities for action from Step 1. The results are interpreted and assessed against Step 1.

The CEED produced in step 4 is an information asset. Effort to design the information appropriately, coupled with effort to improve data collection, modelling, and data management processes, can improve this asset over time. The System of Environmental-Economic Accounting (SEEA) provides agreed concepts which contribute to the quality of the CEED. Further, as the network of public and private organisations that produce the CEED increases, employing the concepts contained in the SEEA means that the quality of the sum of all data increases. For example, it connects business and public sector information and supports comparability across locations and sectors.

The approach also makes a clear distinction between the application of the data and the generation of coherent data. This feature allows a single CEED to support use of a range of natural capital related reporting and analytical approaches including environmental accounts, ESG and sustainability reporting, risk assessments (e.g. TCFD), certification (e.g. Forestry, Water, Organics, Biodiversity, Carbon) and productivity analysis. By doing this, information can contribute to the sustainable management of the seafood sector and the marine environment in an efficient way.

3.3 Application of the NC-DIP for the Irish Seafood sector

3.3.1 NC-DIP Step #1: Scope potential policy, decision and reporting uses

During phase 1 of the project, an understanding of potential policy, decision and reporting needs was developed. Four priority applications were identified:

1) Preparing data and information for the Seafood sector to support their participation in Marine Spatial Planning (MSP)
2) Improving sustainability performance and communicating the results
3) Reporting on Sustainable Development Goals (SDG)
4) Assessing the sustainability of the seafood sector in terms of natural capital and produced, human and social capital

3.3.2 NC-DIP Step #2: Select approach and method

Each of the applications identified in Phase 1 have a suite of approaches / methods could be used to collect and interpret available information. For example, reporting on SDGs requires the presentation of number of specific indicators, whereas meeting the needs of MSP may require a different set of indicators. This section describes the information needs for each of the four identified priority applications.

Priority 1: Marine Spatial Planning

Healthy marine ecosystems and their multiple services, if integrated in planning decisions, can deliver substantial benefits in terms of food production, recreation and tourism, climate change mitigation and adaptation, shoreline dynamics control and disaster prevention. Marine Spatial Planning is being used in Ireland (see Box 1) to allocate human activities within the marine domain through a participatory process. The area-based marine spatial planning framework supports the management of conflicts for space and resources, and the pressures posed by human activities on the environment (Gacutan et al., 2022).

Box 1– Marine Spatial Planning in Ireland

- Ireland's Marine Spatial Plan is called the National Marine Planning Framework (NMPF) and was formally launched by An Taoiseach, Micheál Martin TD and fellow Ministers on the 1st of July 2021. The framework, which will apply to a maritime area of approximately 495,000km^2, outlines a vision for how we want to use, protect and enjoy our seas in the years up to 2040.
- The NMPF contains a vision, objectives and planning policies for all marine-based human activities. It outlines how those activities will interact with each other in an increasingly pressured ocean space. It is the key decision-making tool for Government departments, State agencies, regulatory authorities and policy makers for decisions on marine activities up to 2040. Decisions will include planning applications as well as policies, projects and strategies.
- The competent authority for MSP in Ireland is the Department of Housing, Local Government and Heritage (DHLGH) and the Marine Institute is providing technical and scientific advice to support the process. Further details on the journey to the NMPF can be found here.
- Through the Blue Growth and MSP Scheme of the European Maritime Fisheries Fund 2016-2021, we have implemented a series of projects to support MSP in Ireland. These cover areas such data collation and management, socio-economic study of seaweed harvesting, defining and classifying Ireland's Seascape. Further details about each project can be found at: emff.marine.ie/blue-growth
- Ireland's Marine Atlas provides up-to-date spatial data to support for the NMPF. It contains information of the marine environment and its ecosystems as well as the location of various human activities.

Marine spatial planning should cover the full cycle of problem and opportunity identification, information collection, planning, decision-making, implementation, revision or updating, and the monitoring of implementation, and should have due regard to land-sea interactions and best available knowledge.

Table 2 links some of the policy and decision-making challenges to information. There are many potential applications of coherent accounting information across the decision-making process including problem diagnosis, forecasting, target setting, scenario analysis, monitoring and reporting, and impact evaluation.

Table 2 Linking decision making to accounting information and data collection

Decision element	Description	Accounting information application
Problem diagnosis	Quantify trends in physical and environmental state and build business case for policy intervention	Interpret accounting information to assist with diagnosis on the current state of the environment
Problem diagnosis	Understand how a problem may manifest in the future, building additional evidence for action	Forecast based on accounting information: forecast outcomes associated with business-as-usual scenario
Design solution	Set target to help guide policy	Identify a practical target by considering accounting information
Design solution	Understand the influence of specific drivers in problems – e.g. to identify which policy levers will be most influential in solving the problem.	Use accounting information as inputs to scenario analysis to estimate outcomes associated with different actions (e.g. business as usual or interventions)
		Use accounting information to estimate the relative efficiency of alternative solutions e.g. trade-offs between economic benefits of planned urban development versus degradation of ecosystems or loss of biodiversity that may result
Design solution	Establish relationships between key variables	Use consistent accounting information combined with statistical techniques to establish relationships (e.g. increased temperature affects ecosystem health which affects yield)
Evaluate success of solution	For reporting purposes – e.g. to demonstrate progress in solving the problem along a time series	Use accounting information to monitor performance against projected outcomes
		Use accounting information for evaluation of performance against targets – e.g. to demonstrate progress against a target and/or attribute influence of policy
Evaluate success of solution	Understand the effectiveness and efficiency of different investments across the landscape	Use accounting information to demonstrate return on investment
		Use consistent accounting information to underpin quasi-experimental approaches to evaluate impacts

There are many different requirements for information as part of marine spatial planning. The needs of each of the decision elements in Table 2 vary significantly, but each can be supported by a common information base. The information base should be spatial and collected consistently across time and space to inform area-based management decisions. Further, the information should be coherent across the environmental, economic and social domains.

A key value add of a consistent set of information is that it helps to remove barriers between MSP stakeholders since they can all work with the same set of information. Communication is benefited, there is less time spent arguing about the content of what is being managed and more time spent arguing about how to manage.

Priority 2: Improving and communicating sustainability performance

The sustainability of the Irish seafood sector is a marketable quality attribute. As social expectations change and environmental and social considerations are given increased weight, sustainability as a quality attribute will become more important. The Irish seafood sector can use good sustainability performance as an advantage in international markets. Conversely, poor sustainability performance may be a barrier to entry. Transition towards sustainability is important for the seafood sector as a whole, and failure to transition may have large and lumpy costs.

Improving sustainability performance requires public and private investments that are made simultaneously across four capitals: produced capital, natural capital, human capital and social capital. A natural capital framing enables us to understand our dependencies and impacts on the environment. We can identify those assets which we depend on, and make investments which ensure that those assets, and our sustainability performance (which ensures the long term economic performance of our operations), are maintained. Where we have large impacts, we can make investments to improve our sustainability performance.

Building up to describe sustainability performance, which is ultimately a description of our dependencies and impacts on the environment, can be completed by building a natural capital profile. A natural capital profile describes the relationship between the economy (in this case seafood sector participants) and the environment in a particular geographic area, which in this case is Clew Bay. The relationship is described by identifying the dependencies and impacts on natural capital by considering the different economic actors in Clew Bay, and the stocks (the extent and condition of ecosystems and other environmental resources such as fish) and flows (physical and monetary denominations of ecosystem services) provided by natural capital that they are managing.

Table 3 Steps in building a natural capital profile

Step	Description
1	The geographic area of interest and key characteristics: this defines the geographic boundary for the purposes of the profile, and more explicitly the natural capital that is being managed.
2	Who are the economic actors managing natural capital and how is it managed? For example, what are the institutional arrangements that affect the management of natural capital by the public sector?
3	What natural capital is being managed by each of the economic actors and what is its condition? Are there other capitals that are being managed that affect natural capital and what are they?
4	What are the key dependencies between the economic actors and natural capital? This builds on an understanding of who is managing natural capital, and what is being managed. There may be multiple economic actors that depend on the natural capital.
5	What are the key pressures (negative) on natural capital in the area of interest? Pressures include the direct use of natural capital, and indirect or exogenous impacts from, for example, climate change or nutrient runoff, and pressures from use that may be impacting others.
6	What are the key environmental and socio-economic impacts in the area of interest? This includes both positive and negative impacts that have both a time and spatial dimension. Understanding impacts requires an understanding of how natural capital and ecosystem services are changing over time.

The following provides an example of how after building a natural capital profile, an impact analysis could be presented for Cultch restoration.

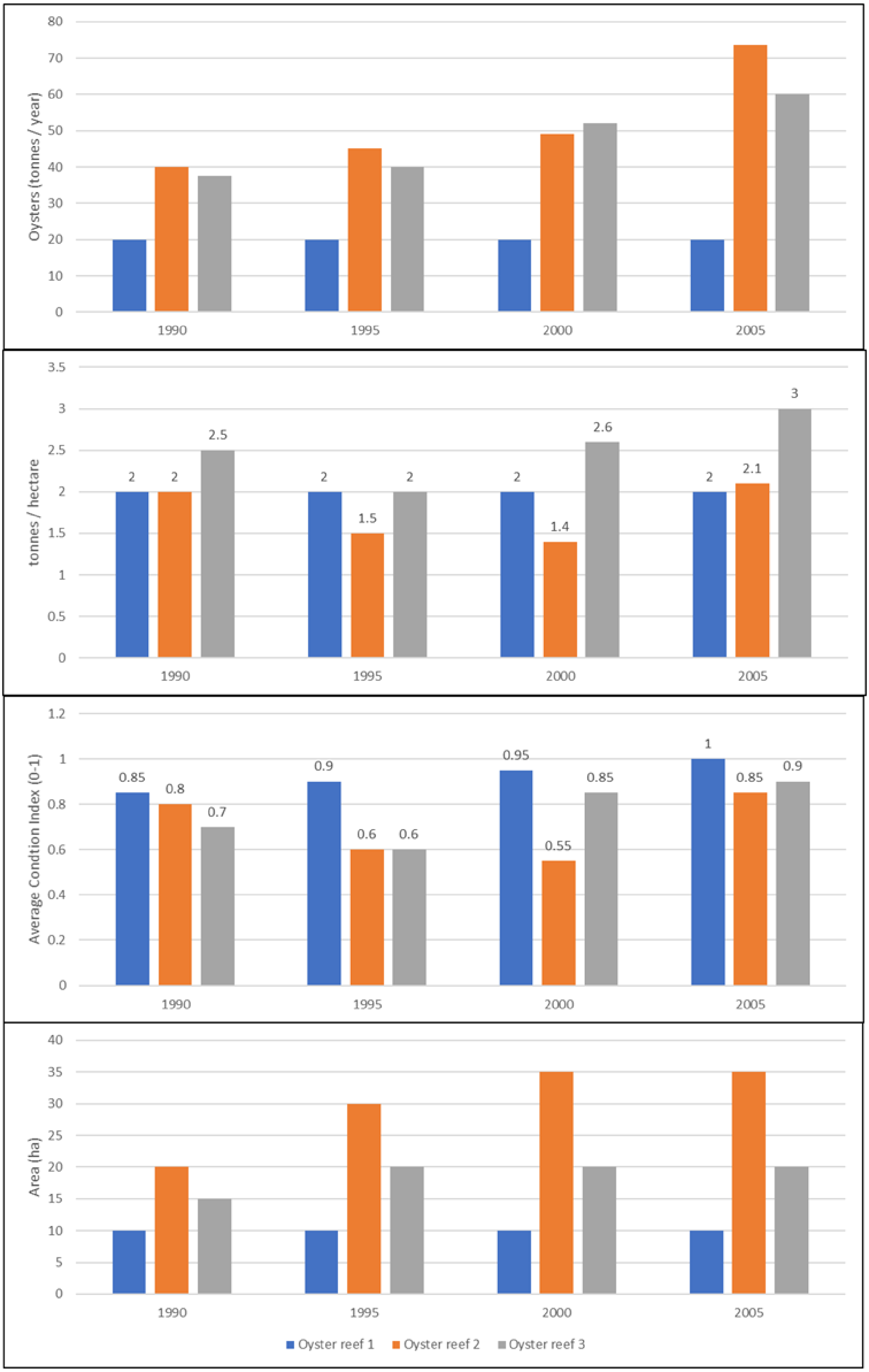
Figure 5 shows a stylised representation of changes in oyster reefs as a result of laying cultch for reef building linked to the condition of the reefs and in turn oyster production. The lower part of the figure shows a times series of three oyster reef areas changing every five years over a 15-year time period. Reef 1 remains stable with no cultch added across the 15 years, Reef 2 expands in area between year 0 and year 10, and reef 3 expands between year 0 and year 5.

The graph which is second from bottom shows the average condition for each reef. The condition of reef 1 is relatively stable but increases naturally with time. The average condition of reef 2 has fallen because new cultch has been laid which needs to settle and develop into a reef that is close to natural where the condition would be measured as 1, very good. However, reef 2 in the final year has settled very well and its condition has increased. Reef 3 had clutch laid, also resulting in a fall in the average condition of the reef 3. However, reef 3 has settled and developed in a high condition reef relatively quickly with its average condition being close to natural (0.9) in the final reporting period.

There has been an increase in the stock (area) of reef and a change in the condition of the reefs. Both these changes will result in a change in ecosystem services. This is shown in stylised form as a change in the tonnes of oysters produced per hectare, which is equivalent to a measure of productivity per hectare for each of the reefs. Reef 1 has remained stable over time, reef 2 falls for two periods and finally increases in the last period, and reef 3 has a small fall but increase quite quickly over the remaining years. The productivity of the reefs is closely correlated with the condition of the reefs, water quality, spat fall and the condition of surrounding ecosystems.

Finally, the production of oysters in shown in the top graph. Production is either stable or increasing over time reflecting the combined effect of a change in area of reef and a change in the condition of the reefs. These graphs could be presented each year if appropriate data were collected on changes in reef area, reef condition and measures of reef productivity. It would then be a relatively straight forward exercise to link investments in natural capital (oyster reefs) via cultch deposition to economic, social and ecosystem benefits.

Figure 5 Stylised representation of cultch expansion



Priority 3: Reporting on SDGs

The 2030 Agenda for Sustainable Development is built around 17 Sustainable Development Goals (SDGs) and 169 targets. This infrastructure represents an ambitious plan for achieving sustainable development and serves as the basis for countries to shape their national policies and priorities. The SDGs span across economic growth, health and education and nature, and the interlinked and cross cutting nature calls for an integrated approach to policy decisions. As the international statistical standard for measuring the environment and its relationship with the economy, the SEEA is well positioned to support integrated policies based on a better understanding of the interactions and trade-offs between the environment and economy.

There are 10 targets under the SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. It would be possible to report on 5 of the targets by implementing the SEEA (see Table 4). Further there are multiple indicators under other SDGs that can be supported by the system of natural capital data.

Table 4 SDGs and their link to natural capital information

Target	Indicator	Account
SDG 14 Life below water		
14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1 (a) Index of coastal eutrophication; and (b) plastic debris density	Condition account
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	14.2.1 Number of countries using ecosystem-based approaches to managing marine areas	Use accounting information to inform thresholds
14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations	Condition account
14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	14.4.1 Proportion of fish stocks within biologically sustainable levels	Central Framework, stock account
14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information	14.5.1 Coverage of protected areas in relation to marine areas	Ecosystem account overlayed with management areas
14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation	14.6.1 Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing	Central Framework – expenditure accounts
14.7 By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism	14.7.1 Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries	Define sustainability, select those operators and then calculate GDP
14a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of	14.a.1 Proportion of total research budget allocated	–

Target	Indicator	Account
Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries	to research in the field of marine technology	
14.b Provide access for small-scale artisanal fishers to marine resources and markets	14.b.1 Degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries	–
14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want	14.c.1 Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nations Convention on the Law of the Sea, for the conservation and sustainable use of the oceans and their resources	–
SDG 6 Clean water and sanitation		
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of wastewater safely treated	SEEA Water Accounts
	6.3.2 Proportion of bodies of water with good ambient water quality	SEEA Water Accounts & Ecosystem Condition Account
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time	SEEA Water Accounts
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	SEEA Water Accounts
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the extent of water-related ecosystems over time	Ecosystem Extent / Land Cover Account & SEEA Water Accounts
SDG 8 Decent work and economic growth		
8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	8.9.1 Tourism direct GDP as a proportion of total GDP and in growth rate	Ecosystem Extent / Land Cover Account & Ecosystem Services Account
SDG 11 Sustainable cities and communities		
11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1 Ratio of land consumption rate to population growth	Ecosystem Extent / Land Cover Account
11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	11.7.1 Average share of built-up area of cities that is open space for public	Ecosystem Extent / Land Cover Account & Ecosystem Services Account

Target	Indicator	Account
	use for all, by sex, age and persons with	
SDG 15 Life on land		
15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1 Forest area as a proportion of total land area	Ecosystem Extent / Land Cover Account
15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2.1 Progress towards sustainable forest management	Ecosystem Extent / Land Cover Account & Ecosystem Condition Account
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1 Proportion of land that is degraded over total land area	Ecosystem Condition Account & Ecosystem Extent / Land Cover Account
15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	15.4.1 Coverage by protected areas of important sites for mountain biodiversity	Biodiversity Account & Ecosystem Condition Account
	15.4.2 Mountain Green Cover Index	Ecosystem Extent / Land Cover Account & Ecosystem Condition Account
15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	15.9.1 (a) Number of countries that have established national targets in accordance with or similar to Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020 in their national biodiversity strategy and action plans and the progress reported towards these targets; and (b) integration of biodiversity into national accounting and reporting systems, defined as implementation of the System of Environmental-Economic Accounting	All

SDG Output Indicators that are 'Full Possibilities' for alignment with the SEEA
(UN Environment World Conservation Monitoring Centre & United Nations Statistics Division, 2019)

Priority 4: Assessing the sustainability of the seafood sector in terms of natural produced, human and social capital

There is a dearth of approaches to tackling sustainability, including the use of targets to say whether a business is sustainable, or promoting continual improvement by getting businesses to understand their dependencies and impacts, and gradually embracing change. However, defining sustainability is a challenge and difficult to implement on the ground. Is it no degradation of natural capital? Is it maintaining ecosystems within thresholds / limits? Is it not crossing any ecological / socio economic thresholds? More generally, sustainability is concerned with meeting today's needs without compromising the ability of future generations to meet their needs (Brundtland, G.H. and Khalid, 1987).

There are various technical debates about the elements of sustainability, including discussions about weak and strong sustainability (see Box 2). However, determining whether a business is sustainable or not, is perhaps not as important as understanding and talking about sustainability in a common way. The concept of multiple capitals provides a comprehensive framework for describing the elements that are commonly considered to be a part of a sustainability assessment.

In working with the seafood sector, BIM is promoting gradual and incremental change through education to understand the sector's impacts and through continual improvement of their operations to reduce and minimise impacts. Globally we are entering into a period where transformative change will be required in all aspects of life (including how the seafood sector conduct themselves,) to manage global environmental change. Capital accounting is a tool to help manage and inform decision making in this era.

Box 2 Weak vs strong sustainability

The fundamental debate regarding sustainable development is whether we choose to adopt a strong or a weak conception of sustainability.

Weak sustainability postulates the full substitutability of natural capital whereas the strong conception demonstrates that this substitutability should be severely seriously limited due to the existence of critical elements that natural capital provides for human existence and well-being.

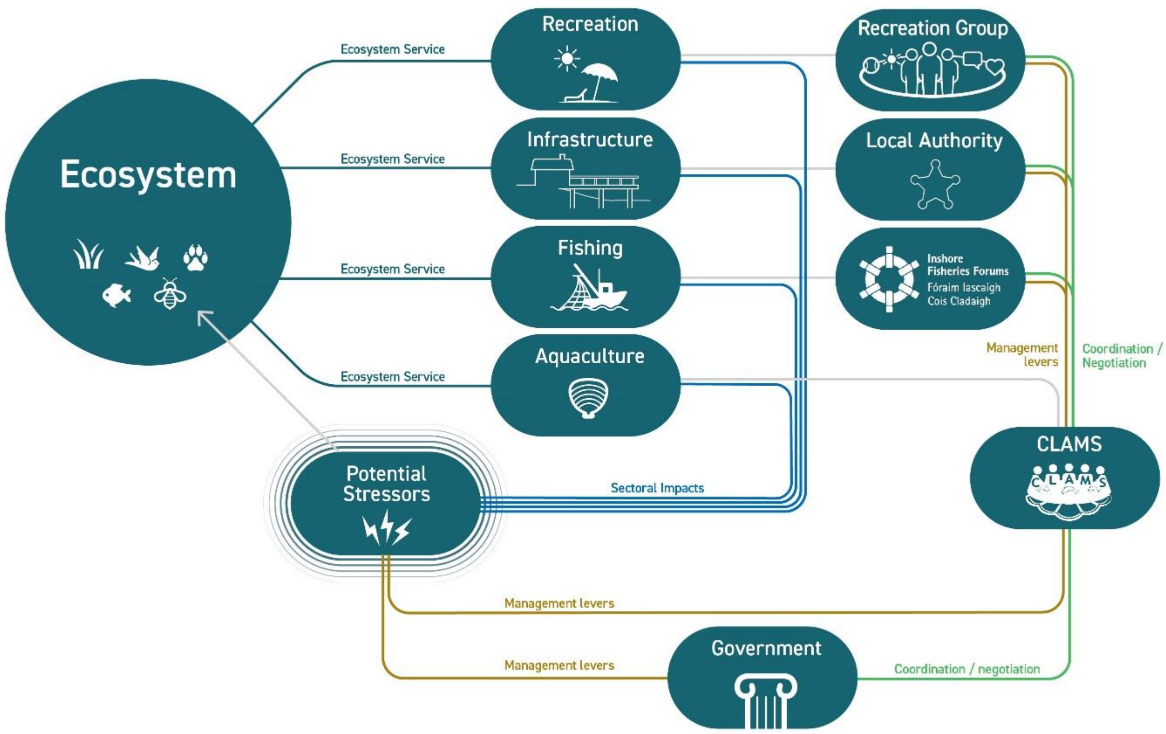
Weak sustainability assumes that natural capital and manufactured capital are essentially substitutable and considers that there are no essential differences between the kinds of well-being they generate (Ekins et al., 2003; Neumayer, 2003; Neumayer, 2012). The only thing that matters is the total value of the aggregate stock of capital, which should be at least maintained or ideally increased for the sake of future generations (Solow, 1993).

Authors writing on strong sustainability demonstrate that natural capital cannot be viewed as a mere stock of resources. Rather natural capital is a set of complex systems consisting of evolving biotic and abiotic elements that interact in ways that determine the ecosystem's capacity to provide human society directly and/or indirectly with a wide array of functions and services (Noël and O'Connor, 1998; Ekins et al., 2003; De Groot et al., 2003; Brand, 2009). The proponents of strong sustainability invoke several reasons to demonstrate the non-substitutability of natural capital.

Understanding the contribution of different investments and activities to sustainability objectives is important in assessing environmental importance. The linkages between management and elements of the accounting framework are shown in Figure 6. The example shows the ecosystem (or many ecosystems), which are a particular size, type and condition, that provide a suite of services to different sectors. For example, ecosystems supply recreational services, which can be harnessed by tourism operators, and ecosystems also provide biomass, which can be harvested by the seafood sector. These sectors combine natural, human, and produced capital to create value. However, through their production process, each of these different sectors may have a negative impact on the ecosystem. For example, an aquaculture operator using a tractor to access intertidal sites may disturb birds and cause compaction of sedimentary habitats.

Typically, the government would regulate/manage/mitigate the negative pressures through assessment and the establishment of licence conditions. The initiation of the CLAMS group enables the Aquaculture sector to work together to further manage their pressures, and also develop activities that generate positive outcomes and improve the environmental performance of the sector. This in turn, provides a basis to coordinate and negotiate with statutory authorities, and other sectors to ensure their interests are protected, within reasonable grounds.

Figure 6 CLAMS Joint management of oceans and the benefits they provide



3.3.3 NC-DIP Step #3: Tailoring an accounting system

An accounting system provides a structured way of collecting and organising information that can be used across multiple applications (like those described in section 2.2).

Before collecting and transforming data, it is valuable to develop the architecture that needs to be populated to deliver on the applications. The natural capital conceptual diagram (see Figure 3) provides the foundation for designing the system, and there are other data and accounts that can be added. Figure 7 provides a framework for linking applications to the accounts, and determining the focus of data collection and transformation.

In this project, we tailored the accounting system to understand the relationship between the seafood sector and the marine environment. This included specifying the services provided by the marine environment to the seafood sector. There were some common threads across the priority applications including:

- An understanding of the benefits provided by particular ecosystem assets within Clew Bay, acknowledging that those benefits depend on a healthy and thriving marine environment
- An understanding of whether the use of the asset that supplies those benefits is sustainable; that is its condition is not being damaged as a result of its use
- The subsequent identification of pressures on the condition of ocean ecosystems
- An understanding of the impact of management actions on ocean ecosystems and the benefits they provide.

Figure 7 Linking Clew Bay policy drivers to natural capital accounting

	Ecosystem Accounts				Other Natural Capital Accounts					Other Data				
Potential Priority Issues & Applications	**Ecosystem extent**	**Ecosystem condition**	**Ecosystem services (physical & monetary)**	**Ecosystem asset values ($)**	**Carbon**	**Water**	**Biodiversity**	**Land use**	**Fish stocks**	**Energy accounts**	**Environmental management costs & inputs**	**Production, Revenue & Costs**	**Employ-ment**	**Networks of organisation s**
Marine Spatial Planning	✓✓✓	✓✓✓	✓✓✓		✓	✓	✓	✓	✓✓		✓✓✓	✓	✓	
Improving sustainability performance & communicating the results	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	✓✓✓	✓✓✓		✓✓	✓	✓✓✓	✓	✓	
SDG reporting	✓✓	✓✓	✓	✓	✓✓✓	✓✓✓	✓✓	✓	✓	✓	✓✓			
Assessing the sustainability of the seafood sector in terms of multiple capitals	✓✓✓	✓	✓	✓✓✓	✓	✓✓✓		✓	✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓

Priority 1: Marine Spatial Planning

Table 5 presents the comprehensive set of accounting information that is needed for marine spatial planning.

Table 5 Information for marine spatial planning

Accounting information	Links to MSP
Ecosystem extent	Each MSP stakeholder will have links to specific geographies across the marine environment. Creating a common understanding of those areas and identifying the dependencies that overlap across stakeholders is important to finding common solutions. Understanding how the extent of ecosystems is changing over time will help the MSP process to focus on ecosystem types that are at risk and the dependencies at risk.
Ecosystem condition	By measuring condition, the activities (for example, the use and management of ecosystems) that are being undertaken by MSP stakeholders can be linked to the health of the environment.
Ecosystem services (physical and monetary)	Each MSP stakeholder will depend on a set of ecosystem services. The ecosystem services need to be described in both physical and monetary terms. This information can help frame the relative importance of the services and thus the ecosystems providing them.
Benefits	Who are the beneficiaries (stakeholders) of the ecosystem services and what are the benefits they are receiving? What are the relative size of those benefits?
Activities and Investment	All activities and investments need to be analysed to understand how they are impacting on ecosystem extent and condition
Pressures	MSP stakeholder activities that result in pressures on extent and condition. This builds on an understanding of the ecosystem services but importantly links back to the activities being undertaken to influence the extent and condition of the ecosystems.

Priority 2: Improving and communicating sustainability performance

Table 6 presents the comprehensive set of accounting information that is needed for improving and communicating sustainability performance for the seafood sector.

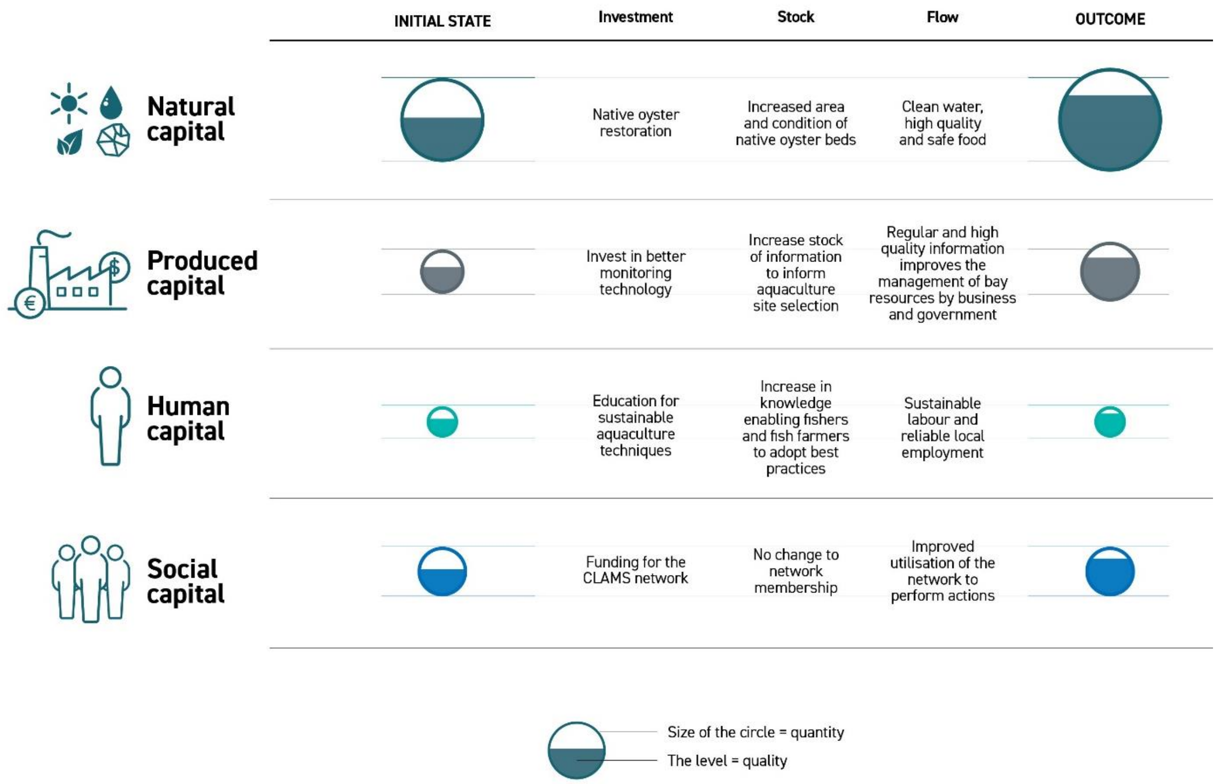
Table 6 Improving and communicating sustainability performance

Accounting information	Links to sustainability performance
Ecosystem extent	Document the extent of the ecosystems that are important for native oyster production
Ecosystem condition	List the condition variables that driver or influence the ability of the native oyster to reproduce, for example, chemical properties of the water.
Ecosystem services	Record the biomass provisioning service to understand how many oysters are being harvested
Fish stocks	Record the stock of native oysters to understand the annual growth of oysters in the system and then link this to the number of oysters that are harvested each year to determine if they are being harvested sustainably. Record the quality of oyster stocks to support the sustainability assessment, for example, recording the age, reproductive ability and genetic diversity of oyster stocks.
Benefits	Who are the beneficiaries of the native oysters that are being harvested and what are the benefits they are receiving?
Activities and Investment	All activities (for example, harvesting activities), and investments (restoration of native oyster reefs) need to be analysed to understand how they are impacting on ecosystem extent and condition
Pressures	Activities that reduce on the stock of oysters, for example harvesting of fish from the system

Priority 3: Reporting on SDGs
Table 4 in section 3.3.2 presents information on the accounts that can support reporting on SDGs.

Priority 4: Assessing the sustainability of the seafood sector in terms of natural, produced, human and social capital
Investment in each type of capital is associated with changes to the stocks (quantity and quality) of the capital and changes in services delivered through the value chain. Figure 8 illustrates how multi-capital accounting captures the interactions between stocks and flows associated with an investment. In this case we have illustrated how native oyster restoration, monitoring sites, education about sustainable aquaculture techniques, and funding for the clams network can impact on the stocks and flows of all types of capital.

Figure 8 Linking investments in the aquaculture sector to changes in stock and flow

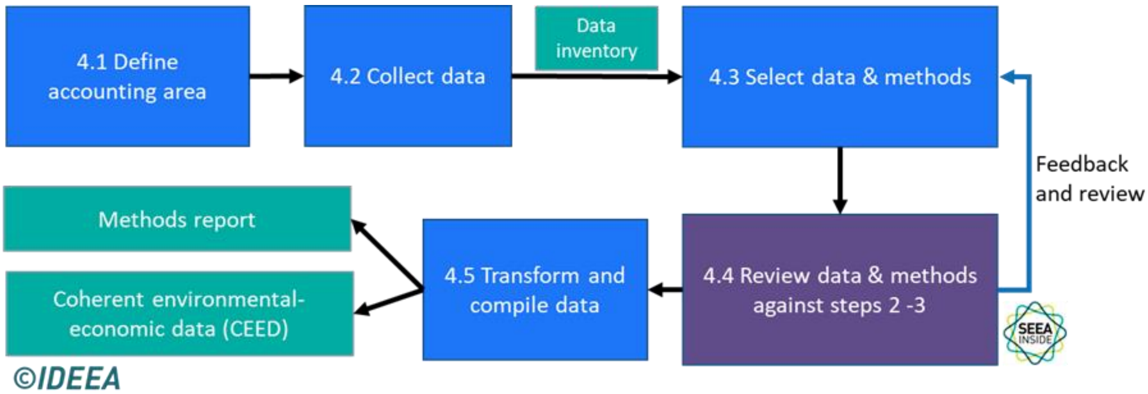


3.3.4 NC-DIP Step #4: Transform and compile

Natural capital accounting details a set of concepts and principles for data collection, transformation, and organisation to support transparent and integrated decision-making. The concepts and principles involve consistent framing, classifications, transformation methods, and data collection methods. This project applied the concepts and principles contained in the United Nations System of Environmental-Economic Accounting (SEEA), specifically the Ecosystem Accounting framework.

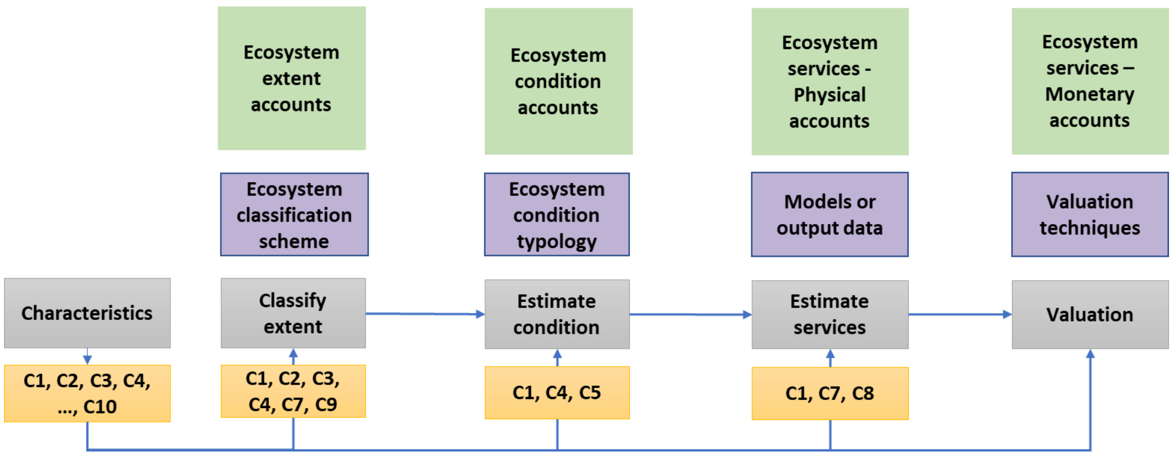
Step 4 of NC-DIP includes the compilation and assessment of both data and methods to populate the chart of accounts. Step 4 has five sub-steps (see Figure 9) and the outputs include a data inventory, coherent environmental-economic data, and details of the methods used.

Figure 9: Details of NC-DIP Step #4



The natural capital framing in Figure 3 is fundamental to the orgainsation of information for decision making. Coherence across the four elements of the ecosystem accounting framework is central to establishing a link between environmental and economic information. Coherence requires that where a particular characteristic is relevant in the measurement of different components of the accounting framework, the same data and methods are used for that characteristic throughout the accounting system (see Figure 10). For example, canopy cover will be a relevant characteristic in measuring and classifying ecosystem extent, ecosystem condition and in modelling some ecosystem services. In this case, canopy cover is used consistently in each component of the accounting framework for a given accounting area.

Figure 10 Coherence across the core ecosystem accounting framework



3.3.5 NC-DIP Step #5: Apply and interpret results

Step 5, apply and interpret results, involves using the CEED to apply the approach and methods described in Step 2 to provide insights concerning the priorities identified in Step 1. Thus, through Step 5 there will be a series of outputs that will be used to support the priorities for action from Step 1. By connecting back to step 1 the process can be refined and the priorities for action can be updated. It may be that further work is required or a set of recommendations can be developed for future iterations of the process. However, the NC information infrastructure is now in place so the process can be completed faster and at low cost.

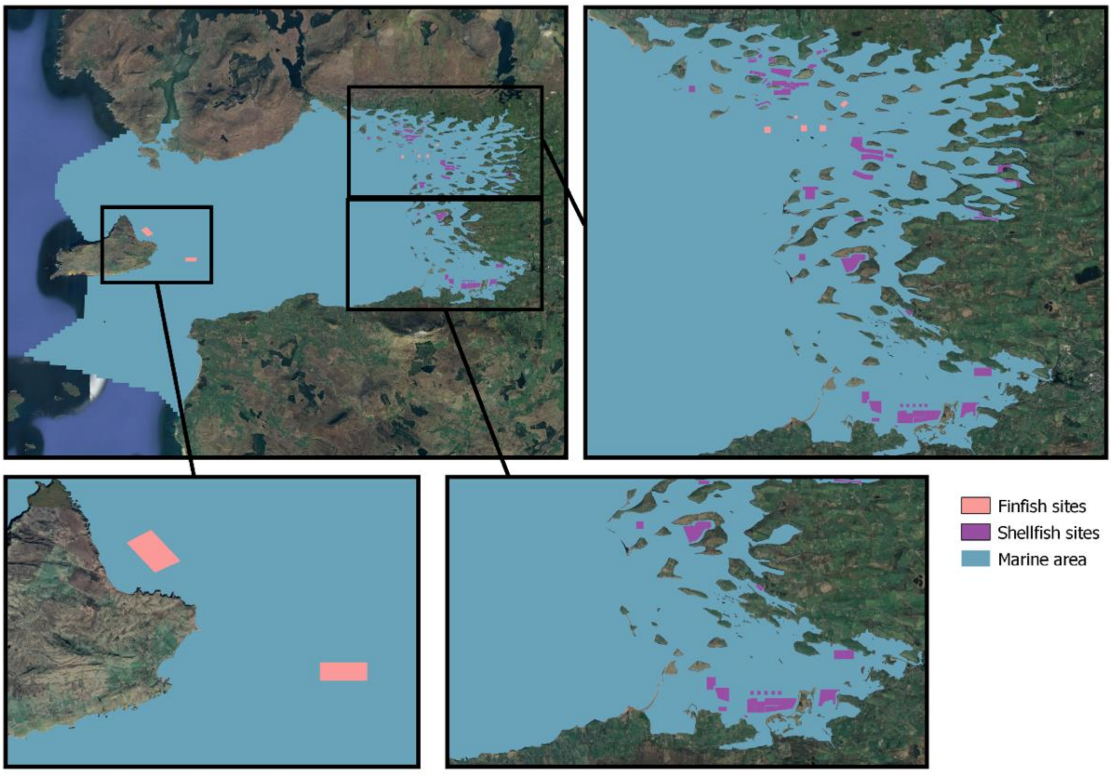
4 Findings from the study

This section presents a number of quantitative results that were produced as part of this project. More detailed results can be found in the accounting report.

4.1 Seafood sector

Figure 11 shows the aquaculture sites (finfish and shellfish) in Clew Bay. Currently, there are 58 aquaculture licences within Clew Bay. There are 41 farmed oyster sites (*Magallana gigas*), 5 farmed salmon sites, 4 rope mussel sites, 5 multi specie sites and 1 abalone site. There are 2 salmon farming sites at Clare Island. In Inner Clew Bay there are 2 Native Oyster Fishery Orders – the main one being the Clew Bay Oyster Fishery Order 1979 and a small Order at Cullenmore. The area of the aquaculture sites range from 0.5 hectares to 25.5 hectares and 60 per cent of the sites are between 0 and 4 hectares.

Figure 11 Licensed Aquaculture sites



Source: Mul_003

4.2 Ecosystem extent

Ecosystem extent accounts present measures of the area of different ecosystem types within the accounting area. Detailed mapping has been completed for the Special Area of Conservation (SAC) within Clew Bay. Each distinct area of a single ecosystem type – for example a single seagrass meadow, is treated as an ecosystem asset. For Clew Bay, the dominant habitat type in the area covered by the SAC is the sandy mud with polychaetes and bivalves community complex (see Table 7). Laminaria dominated community, reef intertidal and intertidal sandy mud are other dominant types within the area. The spatial distribution of the habitat types are shown in Figure 12.

Table 7: Marine community extent in SAC in Clew Bay

Marine community	Area (ha)	% of total
Fine sand dominated by Nephtys cirrosa community	297	0.77%
Intertidal sandy mud	791	2.04%
Laminaria dominated community	1,634	4.21%
Maerl dominated community	287	0.74%
Reef Fauna	215	0.55%
Reef Intertidal	832	2.14%
Sandy mud with polychaetes and bivalves community complex	5,788	14.92%
Shingle	145	0.37%
Zostera community	142	0.37%
Not covered by SAC	28,655	73.88%
Total	38,786	100.00%

Note: Intertidal sandy mud with Tubificoides benedii and Pygospio elegans complex community has been shortened to intertidal sandy mud.

Figure 12 Marine community types

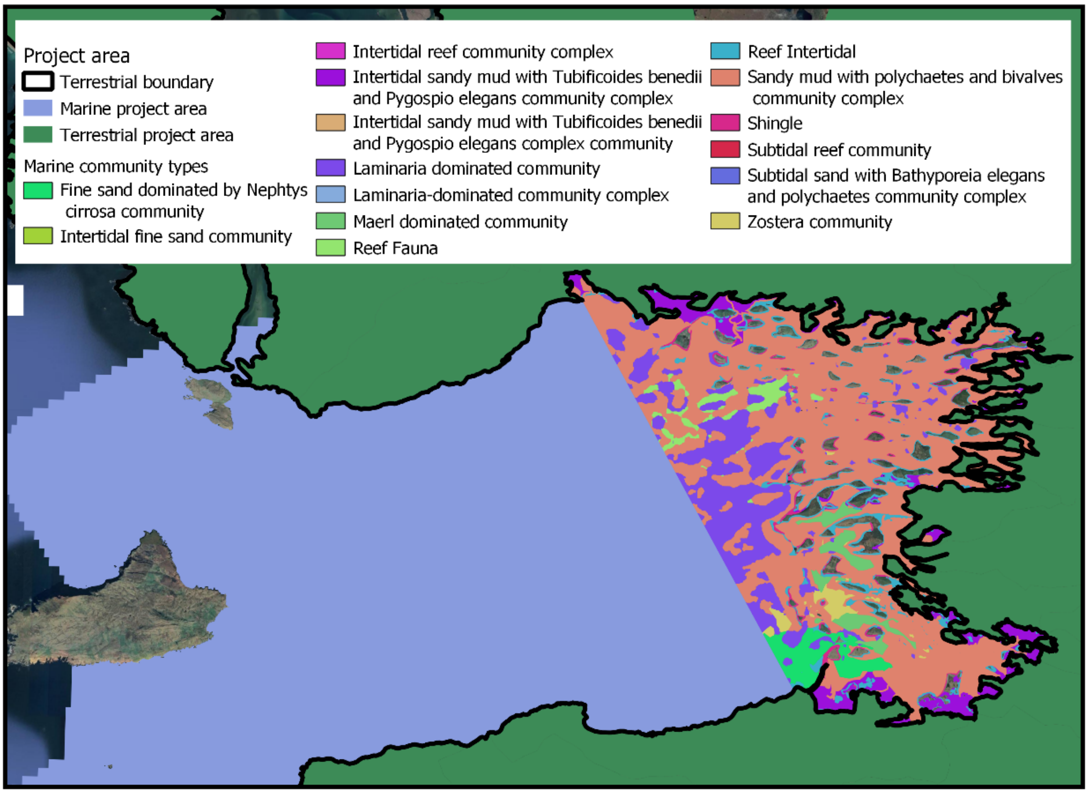


Table 8 provides a table which shows the area of overlap between aquaculture operations and different marine communities. A large proportion of the aquaculture sites overlap with sandy mud with polychaetes and bivalves community complex. That might speak effectively to questions of capacity / suitability for aquaculture.

Table 8 Overlap of aquaculture sites and marine community

Marine community	Aquaculture			
	Finfish	Shellfish	Non-aquaculture	Total
Fine sand dominated by Nephtys cirrosa community		7	290	297
Intertidal sandy mud		13	779	792
Laminaria dominated community	1		1,634	1,635
Maerl dominated community		9	278	287
Other		3	134,405	134,407
Reef Fauna	5		210	215
Reef Intertidal		7	829	836
Sandy mud with polychaetes and bivalves community complex	11	239	5,538	5,788
Shingle			148	148
Subtidal reef community			0	0
Zostera community			142	142
Grand Total	16	278	144,252	144,546

Note: Marine communities are from Clew Bay Special area of conservation
Source: OA_010 and Mul_003

Ideally, information on the extent of different ecosystems will cover two time periods and can be organised into an asset account (see Table 9 for an example). Investment in the consistent collection of data on ecosystem type and extent across time periods and also for the entire project area is required to populate the asset account.

Table 9 Asset account example

Extent	Ecosystem type A	Ecosystem type B	Total (ha)
Opening extent	100	200	300
Additions to extent			
Managed expansion	1	23	24
Unmanaged expansion	3	5	8
Unclassified expansion	–	–	–
Total additions	4	28	32
Reductions in extent			
Managed reduction	1	4	3
Unmanaged reduction	41	6	9
Unclassified reduction	–	–	–
Total reductions	42	10	12
Net change in extent	-38	18	20
Closing extent	62	218	320

Note: This is a stylised example based on Table 4.1 in the SEEA EA framework (UNCEEA 2021). '–' = 0

4.3 Ecosystem condition

Ecosystem condition accounts present data on the ecosystem integrity (including their composition, structure, and function) of the different ecosystem assets within the accounting area. Data was not in a format which could be organised into an ecosystem condition account but there have been condition assessments completed.

Between 2016 and 2018, approximately one third of large shallow inlets and bays within SACs around the coast of Ireland were surveyed to assess their structure and function. The site-based conservation assessment was unfavourable-to-bad at eight sites, amounting to 52 per cent of the area surveyed. Clew Bay was assessed as unfavourable to bad.[2] The principal reason for the failure of the habitat to meet Favourable Conservation Status was the loss of eelgrass beds (Zostera marina in particular). This ranged from a gross negative change in abundance to a total loss of an area of eelgrass.

4.4 Ecosystem services

Ecosystem services are measures of the contributions or inputs that ecosystems make to people and their well-being. In a marine context, this includes (i) provisioning services such as the ecosystem inputs to the seafood sector in terms of fish catch; (ii) regulating and maintenance services such as the contribution of ecosystems to water purification and carbon sequestration; and (iii) cultural services such as the role of the ecosystems in providing amenable and high-quality locations for recreation.

For Clew Bay, the ecosystem services (described following the SEEA Ecosystem Accounting ecosystem services reference list) supplied to different users is presented in Table 10. The provisioning services identified include aquaculture provisioning services, and wild fish and other natural aquatic biomass provisioning services. Both of these services are provided to both household and industry. Regulating and maintenance services include global climate regulating services, water purification services, nursery population and habitat maintenance services, and flood control services. Cultural services include recreation related services, visual amenity services, education, scientific and research services, and spiritual, artistic and symbolic services. No systematic link between the users and the ecosystem type is made in this table, but it is true that each ecosystem service is provided by an ecosystem type, to a user.

[2] Kenmare River SAC, Valentia Harbour/Portmagee Channel SAC, Mulroy Bay SAC, Clew Bay Complex SAC, Broadhaven Bay SAC, Mullet/Blacksod Bay Complex SAC, Kingstown Bay SAC and Roaringwater Bay SAC were all assessed as unfavourable to bad.

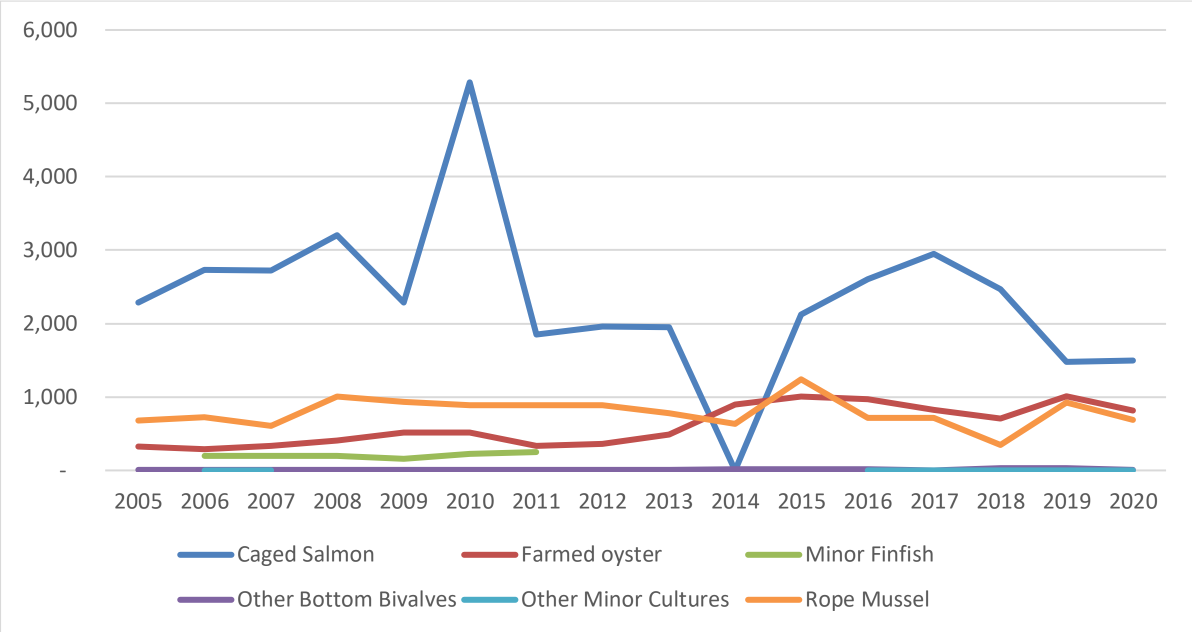
Table 10 Ecosystem services supplied by Clew Bay to different economic actors

Ecosystem Service	Household	Industry	Government
Provisioning services			
Aquaculture provisioning services	Yes	Yes	No
Wild fish and other natural aquatic biomass provisioning services	Yes	Yes	No
Regulating and maintenance services			
Global climate regulation services	No*	No*	Yes
Water purification services	No	Yes	No
Nursery population and habitat maintenance services	Yes (intermediate)	Yes (intermediate)	No*
Flood control services	Yes	Yes	No
Cultural services			
Recreation related services	Yes	No	No
Visual amenity services	Yes	No	No
Education, scientific and research services	Yes	Yes	Yes
Spiritual, artistic and symbolic services	Yes	No	No
Flows related to non-use values			
Ecosystem and species appreciation	Yes	No	No

Note: Ecosystem services are from the first column of table 6.3 in the SEEA EA. The second column of table 6.3 further breaks down ecosystem services where possible. For example, water purification services are composed of both retention and breakdown of nutrients, and retention and breakdown of other pollutants. Flood control services include coastal protection services and river flood mitigation services. *This table serves as an example and focusses on the use of accounting conventions under the UN SEEA. Other interpretations may suggest that all economic actors benefit from all ecosystem services, for example, that household and industry benefit from global climate regulation services.

In this project, data on ecosystem services was only available for aquaculture provisioning services and global climate regulation services. Figure 13 show trends in aquaculture tonnage since 2005. Salmon tonnage and value has exhibited the most variation between years, while farmed oysters has shown an increasing trend in production and value since 2005.

Figure 13 Tonnage harvested by aquaculture type, 2005 to 2020



Source: Mul_004

Some of the ecosystems in Clew Bay provide global climate regulation services through carbon sequestration by soil and biomass. This service can be quantified in terms of the tonnes of carbon sequestered per year. Following the SEEA Ecosystem Accounting, the user of global climate regulation services is the national government, who are treated as using the service on behalf of the Irish and global communities who benefit from the reduced impacts of climate change.

Using the area of the marine communities in the SAC that partially cover Clew Bay, a lower bound estimate of carbon sequestered in Clew Bay is 1,972 tonnes per year (see Table 11). The Maerl dominated community has the highest sequestration rate per hectare, followed by the Zostera community, and the Laminaria dominated community. The estimates can be improved with local carbon sampling and further delineation of ecosystem types within Clew Bay.

Table 11 Carbon sequestered by habitat type

Marine community	Area (ha)	Carbon sequestered (Tonnes per ha per year)	Total carbon sequestered (Tonnes per year)
Fine sand dominated by Nephtys cirrosa community	297	-	-
Intertidal sandy mud	791	-	-
Laminaria dominated community	1,634	0.49	801
Maerl dominated community	287	3.4	976
Reef Fauna	215	-	-
Reef Intertidal	832	-	-
Sandy mud with polychaetes and bivalves community complex	5,788	-	-
Shingle	145	-	-
Zostera community	142	1.38	196
Not covered by SAC	28,655	-	-
Total	38,786	-	1,972

Note: see table 18 of the accounting report for figures used

Supply and use tables (see Table 12 for an example) provide an understanding of dependencies for different economic units. Ideally, the supply and use table would have full coverage of the list of ecosystem services provided in Table 10, with each service being supplied by an ecosystem and used by an economic unit. Further research and data collection is needed to populate a comprehensive supply and use table.

Table 12 Supply and use accounts example

Ecosystem service	Units	Industry	Household	Government	Tidal Mudflats and Sandflats	Large Shallow Inlets and Bays	Atlantic Salt Meadows
Supply							
Aquaculture provisioning services	kg	No value	No value	No value	3,000	12,000	–
Carbon sequestration	Tn	No value	No value	No value	2,000	7,000	6,000
Use							
Aquaculture provisioning services	kg	12,000	3,000	–	No value	No value	No value
Carbon sequestration	Tn	–	–	15,000	No value	No value	No value

4.5 Multiple capitals – Coordinated Local Aquaculture Management System (CLAMS) Group

Improvements in natural capital in Clew Bay can be achieved by making investments in produced capital, human capital, and social capital. A combination of investments across the capitals is typically needed to ensure sustainable economic growth.

Social capital is a network (or group) of individuals, entities or other units that share similar norms, values and understandings that facilitate cooperation within or among groups (OECD, 2001, p 41.). The pervasiveness of social capital means that its creation and continued management can provide benefits for all members of society, including the private sector, the public sector, and the broader public.

The Coordinated Local Aquaculture Management System (CLAMS) program, established by the Irish Government in 1998, encouraged the formation of social capital among aquaculture operators, such as fish and shellfish farmers. CLAMS is a nationwide initiative to manage the development of aquaculture in bays and inshore waters throughout Ireland at a local level.

The aim of the program is to support the *sustainable* development of aquaculture by facilitating a coordinated approach to management by:

- Establishing a local CLAMS group – a local CLAMS group is a self-governing network of operators with shared norms, values and understandings. There are a number of these groups spread throughout Ireland with similar or the same set of shared norms, values and understandings
- Supporting the groups to develop management activities by providing seed funding and secretariat support. For example, the Clew Bay CLAMS Group has agreed to a number of operating protocols for the area, which are incorporated into working routines, practices and policies. These cover hygiene, biosecurity, waste management, and ensuring sites, shore bases and access points are maintained in a clean, tidy and environmentally sound order.

The CLAMS program has been widely adopted by fish and shellfish farmers in Irish bays and inshore waters as a proactive step to encourage public consultation on their current operations and future plans. The management approach is a locally based all-embracing system designed to maximise production and environmental management through the integration of production goals with minimal conflict with other resource users.

An individual management plan is drawn up for each CLAMS bay or area, which clearly lays out what fish and shellfish farmers are currently doing in the bay, how they operate and what their future plans are. In each case, the plan aims to fully integrate aquaculture interests with relevant national policies. There are a range of projects determined and prioritised by the CLAMS members and which vary in type and intensity depending on local needs and groups preferences including:

- Navigation Plans
- Deployment of navigation markers
- Re-alignment and rationalisation of mussel lines

- Oyster trestle recycling
- Improvement of mussel training areas
- Beach and pier clean-ups
- Water quality monitoring

Assessing the benefits of CLAMS as a form of social capital requires an understanding of the services that are being provided by the groups both individually and collectively at national level.

The seafood sector depends on social capital to reduce **transaction costs** when performing activities that contribute to the sustainable development and management of aquaculture. Examples of such activities include day-to-day business activities; sharing knowledge and innovation, creating knowledge and innovations; and cooperation and coordination.

Where social capital does not exist, transaction costs may be higher than the benefit that is attainable from cooperating, bargaining or negotiating with other parties. Transaction costs, which consist of search and information costs, bargaining and decisions costs, and policing and enforcement costs, exist due to a lack of information. The role of social capital for the seafood sector is therefore to facilitate information sharing within the network and between different networks.

Trust, as a characteristic of social capital, is the foundation of most relationships, and can help to minimise the emotional and monetary costs of doing business and delivering on shared goals. For example, in a workplace, trust can improve information flows between staff, reduce the need for employers to monitor their employees, and facilitate the introduction of more flexible work arrangements that improve productivity. High levels of trust between members can lessen the need for detailed contracts to cover all possible interpretations and contingencies, and for monitoring of the other members to ensure their compliance.

Table 13 provides examples of how an investment in social capital can be linked to impacts across natural, human and produced capital. It is beyond the scope of this project to comprehensively examine the relationship between investments in social capital and the impacts on other capitals quantitatively, but the framing provides guidance for future data collection by both CLAMS and those that use social networking services of CLAMS. Further detail on impacts is provided below.

Table 13 Multiple capital approach to assessing social capital (CLAMS) in Clew Bay

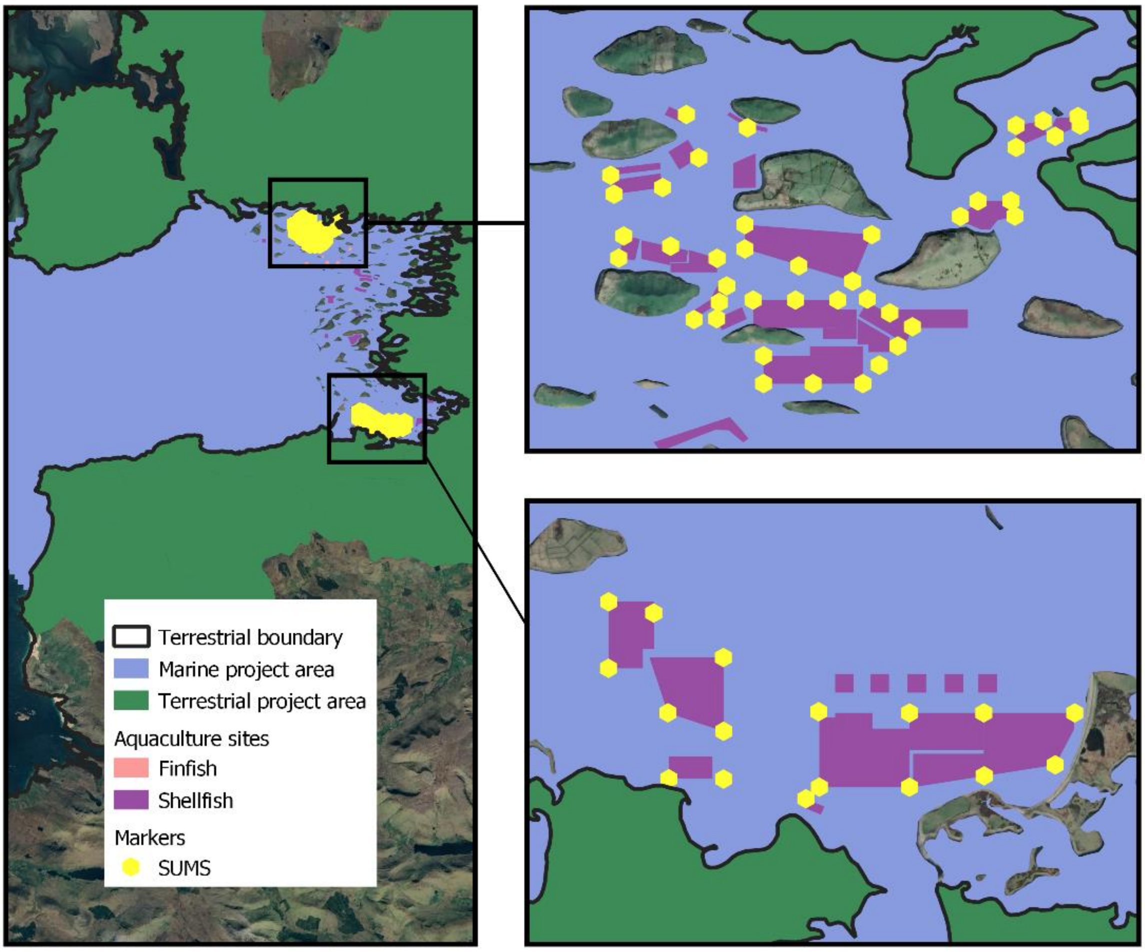
Types of investment in SC	Benefits			
	SOCIAL CAPITAL	NATURAL CAPITAL	HUMAN CAPITAL	PRODUCED & BUILT CAPITAL
Government seed funding to establish CLAMS and support the secretariate	CLAMS as a group of people can provide networking services	Knowledge is efficiently transferred between human capital, benefiting natural capital	Human capital gains knowledge via networking faster and more efficiently	Produced capital is better utilised via shared knowhow between human capital
Time contributed by each of the members Time and resources contributed by supporting agencies including BIM and Marine Institute officers	BIM have access to knowledge and information that they put into the group Shared approach lowers the cost of water quality coordination and installation	Share knowledge about natural capital What activities are being undertaken to manage the NC better? Sustainable seafood harvest due to improved information flows? Water quality improvements that contribute to maintaining healthy NC	Training and building a shared knowledge base of key issues Joint monitoring of invasive alien species (awareness) Human capital more knowledgeable and can act more responsibly contributing to positive NC condition	Engagement with COCO on condition of piers and other access points Lower cost investment in produced capital – environmental monitoring / data loggers.

An example of a CLAMS initiative within Clew Bay is explored to demonstrate the benefits of the social capital. As part of the CLAMS process BIM's regionally based Development Officers co-ordinate and manage a range of projects including the installation and maintenance of Special Unified Marking Schemes (SUMS).

SUMS provide improved navigation and safety for all users of the marine environment in areas where aquaculture coexists with other users. The SUMS marking schemes uses fewer, higher quality marks with a long lifespan, achieving efficiencies for the producers. BIM and the Commissioners for Irish Lights (CIL) ensure that marks are included in the UK Hydrographic Office's Admiralty Charts which informs visiting vessels of the perimeter of the production areas.

This is an exploratory demonstration of the monetary benefit of participating in the SUMS initiative vs individual site marking by the different aquaculture operators in the bay. It focuses only on Clew Bay North where there are a large number of oyster aquaculture licences spatially distributed in a clustered pattern. Figure 14 shows the location of sums markers and aquaculture sites.

Figure 14 SUMS locations



Source OA_102

There are 20 licenced sites in Clew Bay North which comprise of various polygons. Working through the CLAMS group, the SUMS initiative has procured, installed and maintains 41 marks in this area. 8 of these marks are lighted, 3 are cardinal south and 30 are standard.

A cost breakdown (excluding labour) has been extrapolated from a similar exercise completed by the CLAMS group in Dungarvan, Co Waterford (see Table 14). Costs for co-ordinated time and efforts for installation and maintenance are not included. Pole replacement is required after 5 years. All other marker components have an 8-to-20-year lifespan.

Table 14 SUMS initiative costings

Cost per lighted pole per year	Number of poles	Total cost per year
162.23	8	€1,297.84
52.25	33	€1,724.25
		€3,022.09

Source

By contrast, a cost breakdown in a scenario where individual licence holders work alone to meet their licence requirements for site marking has also been developed. Prior to the SUMS initiative this would have been the typical approach. Note: There is no value in investigating what was officially marked previously as sites have changed, there are additional sites and marking requirements have also changed.

The following scenario applies the old marking regime to the current licences in Clew Bay North. At a crude level where each site was to be marked individually at four points, that would equate to 80 marks. Marking all site corners (some sites are 5+ sided polygons) this equates to roughly 92 marks). Installation and maintenance is carried out individually and at the operators own expense and time. These costs are based on the typical marks that were used across Ireland prior to the development of the SUMS initiative. It is important to note that the labour and time requirement for installation and maintenance would be much higher in this scenario due to an average marker lifespan of 2 years. In addition, one of these marks would have lights.

Table 15 Old Type Mark costings

Cost per lighted pole per year	Number of poles per year	Total cost per year
80	37.50	3,000
92	37.50	3,450

Source

Based on the figures in Table 15, while the financial saving is limited to nil (depending on the scenario, SUMS may even cost more), it must be noted that labour costs are not included. Working individually, the old type marks require replacement every two years compared to the 15–20-year lifespan of the SUMS marks. If a monetary value were to be placed on the equivalent labour costs in each scenario it can be inferred that the monetary savings of the SUMS marker would be significantly higher.

There are a number of benefits beyond the monetary savings on capital costs:

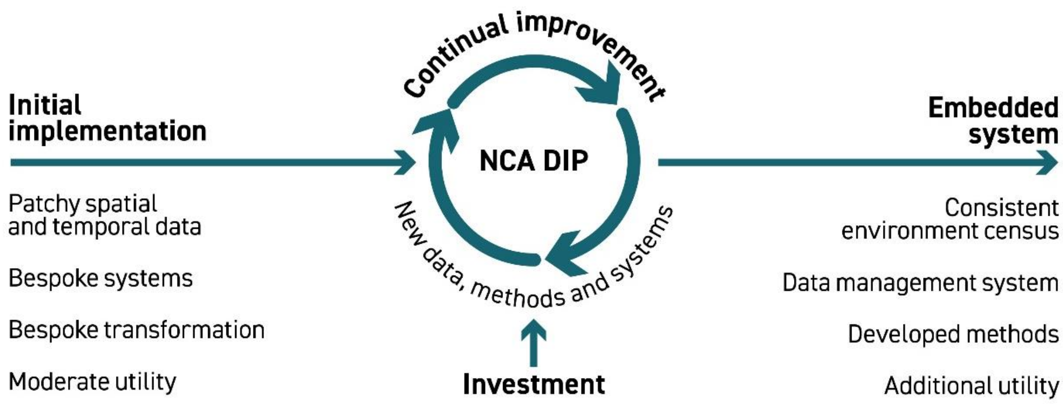
- As mentioned above a major factor is the time required for maintenance. 92/80 poles painted annually is a lot of time with associated labour costs compared with the lower maintenance schedule required by the 41 modern beacons. Annual maintenance is no longer required, saving time and business costs further.
- The initial cost is higher but the materials are more durable and overall fewer materials are used. This means less waste and a lower risk ending up in the marine environment (lost to storms etc)
- The lights are a major safety feature used by aquaculture operators (for example a sudden fog on a rising tide) and other marine users for safe return to shore in poor weather or fading light.
- The collaborative aspect of the project means that deployment is centralised and maintenance schedules are also centralised meaning that a reminder can be provided to the responsible operators whenever work needs done

5 Lessons learned and future requirements

Natural capital accounting is a data driven process that provides quantitative evidence for decision makers. The implementation of natural capital accounting within business and government is in its infancy compared to the implementation of financial accounting and national economic accounting (e.g. the measurement of gross domestic product). As such, there is still a lot of capacity to be developed, systems to be organised, and technological advancements to be implemented (for example, the use of higher resolution satellite imagery). Further, a pragmatic approach is required to continue to extend the transition towards integrated multiple capitals accounting that incorporates produced, human and social capital in addition to natural capital.

This project was the first attempt at natural capital accounting for ocean areas in Ireland and only existing data was used. First attempts at natural capital accounting are generally similar in that data is patchy, methods are exploratory, and there are no systems in place. This section discusses the lessons learned in relation to each section of the NC DIP. The overall conclusion is that investment is needed to gradually transition towards an embedded system of accounting. In this context the NC DIP can be used as a process to gradually improve the system while ensuring fit for purpose information, with priority adjustments made after each iteration of the DIP (see Figure 15).

Figure 15 Transitioning to an embedded system



5.1 NC-DIP Step #1: Scope potential policy, decision and reporting uses

Judging the utility of ocean accounting ultimately depends on how the information is used in decision-making. There are various types of decisions that ocean accounting can underpin:

- Planning and strategy (setting outcomes within and across sectors)
- Regulatory decisions (licensing/setting conditions for activities)
- Operational and management decisions

- Investment decisions

From the supply of information side, there are many opportunities for information that can be envisaged to support any of the decision contexts just listed. However, for this information to be useful it is necessary to identify the specific policy, decision and reporting contexts that require and demand information and how that information will be used in those contexts. An approach that marries the supply of information with the demand for information will see the transition towards an embedded system occur more quickly. In this endeavour, a considerable amount of work is needed to engage with the different agencies and businesses to prioritise particular decisions. Gathering buy-in can support projects and provide an avenue for investment in data and systems and including users in the design phase can contribute to more useful accounts.

Each decision maker will have different information requirements in terms of accuracy, and there will also be budget constraints which affect the quality of the information that can be supplied. These considerations are important when thinking about the information required to deliver on the different uses.

5.2 NC-DIP Step #2: Select approach and method

There are likely to be very specific information needs of different approaches and methods. For example, to calculate the return on investment for multiple services across different spatial areas, information needs to be organised so that all ecosystem services can be stacked spatially, and investments need to be spatially allocated across the seascape. For estimating restoration scenarios, there may be a requirement to estimate the future supply of ecosystem services, potentially using restoration functions to do so.

Also, different approaches and methods may require different levels of accuracy. For example, information for a carbon market may need to be very accurate, and need to be presented according to the standards that have been defined or legislated for that particular market. It may be necessary for market participants to collect new data to ensure it is market appropriate. In contrast, for running scenario analyses, existing data may be appropriate.

It should be understood prior to developing the natural capital accounting system that the organisation of existing data in an accounting framework may not reveal many new insights for decision makers. This is likely due to missing data; the data being collected in a bespoke manner and data not being interoperable. Undertaking the accounting process can therefore inform future investment in data collection and improve the utility of both the data and any accounts produced. The data is an asset that needs to be maintained and improved through time to ensure it can continue to be relevant and provide support to decision makers and researchers and thus contribute most effectively to the design and implementation of truly sustainable management practices.

5.3 NC-DIP Step #3: Tailoring an accounting system

The process of tailoring an accounting system relies on a clear description of the potential policy, decision and reporting uses, and well understood approaches and methods for delivering the information in a particular way. It is useful to tailor the accounting system to some ideal level, with the aim of delivering on the method and approach, regardless of what data is available. The accounting system can be used to evaluate the data available and indicate where investment is required to complete the system for the particular method.

A tiered approach to determining the level of accuracy for each component of the accounting system can be used in future projects. The tiered approach builds on the understanding that each user and application of information will require different levels of accuracy, and each will have its own resource constraints. The tiered approach may consist of three tiers and will provide all users with an opportunity to produce information at a level of specificity that is tailored to their given circumstance.

5.4 NC-DIP Step #4: Transform and compile

In this project, we attempted to complete step 4 and link environmental-economic information to the priority applications described in section 2. Overall, this was difficult due to inconsistent and missing data with and across the different components of the accounting framework (extent, condition, services, and benefits). The process of transforming and compiling data did provide some useful insights.

The data collection phase supported the discovery of environmental and economic data related to Clew Bay. The data collection phase has:

- Identified existing information that can support a sustainability narrative with respect to the seafood sector
- Identified information gaps
- Informing priorities for ongoing monitoring in Irish waters
- Providing methods for producing an information set that can be tested and improved
- Provided an example of how information collected by different agencies can be fed into the accounts

During the project all existing data that was collected was organised into a data inventory. The inventory covers the topics of ocean asset, ocean condition, ocean services, benefits and environmental transactions (see Table 16). There were over 130 data sets which were recorded in the inventory. Over 50 per cent of the datasets collected were in the ocean asset category, with approximately 25 per cent in both the ocean condition and ocean services category. Not all of the data collected was relevant for this study, but the process of collecting and recording all data should reduce the cost associated with searching for data in future projects.

Table 16 Framework underpinning the data inventory

Ocean asset			Ocean condition		Ocean services		Benefits	Environmental Transactions
Physical	Relates to the physical extent of the area in terms of depth, area, coverage, and arrangement	Topography, geoid, bathymetry, geography, islands	**Abiotic ecosystem characteristics - physical state**	soil structure, water availability etc	**Ecosystem use**	Transportati on, anchoring	Time	Taxes
Ecosystem	Relates to the extent and composition of the ecosystem types	Seagrass, Rocky Reef, Mangrove and Saltmarshes.	**Abiotic ecosystem characteristics - physical state**	soil nutrient levels, water quality, air pollutant concentration etc	**Recreation**	Cultural, Tourism, recreational fishing, nature watching	Health benefits	Subsidies
Biotic assets (species)	Relates to living natural assets	Aquatic plants, algae, seaweeds, plankton, whales, dolphins, sea turtles, fish stock, other marine species	**Biotic ecosystem characteristics - compositional**	including species-based indicators etc	**Fisheries**	nursery, commercial, recreational, aquaculture, mussel seeds, etc	Economic value (production)	Environmental protection expenditure
Abiotic assets	Relates to nonliving natural assets	Minerals, oil/ petroleum/ gas, seafloor sediments and rocks	**Biotic ecosystem characteristics - Structural state characteristics**	vegetation, biomass, food chains etc	**Regulating services**	Carbon, coastal protection, air filtration	Economic value (non-market)	Restoration expenditure
Institutional extent	Relates to ownership of the assets and the rules governing their use such as institutional zoning (e.g. regulatory and planning areas)	Maritime boundaries, coastal communities, IUCN Zones, cultural heritage	**Biotic ecosystem characteristics - Functional state characteristics**	ecosystem processes, disturbance regimes etc	**Other commercial activities:**	Seaweed harvesting	Cost savings (damages, replacement cost etc.) Designated human activity	

Ocean asset			**Ocean condition**		**Ocean services**	**Benefits**	**Environmental Transactions**
Context	Relates to contextual information that makes up the broader socio-ecological system	Agricultural land, river connections, cities, towns	**Landscape/seascape characteristics**	landscape diversity etc			
Environmental stocks	Carbon, water		**Ecosystem type specific landscape characteristics**	forest connectivity/fragmentation etc		Employment	
			Drivers and pressures of change in condition	runoff, pollutants, residual, etc			

A key finding is that additional data is required, through data collection or improved modelling, if the information is to support local management decisions. For example, current data on the ecosystems within Clew Bay provide an understanding of the different ecosystem types, but there are gaps in coverage for all areas within the Bay and the information is very broad and out-of-date for some locations. Only the SAC has detailed information on the habitat types, with this information being compiled in a format and timeline necessary for EU reporting. However, before sourcing additional data that would address these and other information gaps, it is necessary for account compilers to understand how managers make local decisions to best support their decision-making processes and satisfy their data requirements. The intention was for this to occur during this project, however Covid-19 prevented engagement with the seafood sector in Clew Bay.

The challenges associated with data availability during this project are outlined in Table 17. A key finding is that there are large information gaps on the extent and condition of the ecosystems. The resolution of the data was mixed and ranged from fine resolution point data to coarse regional data. The data ranged in spatial and temporal coverage, was collected at different spatial scales, and was temporally very limited (i.e. for much data there was only 1 reference period). A key priority is consistent and standardised monitoring of the extent and condition of ocean assets. Additional research and data collection is required to enable the measurement of ecosystem services in a spatially explicit fashion. There is also a need to understand the responsiveness of services and benefits to changes in extent and condition (measures of ecological characteristics and water quality/chemistry) across different locations.

Table 17 Overview of data availability

Component	Strengths	Challenges
Ecosystem Extent	Estimates for 2012 and 2019.	Broad habitat types
		Finer detail habitat types for Clew Bay SAC in 2019 only.
Ecosystem Condition	Water quality information was available	Lack of information on structural biotic characteristics of the ecosystems, for example, seagrass density, and abiotic characteristics, for example substrate type
		Low spatial coverage of condition data
		Lack of context specific thresholds for water quality assessments
		Lack of information on reference condition
		No time series
		Not all data is publicly available or difficult to find E.g. Irish Wildlife Manual 118 describing the deterioration of 6 key marine habitats. However, baseline data wasn't readily available.
Services	Good information on fish biomass	Missing data for most services
		Some data, for example tourism, not attributable to Clew Bay
		Estimates of some services rely on extent data, which had low coverage

Data collection is variable across institutions, and accounts can provide a focal point for facilitating a constructive dialogue for coordination among these sectors. The accounting approach integrates expertise across a range of disciplines. Existing data collection processes could be adapted to enable the integration of different data sets, thus increasing the value and utility of future data collection. Developing standards on spatial data is also important to ensure integration can take place with minimum interpolation and/or extrapolation.

The project utilised Data4Nature to process data and compile environmental-economic information. Data4Nature is a software for compiling environmental and economic information, including natural capital accounts (see box 3). It has also been used in the project, "Ireland Natural Capital Accounting for Sustainable Environments" (INCASE) to produce ecosystem accounts (extent, condition, physical and monetary denominations of services) for four terrestrial ecosystem catchments.

Box 3: Data 4 Nature: A natural capital accounting system

Data4Nature is a complete and comprehensive solution to establishing (and managing) trusted information about your natural capital. Data4Nature simplifies the process of taking environmental data and turning it into desirable outputs, in a time efficient and effective way. Data4Nature takes the complexity out of data management and storage and centralises natural capital data through two secure and simple-to-use interfaces: D4N Web and D4N Analytics.

Data4Nature web allows you to store all your data securely in one place and link to third party apps and web-based data services to bring your data into the D4N system. The simplified standard for data collection and storage across business units and locations allows you to customise and tailor outputs to your needs; share outputs with users such as banks, and regulators; share access to information with relevant experts; secure your data with full back up and centralised storage; and put your valuable data into the marketplace.

Data4Nature analytics combines the latest high-resolution data, context specific models for ecosystem service modelling and valuation, and analytics, to produce information that is relevant and fit-for-purpose.

A range of biophysical / ecosystem services models are integrated into the D4N platform, with new models available based on specific contexts. Ecosystem service models include:

- Biomass provision services - Crops, grazing, wood, water supply
- Regulating and maintenance services – global climate regulation, rainfall pattern regulation (at national, sub-continent, farm)
- Local (micro and meso) climate regulation services
- Soil quality regulation services - soil erosion control
- Water purification services (water quality regulation) - retention and breakdown of nutrients
- Water flow regulation services - baseline flow maintenance and peak flow mitigation
- Flood control services - River flood mitigation
- Nursery population and habitat maintenance services

Data is everywhere. Having a system, enabling you to put the right data in the right place can support you to do NC-DIP step 4 more easily.

5.5 NC-DIP Step #5: Apply and interpret results

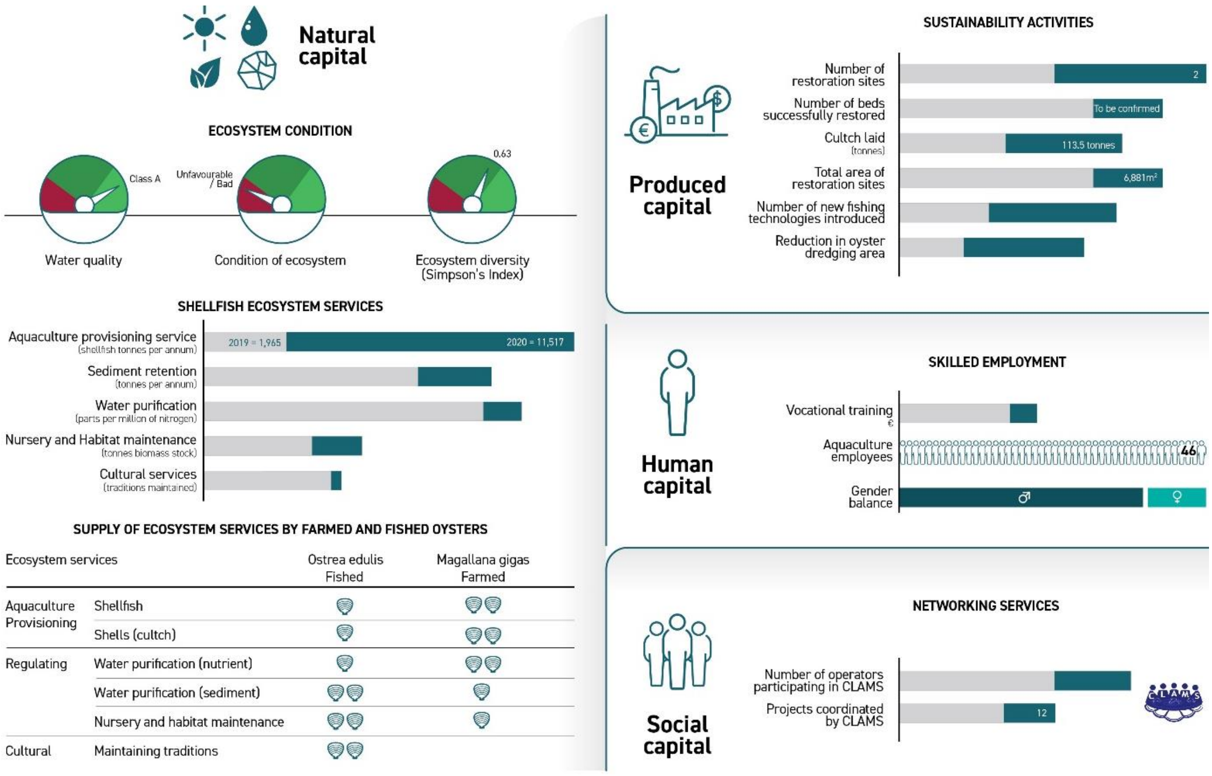
The type of application and interpretation of environmental-economic information depends on the use case identified at the start of the natural capital development and implementation protocol. During this project we used available data to compile environmental-economic information that could be used for the four priority applications:

1) Preparing data and information for the Seafood sector to support their participation in Marine Spatial Planning (MSP)
2) Improving sustainability performance and communicating the results
3) Reporting on Sustainable Development Goals (SDG)
4) Assessing the sustainability of the seafood sector in terms of natural capital and produced, human and social capital

The information developed during this project provides a baseline for evaluating the effectiveness of MSP related policies and programs. Data will need to be collected on a continual basis to evaluate MSP related policies and programs. There are data deficiencies with respect to measuring extent, condition, services and benefits that can be addressed with continual investment over time.

Sustainability performance relates to the condition of the capitals and the measures we take to ensure that they do not degrade over time. With respect to the seafood sector, this includes the health of workers, the stock of oysters and the ecosystems that may be impacted by oyster production and harvesting. The information developed during the project cannot be immediately used to improve sustainability performance and communicate the results. Improved data collection can support the compilation of information to this end. A mock dashboard has been developed (see Figure 16) which can be populated to communicate sustainability performance.

Figure 16 Mock aquaculture sector dashboard



DASHBOARD PROTOTYPE – AN EXAMPLE OF REPORTING CAPABILITIES. FIGURES ARE INDICATIVE ONLY AND CAUTION SHOULD BE TAKEN WHEN USING THE INFORMATION. SOME INFORMATION WAS NOT AVAILABLE AT TIME OF PUBLISHING, AND THE GAPS CAN BE RECTIFIED IN THE FUTURE.

Reporting on the sustainable development goals is possible with populated environmental-economic accounts. With respect to SDG 14, life below water, the data available in our case study could not be used to produce indexes of coastal eutrophication, plastic debris density and average marine acidity (pH). Further, the data available could not be used to produce a fish stock account and then be used to measure the proportion of fish stocks within biologically sustainable levels. We can report that 26 percent of the marine area in our project area is protected. Of the 38,786 hectares of marine area, 10,131 hectares were protected under the Special Area of Conservation.

Assessing the sustainability of the seafood sector in terms of natural capital and produced, human and social capital. Understanding the contribution of different investments and activities to sustainability objectives is important in assessing environmental importance. During the project we began to understand the relationship between social capital and transaction costs, in other words as a way of reducing environmental expenditures.

6 Recommendations for advancing Natural Capital for the Irish seafood sector

This project is an important first step in a transition towards the adoption of a natural capital approach to measuring and reporting on sustainability for the Irish seafood sector.

The implementation of an accounting approach can create efficiencies in decision-making by:

- Gathering information once for multiple uses
- Providing a consistent set of information that can be used pre and post decision-making – meaning that expectations can be adjusted reliably
- Integrating analysis across different policy areas
- Linking micro to macro – to provide context for local decisions

An accounting approach can also reduce the costs associated with making decisions by:

- Reducing the time costs associated with an evidence-based approach by consolidating disparate pieces of information
- Reducing the transaction costs associated with communicating and sharing information across disciplines and institutions
- Enabling economists and policy makers to consider environmental information without incurring high learning costs
- Minimising risk (cost) of making poor decisions where there would otherwise be missing information.

Continued investment in developing methods and reviewing data will improve the utility of ocean accounting in evidence-based decision-making. A number of recommendations have been developed across a number of themes.

One information set for many uses

We recommend workshopping NC DIP steps 1 and 2 with multiple agencies and also the private sector to determine how information requirements overlap. This may create the opportunity for coordinated investment in environmental-economic information as agencies realise synergies across programs and the opportunity to lower transaction costs associated with communicating sustainability performance. An important step which follows on from NC DIP steps 1 and 2 is NC DIP step 3 which is tailoring the accounting system. It is in this step that multiple agencies can see the potential for a set of environmental-economic information to align with wider Irish, EU and Global policies (e.g., National Biodiversity and Action Plan). Coordinated investment in data and information is likely to be more possible once agencies realise there is overlap in their information requirements.

Improving the supply of information

A number of investments in data can be made to improve the supply of information to satisfy the different information demands that develop from NC DIP steps 1, 2 and 3. Existing standards such as the System of Environmental–Economic Accounting should be used and a tiered approach to developing environmental-economic information should be explored. Collaboration across all sectors (government, private, academia, community organisations) is important to encourage standardisation, coherence and sharing across the many diverse and ongoing data collection efforts. Some key data streams that could benefit from being guided by an accounting approach include scientific monitoring and research and environmental impact assessments. Standardising the collection of ecological data will improve the coherence with economic data at a local level, such as that collected by the Irish National Statistics Office.

There needs to be consistent and regular mapping of ecosystem extent and condition, including species monitoring. There should be standardised collection of ecological data to enable comparisons across time and space. Consistent methods and metrics need to be developed for measuring condition of different ecosystem types and further research needs to be completed on key ecosystem services such as water purification. Research projects such as ShellAqua will be important for quantifying aquaculture ecosystem services of shellfish culture in an Irish context and developing tools to monitor environmental performance. Ideally, all information will be recorded in a data inventory, which will be made public.

Supply of environmental-economic information will be most efficient and effective by having a central body that coordinates the production of statistics. The body should have a strong working relationship with relevant state and local institutions, and academia, and should impart authority to the information that is produced. The central body could recommend changes to institutional arrangements so there is coherence in the data collected, enabling it to be integrated more readily.

The central body can generate economies of scale in information production that other institutions can use. It can also facilitate the ongoing development of standards for data collection, transformation, and integration. Establishing standard data quality assessment processes and technical advisory groups would be a part of this.

Data collection in Clew Bay

There are several priority actions that can improve the information set for Clew Bay so that it can be used more effectively to support decision-making for the seafood sector and indeed other bay users:

- Case study on data integration – collect data following an accounting approach to enable better integration across extent, condition, services, and benefits.
- Prioritise individual accounts in the following order:
    - Asset extent – collect additional data to better understand the ecosystem types, their extent and distribution
    - Ecosystem condition – prioritise the measurement of condition based on the use of the ecosystem and its relative scarcity or abundance. A large part of condition measurement would be to engage ecologists to further understand reference condition and how this relates to the occurrence of particular species

– Ecosystem services and benefits – identify ecosystem service hotspots and monitor the area to determine the impact of use on the extent and health of the ecosystem, and the effect on ecosystem service provision.

Scaling up to the national level

The project has found that there is enough existing data to scale up some ocean accounts at the national level. Table 18 provides an assessment of the data, task, relative cost, expected spatial coverage, and time horizon for the different accounting components. This assessment is not exhaustive as it is based on experiences from Clew Bay, but it is a reasonable starting point for scoping national accounts. Scaling up accounts will also require reconsideration of their purpose and intended use. For example, national level accounts that are not a compilation of local data would be better suited to address national level policy questions.

Multiple capitals

The management of natural capital is interdependent with the management of other capitals. For example, labour that is educated on the importance of the environment, may be more likely to embed nature positive actions into their business. Currently, the integration of human and social capital into NCA DIP steps 1, 2 and 3 is lacking. This can be developed in more detail after recommendation 1 is carried out.

Table 18 Scaling up to the national level

Accounting component	Data	Tasks	Relative cost	Expected spatial coverage	Estimated time required
Ecosystem extent	SACs	Collect existing data not captured in SACs and assess differences Model missing data and perform sensitivity analysis to different techniques Concordance between SACs with IUCN Global Ecosystem Typology	Low – medium	Coastal waters	6 months
Ecosystem condition	Water quality monitoring	Collect survey data where required Determine spatial scale for producing condition accounts Develop approach to measuring reference condition	High	Patchy coverage	2 years
Ecosystem services and use	Fisheries data National blue carbon data Tourism	Collect national data on fisheries Determine spatial scale for producing accounts Review approach to valuation.	Medium	Dependent on data set	1 year
Benefits	Further research required	Further research required	Medium	Unknown	1 year