Natural Capital Accounting for Bord Iascaigh Mhara

Accounting assessment report

REPORT PREPARED BY IDEEA GROUP

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Prepared for Bord Iascaigh Mhara

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Executive Summary

Natural Capital Accounting (NCA) is the identification, recording and communication of information on the environment and its contribution to human benefit. Global implementation of NCA is growing, with companies and governments using NCA as an input into decision making and communication with respect to sustainable development. An Irish agenda on NCA is being implemented through the Irish Forum on Natural Capital. The Environmental Protection Agency, Bord na Mona and Coillte have/are undertaking NCA projects. With these projects focussed on land, there is an opportunity for Bord Iascaigh Mhara to lead the extension of NCA to Irish marine areas.

Multiple stakeholders, including coastal communities, tourism operators and aquaculture and fisheries operators depend on a healthy marine environment. Coordination among these stakeholders is fundamental to addressing the degradation and depletion of the marine environment, which left unaddressed, will have long lasting repercussions for the private sector and the wider public. NCA provides a common language for all stakeholders to use as a basis for coordination on the sustainable development of the marine economy.

NCA also supports stakeholder groups to address opportunities and challenges that are specific to them. Bord Iascaigh Mhara (BIM) engaged IDEEA Group in 2019 to assess how NCA could support BIM and the aquaculture and fisheries operators within the seafood industry. This report clearly demonstrates how the accounts can be used across multiple accounting applications, and how these applications can address different challenges and opportunities. For example, NCA can underpin reporting on SDGs, communicating the clean and green image of the seafood industry, and accessing funding from the EU through improved monitoring and evaluation.

Case studies are a common starting point for NCA projects as they test the value add of NCA and the level of work required to perform NCA. Several potential case studies have been explored during this project, including the challenges and opportunities the case studies would address and the data available to populate them. A recommendation of the report is to undertake NCA for a selected bay as this scale provides the best opportunity to test the coordination elements of NCA, in addition to assessing the individual applications to each of the stakeholders. BIM will need to consider the stakeholders (for example, other departments and agencies, aquaculture and fisheries operators, local community groups) and their willingness to engage in different locations before selecting the case study.

A further recommendation is to apply the principles of the United Nations' System of Environmental-Economic Accounting (SEEA) when compiling natural capital accounts. The SEEA, as distinct from other approaches to NCA, is an internationally agreed standard that is being implemented in countries around the world. The principles of the SEEA have been designed such that all environmental information is coherent and harmonised with standard economic and financial information. Thus, the accounts combine to provide a clear narrative on the connection between the environment and people. This report introduces the SEEA and summarises the practical steps needed to undertake NCA for a marine based case study in Ireland.

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1 INTRODUCTION

Natural capital is the stock of renewable and non-renewable resources (including plants, animals, water, soils and minerals) that combine to yield a flow of benefits to people (Natural Capital Coalition, 2018). The exploitation of natural capital in pursuit of private benefits has contributed to the depletion and degradation of natural capital and the services it provides. In the absence of consumers that value sustainably produced goods and services, perfect information exchanged between buyers and sellers, and government policy that effectively addresses market failures, natural capital, one of four capitals that underpin societal wealth (see Box 1), is likely to continue to be depleted and degrade.

Box 1: Multiple capitals

Natural capital: the limited stocks of physical and biological resources found on earth, and of the limited capacity of ecosystems to provide ecosystem services
Human capital: the knowledge, skills, competencies and attributes of individuals that facilitate the creation of personal, social and economic well-being
Social capital: encompasses networks, including institutions, together with shared norms, values and understandings that facilitate cooperation within or among groups
Produced capital: all manufactured capital, such as buildings, factories, machinery, physical infrastructure (roads, water systems), as well as all financial capital and intellectual capital (technology, software, patents, brands etc.)

Source: adapted from TEEB Agrifood

The degradation of natural capital has implications for society and the economy, both now and into the future. Efforts to address the depletion and degradation of natural capital are underway internationally, with standard measures of economic growth being considered in the context of sustainable development.[1] A key focus of recent efforts has been a place-based response to sustainable development, as relationships between the different capitals, and how they contribute to human wellbeing varies by location.

Increasing global attention towards sustainable development is providing new challenges and opportunities for consumers, producers, government, non-government organisations and politicians. Multiple Capital Accounting (MCA) – accounting for the capitals described in Box 1 - can contribute to an evidence base which can be used to understand and respond to these challenges and opportunities in a transparent way. Natural Capital Accounting (NCA) is the best entry point to MCA as people and the goods and services they consume is dependent on a healthy stock of natural capital. NCA is also the furthest developed approach at accounting for capitals after produced capital.

This document, compiled by IDEEA Group with support from Bord Iascaigh Mhara (BIM), Ireland's Seafood Development Agency, aims to demonstrate how NCA can support BIM to add value to the Irish seafood industry and continue to improve the overall sustainability of the sector. Several

[1] There are many different definitions and interpretations of sustainable development. We have defined sustainable development as economic growth that does not degrade the capital base (encompassing the quantity and quality of capitals).

challenges and opportunities are identified for both BIM and the broader seafood industry, before describing how NCA might address them. Potential NCA case studies are then explored with the purpose of testing the effectiveness of NCA to address the identified challenges and opportunities in a later stage.

This report is structured as follows:

i. we discuss the current context of the seafood industry in Ireland (section 2);
ii. we describe several opportunities and challenges for both BIM and the seafood industry (section 3);
iii. we introduce several applications of accounting information and link these to the opportunities and challenges (section 4);
iv. we discuss several potential case studies, and the availability of data based on a preliminary data assessment (section 5);
v. we discuss key concepts relating to NCA and their application to Irish marine waters (section 6);
vi. we provide recommendations and potential next steps for account compilation (section 7).

2 BACKGROUND

NCA is a systematic and organised approach to accounting for, managing, and reporting on the environment. It is beginning to be implemented globally with many countries and companies compiling accounts. Ireland has a large natural capital endowment across terrestrial and marine areas that can be the focus of NCA. A national agenda is being implemented through the Irish Forum on Natural Capital to protect and restore natural capital and the benefits it provides. The network of individuals and organisations in Ireland with capacity in NCA is growing and a number of projects are underway. The Environmental Protection Agency is currently delivering the Irish Natural Capital Accounting for Sustainable Environments (INCASE) project, while Bord na Mona and Coillte have both undertaken NCA projects. To date, the focus has largely been on land and there is an opportunity to extend work on NCA to incorporate marine areas.

BIM, established under the Sea Fisheries Act, 1952, is the state agency with primary responsibility for developing the Irish seafood industry.[2] The Irish seafood industry contributed 1.25 billion to the nation's economy in 2018, an increase of 8.6% on the previous year. It is fast establishing itself as a major contributor to Ireland's international reputation as a producer of high-quality and responsibly produced, sustainable food. The two main components of the seafood industry primary production are capture fisheries production and aquaculture production.[3] Ireland also has a significant seafood processing sector, but this report is more focused on primary production.

[2] In this context seafood encompasses fisheries, aquaculture, seafood processing and other sea or fresh water based animal or plant activity. (Note: fresh water fishing activities are outside of BIM's remit. These are the responsibility of the Inland Fisheries Ireland).

[3] Capture fisheries production consists of Fish and Shellfish caught from the wild. Aquaculture production consists of Fin-fish, Shellfish and Seaweed which are cultivated. Active human effort is involved in maintaining or increasing the number of organisms in aquaculture production.

BIMs purpose is to support and enable an increase in value creation of a sustainable Irish seafood industry across the supply chain, from catch to consumer (Box 2). It aims to do this by using its effective support and deep expertise so that its goal for the Seafood industry in Ireland – that it becomes the international leader in high value differentiated products that satisfy the growing demand for healthy, safe, responsibly and sustainably produced seafood – can be achieved.

Box 2: BIM strategic statements

BIMs mission

"To support and enable an increase in value creation of a sustainable Irish seafood industry across the supply chain, from catch to consumer"

BIMs vision

"Leading the Irish Seafood industry through our effective support and deep expertise so that Ireland becomes the international leader in high value differentiated products that satisfy the growing demand for healthy, safe, responsibly and sustainably produced seafood"

Source: BIM statement of strategy 2018-2020, enabling sustainable growth

BIMs relationship with natural capital is unique. They do not own the resource, rather they support the seafood industry to generate value from the common resource. At primary production level this includes fishers with registered vessels and/or quota allocations, and licensed aquaculture operators. The agency continually works with the sector and government to help identify and respond to emerging needs and issues.

BIM came to explore NCA because of the dependence of the seafood industry on natural capital. BIM is uniquely positioned to pilot NCA in Ireland's marine areas as it has a strong focus on sustainability (sustainability is one of five key pillars that drive BIMs operations – Box 3) and innovation in the marine space. BIM can stay ahead of the curve and support improved decision making, communications and reporting by adopting NCA.

Box 3: Key strategic areas

Sustainability – Demonstrating effective differentiation and environmental credentials

Skills – Creating a professional and educated talent pool for the sectors

Innovation – developing new and smarter ways of doing business

Competitiveness – Creating the means of reliablty benchmarking the economic performance of Irish seafood so changes can be made that will have the most impact of value creation

Leadership – maximising the beneficial impact that Irish seafood has on its host communities and on the national economy.

Source: BIM statement of strategy 2018-2020, enabling sustainable growth

The link between natural capital, human capital, social capital and manufactured capital is also important for the seafood industry. Over 14,000 people are directly and indirectly employed in the

seafood industry, many of them based in Ireland's remote coastal communities where alternative options are limited. The success of the Irish seafood industry is vital to the economies of these regions, where it provides employment on fishing vessels, fish farms, in processing operations and in the distribution of seafood. In turn they support local businesses such as shops and can contribute to the retention of local services and infrastructure such as schools.

2.1 Drivers of a Sustainable Irish Seafood industry

There are various drivers that affect the sustainable development of the Irish seafood industry. The drivers, which are evolving over time, include but are not limited to:

i. changing environmental conditions – affecting the productivity of production processes;
ii. population growth and urbanisation (for example, International markets such as China) – affecting the demand for Irish marine products and demand for healthy protein.
iii. changing consumer tastes and preferences with respect to sustainably produced goods and services – affecting the demand for marine products;
iv. changing trade conditions that are a result of nationalistic/protectionist policies such as Brexit – affecting both supply and demand in the industry; and
v. changing policy such as new regulation and financial incentives for sustainable production and environmental protection – affecting both supply and demand in the industry.

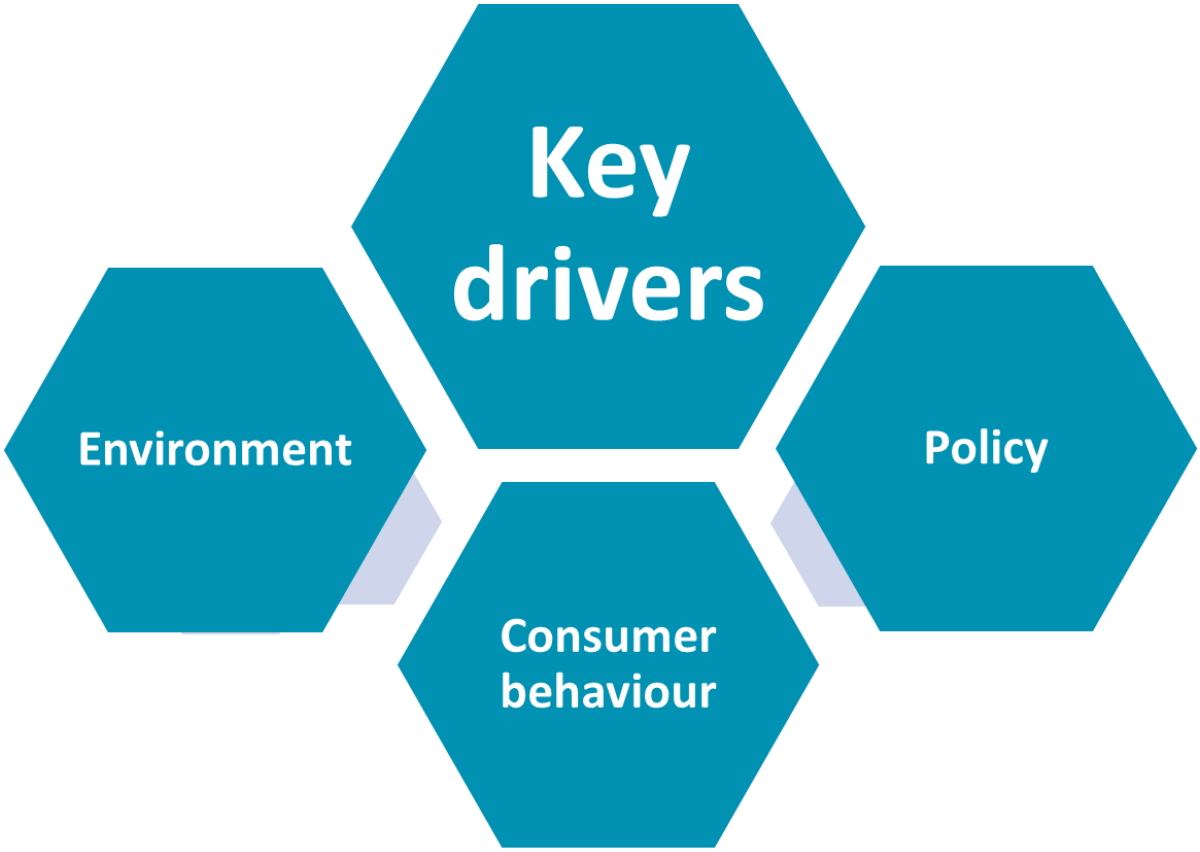
A key focus for the seafood industry, supported by BIM, will be responding to these drivers. The seafood industry can invest time and money into maintaining or enhancing the capitals that are relevant to adding value to their production process amid changing drivers. For example, some members of the seafood industry may invest in improving their marketing material (built capital) to help differentiate their products, some may apply for new courses in sustainable aquaculture to learn (human capital) new techniques that reduce risk, while others may invest in building new networks (social capital) with global trade partners.

BIM supports the seafood industry's response to these drivers through its five key pillars. For example, BIM provide training to the seafood industry, to take advantage of new opportunities and add value to production. BIM may also facilitate partnerships between buyers and sellers. NCA, and MCA more broadly, can support BIM and the seafood industry to respond to these drivers.

The drivers discussed above can be organised into three main areas: the consumer, the environment and policy (Figure 1). The environment has been under increasing stress since the beginning of the industrial revolution. However, the capacity of the environment to adapt to the impacts of increased human activity has recently reached a critical point. Ecological thresholds are being crossed and new constraints on human activity are evident. Take climate change for instance, where the extraction and consumption of fossil fuels for energy, and intensive agricultural activity have pushed atmospheric carbon beyond the ecological threshold for climate maintenance. Changes in seasonality, increased storm frequency and increased drought periods are all affecting production capacity.

Population growth is a strong demand side factor that influences the seafood industry. Seafood remains the protein source of choice for many in Africa and an increasing number of middle-class consumers in the Asia-Pacific region, where per capita consumption of seafood has trebled in the last 25 years alone.

Figure 1: Key categories for drivers in the seafood industry



The change in environmental conditions is beginning to influence the way people, who are better informed about the environment, interact in the economy. Those concerned for their future wellbeing, for example the younger generation, are changing their consumption patterns. Changing consumer expectations provide producers with the opportunity to respond with a new range of sustainable and responsibly produced products. Further, with increasing quantities of information available, and means of spreading information quickly (for example, social media), the public can have affect reputation quickly. Businesspeople are at risk of destroying their reputation if they are seen to degrade the environment while politicians are also at risk if they are seen to protect the vested interests of businesses that do so.

Other global conditions, such as movements towards protectionist policies in Britain and America are likely to affect the Irish economy. Concerning trade between Britain and Ireland, more than 30% of Irish fishing quotas are caught in Irish waters and the UK is one of Irelands main export (12%) destinations valued at €81 million. Conversely Ireland's imports an estimated €219m of seafood for direct retail and raw material, particularly salmon and whitefish. Specifically, prepared seafood exports to the UK (excl. filleted) consist mainly of Flours, Meals and Pellets (33%), Salmon (7%) and Dublin Bay Prawn (6%). Brexit will have many implications and challenges for the Irish seafood industry including currency volatility, tougher UK trade and more competition from UK processors. There may also be implications for supply chain management and tariffs.

Post Brexit there is the potential for tariffs on imports and exports. Higher estimates of tariffs could be based on third country rates for the European Union and would be as follows: Crab, 8%, Nephrops 12%, Whitefish, (Monkfish fresh, 15%; Haddock fresh, 8%; Cod fresh, 12%) Pelagic (Tuna prepared 24%; Herring prepared 20%; Mackerel prepared 25%; Horse mackerel frozen, 15%) and Fish oils 11%.

Additional time delays/costs are one of the most significant potential impacts, with wide reaching effects. Depending on the outcomes of Brexit negotiations, there may be an increased number of customs, border controls and product checks. This would have a range of potential time delays and increased costs for products being shipped to, through or imported from the UK. Additional time required to process paperwork, customs for Irish seafood being transported into or through the UK customs would increase "time to market". This will impact Irish companies' costs, product quality and customer base. Short shelf-life products such as fresh live Irish mussels may be exposed to significant delays, which may result in the shipment of these and similar products becoming economically unviable.

3 ADDRESSING CHALLENGES AND OPPORTUNITIES WITH NCA

BIM and the broader seafood industry both have multiple challenges and opportunities that arise from the drivers described in section 2.1. Table 1 shows the different challenges and opportunities that exist and their relevance to both BIM and the seafood industry. Each challenge and opportunity as they relate to BIM or the wider seafood industry is described in this section, as well as the potential for NCA to support them.

Table 1: Challenges and opportunities

Description	Type	BIM	Seafood industry
Implementing effective place-based policy	Challenge	X	
Sustainable development/achieving environmental and social objectives	Challenge	X	X
Managing reputation/social license to operate	Challenge	X	X
Clean & Green; product differentiation	Opportunity	X	X
Reducing time and cost of monitoring and reporting	Opportunity	X	X
Access to funding/finance	Opportunity	X	X
Sustaining profitability	Opportunity		X
Sustaining business operations e.g. licenses/quotas	Opportunity		X

3.1 Challenges for BIM

3.1.1 Effective place-based policy and programs (policy cycle)

NCA underpinned by the SEEA helps government departments and agencies develop effective place-based policies by measuring how the stock of natural capital is contributing to the production of private and public benefits within a specific spatial context.

BIM is tasked with intervening in the seafood industry when key issues are identified, including those relating to changing environmental conditions, changing social expectations and changing policy. Identification of how these issues impact the stock of natural capital and its contribution to human wellbeing is fundamental for good policy.

Different locations and their constituents are likely to be affected differently by the drivers described in section 2.1. Developing context-specific policies that build resilience to environmental pressures becomes an important driver of private and public benefits. To develop effective policies, government departments and agencies need to be aware of the key environmental risks, how they relate to the condition of natural capital, and the capacity of the natural capital to continue to contribute to private and public benefits across space and time. All this needs to be done within the local context and should be linked to other forms of capital such as human and social capital.

Effective place-based policy requires collaboration across local communities, business, government departments, and agencies. There needs to be a common understanding of the state of play that is supported by objective evidence. Synergies across agencies and departments can be identified and cross cutting policies and programs can be delivered effectively.

3.1.2 Sustainable development of the seafood industry

NCA underpinned by the SEEA helps government departments and agencies maintain intergenerational equity by monitoring how the stock (extent and condition) of natural capital is changing over time and its distance from local thresholds and limits.

“Sustainability is a strong driver of Ireland’s marine economy and has become the keystone for success in the modern seafood industry. BIM works with the seafood industry to ensure that responsible development is at the heart of all its activities and that Ireland’s natural resources are preserved and protected for present and future generations (Bord Iascaigh Mhara, 2017).”

Environmental conditions are changing, placing new pressures on the stock of natural capital. With sustainability as a key pillar of its strategy, BIM will need to ensure that the seafood industry understands and behaves responsibly in the marine environment. Sustainable profit is dependent on the sustainability of the environment.

Initiatives that look to the future and tackle issues as they emerge will help maintain the stock of natural capital and its contribution to the seafood industry. Continual monitoring of ecosystems and their condition can help to contribute to policy development that protects the wellbeing of future generations.

Human and social capital is also fundamental to preserving intergenerational equity. Targeted training and networks built on trust enable the seafood industry to create value that is environmentally sustainable. The relationship between human, social and natural capital are an important factor in determining the benefits provided by the seafood industry.

3.1.3 Managing BIM's reputation

NCA underpinned by the SEEA helps government departments and agencies manage their reputation through the transparent communication of robust and coherent evidence on trends with respect to sustainability outcomes.

Every rose has its thorn – pursuing environmental sustainability can either be an advantage or a risk for BIMs reputation. Poor communication in terms of environmental performance can affect BIMs reputation with the public, between agencies in the public sector, and for Ireland's reputation with International governments.

How BIM measures and communicates its sustainability outcomes is crucial maintaining its image. BIM can build good working relationships by building trust and transparency in relation to sustainability outcomes. The credible and consistent language inherent in NCA can help support BIM in its sustainability objectives and enhance BIM's role as a National SDG champion.

3.2 Opportunities for BIM

3.2.1 Driving Ireland "clean and green" as a comparative advantage

NCA underpinned by the SEEA helps government departments and agencies increase the competitiveness of Irish seafood exports by communicating sustainability focussed outcomes in the seafood industry.

Social expectations in relation to sustainability standards are changing. With its high natural endowment of marine resources, Ireland is uniquely placed to make sustainability a competitive advantage. This requires the development and maintenance of environmental performance to a level over and above that required by the law. Indeed, it is a strategic priority to establish and drive a range of effective approaches to differentiate Irish seafood products, based on demonstrating their environmental credentials and provenance.

An outcome focussed information set on sustainability can be used to show a new level of commitment to environmental performance. Assistance provided by BIM towards initiatives that go beyond mandatory requirements help the Irish seafood industry stand out both domestically and internationally as an active, aware and responsible player working towards environmental sustainability.

3.2.2 Cost reduction

NCA underpinned by the SEEA helps government departments and agencies to reduce the cost of monitoring, evaluation and reporting by streamlining and standardising the collection, management and dissemination of natural capital data.

Government is reporting more often to a variety of audiences, for a variety of purposes (for example, in accordance with European legislation or for market reports). The requirements are usually highly variable in each case, burdening government with higher data and analysis costs. Government can reduce these costs by investing in an efficient system designed to provide one core data set to support multiple purposes.

BIM is the national agency with responsibility for collecting economic data on the seafood industry. This is collected to a prescribed standard set by the European commission. However, the range and variety of work carried out by BIM is not captured in this system and measurement of additional data by a single set of metrics difficult. There is no single reporting function for progress and achievements, so a lot of potential data is not captured. An accounting system would support the integration of different data sources to tell a story about sustainable economic activity in the seafood industry.

3.2.3 Access to funding

NCA underpinned by the SEEA helps government agencies to access finance by providing a new outcomes-based narrative and an evidence base to demonstrate the return on investment in natural capital.

Funding is central to BIM's and the wider seafood industry's ability to respond to the drivers whilst pursuing sustainable value add. BIM provides grant assistance through the EMFF and gives direct assistance to the seafood industry in making grant applications.

An outcomes-based sustainability narrative will help demonstrate the return on investment made through the EMFF and future EU programmes. A better evidence base can help BIM and Ireland in general build the case for greater investment in their activities, relative to other agencies and member states.

3.3 Challenges for aquaculture and fisheries operators

3.3.1 Sustaining profitability

NCA underpinned by the SEEA helps aquaculture and fisheries operators sustain profitability and minimise the variability of income by systematically recording how the stock of natural capital is contributing to current production.

Variable and disruptive environmental conditions are increasingly impacting on natural capital and affecting farm level and natural productivity and profitability. Environmental pressures are also making aquaculture and fisheries operators profitability less certain. Building business level resilience – the ability of the farm to respond to environmental pressures – becomes critical for the operator looking to sustain profits in the future. Aquaculture and fisheries operators need to be aware of the

environmental risks (climate change – increased storm frequency, ocean acidification, disease, alien species) they face, how they relate to the condition of the natural capital they manage, and the capacity of the natural capital to continue to contribute to production.

The drivers also provide new opportunities for innovative aquaculture and fisheries operators. To sustain profitability into the future, aquaculture and fisheries operators must adapt by finding new revenue streams, for example payments for ecosystem services (Water filtration provided by farmed shellfish, Carbon sequestration from farmed seaweed, improvement in ecological condition brought about by fishing for litter) all while maintaining the condition of the natural capital they manage.

3.3.2 Realising business level environmental and social objectives

NCA underpinned by the SEEA helps aquaculture and fisheries operators to achieve their own environmental and social objectives by fully integrating natural capital outcomes with business level decision-making.

Individual and business level attitudes around the exploitation of natural resources are changing. While aquaculture and fisheries operators must sustain their profitability, business level environmental and social objectives are becoming increasingly important across the entire seafood industry (farming, capture and processing). Decisions can be informed by considering the role and values of natural capital and their services to the seafood industry in conjunction with a traditional financially driven approach.

3.3.3 Maintaining social license to operate

NCA underpinned by the SEEA helps aquaculture and fisheries operators to secure their social license to operate by organising the information required to demonstrate they are responsible stewards of natural capital.

Increased scrutiny by both communities and governments is making it harder for businesses to continue accessing natural resources. Businesses can better secure their social license to operate by developing a new narrative about their relationship with natural capital. Robust outcomes-based evidence and communication about seafood industry sustainability is central to securing a social license to operate.

3.3.4 Sustaining business operations i.e. licences / quotas.

NCA underpinned by the SEEA has the potential to support the aquaculture and fisheries operators to obtain legal permission to operate in marine areas.

Business operations in common resource areas are heavily regulated. Licences are issued for aquaculture on a 10-year basis. Fisheries are governed/regulated by combination of vessel licences with gear specifications and quotas. Aquaculture activities are spatially defined. Fisheries are not spatially defined to the same extent but are managed within Regulatory Areas and Fishery Management Regions, by Member States inside six miles (territorial waters) under National law, the

European Commission under the Common Fisheries Policy in European waters from 12-200 miles and by the North East Atlantic Fisheries Commission outside EU waters .

An application for an aquaculture licence must be spatially assessed against competing demands on the coastal zones as well as conservation of the marine environment within which the activities are proposed. NCA offers the potential to make the licences more flexible as they are currently quite rigid. Objective evidence on the co-existence of a healthy aquaculture and fisheries operations and healthy marine ecosystems may support a case for flexible licences that consider local context. Business viability can be maintained while managing the environmental impacts responsibly.

3.4 Opportunities for aquaculture and fisheries operators

3.4.1 Reduced costs and time of reporting

NCA underpinned by the SEEA helps aquaculture and fisheries operators to reduce the cost of reporting by streamlining and standardising the collection, management and dissemination of natural capital data.

Aquaculture and fisheries operators are reporting more often to a variety of audiences and for a variety of purposes. The requirements are usually highly variable in each case, burdening businesses with higher data and analysis costs, and time costs. Businesses can reduce these costs by being supported to adopt and investing in an efficient system designed to provide one core data set to support multiple purposes.

3.4.2 Improving market access through product differentiation

NCA underpinned by the SEEA helps aquaculture and fisheries operators access and secure markets by objectively communicating their environmental and social outcomes using a standardised framework.

Social expectations are changing. The global consumer is increasingly better informed and is buying products that minimise their environmental footprint. This provides an opportunity for aquaculture and fisheries operators to access new markets (and secure existing markets) by differentiating their products with respect to the sustainability of their environmental and social outcomes and their good stewardship of natural capital.

3.4.3 Access to finance

NCA underpinned by the SEEA helps aquaculture and fisheries operators to access finance by providing a new dependencies and outcomes-based narrative and an evidence base to demonstrate the return on investment in natural capital.

New financing mechanisms are being introduced into the current economic system. Impact investing links investors (including prospective shareholders) with businesses that deliver environmental and social outcomes. Businesses that provide a new narrative to their investors (and potential investors)

on environmental and social outcomes and the connection to natural capital investment actions, may access increased (and a wider range of) finance. Further, improved accounting for dependencies and risks may improve the case for lower cost finance through traditional channels.

4 APPLICATIONS OF NATURAL CAPITAL ACCOUNTS

Both BIM and the wider seafood industry apply information in several ways to maintain sustainable development and respond to emerging issues. These applications are spread across decision making and reporting and can be internal or external to an organisation (see Table 2).

Table 2: Applications of NCA information

Decision making	**Communication**
Monitoring and evaluation	External reporting
Asset management	Internal reporting
Trade off analysis	
Scenario analysis	
Risk profiling	

NCA can support the information applications described in Table 2. Box 4 describes 6 key features of NCA that make the accounting information useful in these applications. This section describes the applications of NCA as they relate to BIM and the seafood industry.

Box 4: Key features of natural capital accounting

Sustainability focused – NCA underpinned by the SEEA links business activities and decision-making to changes in the stock and condition of natural capital and its capacity to contribute to the production of goods and services, including public ecosystem services

Systems based – NCA underpinned by the SEEA provides a holistic picture of business activity by combining a broader range of information – ecological, social and economic

Spatial – NCA underpinned by the SEEA compiles information spatially to explicitly reflect the local context and dependencies on natural capital

Standardised – NCA underpinned by the SEEA provides a common language that all stakeholders can refer to when collaborating

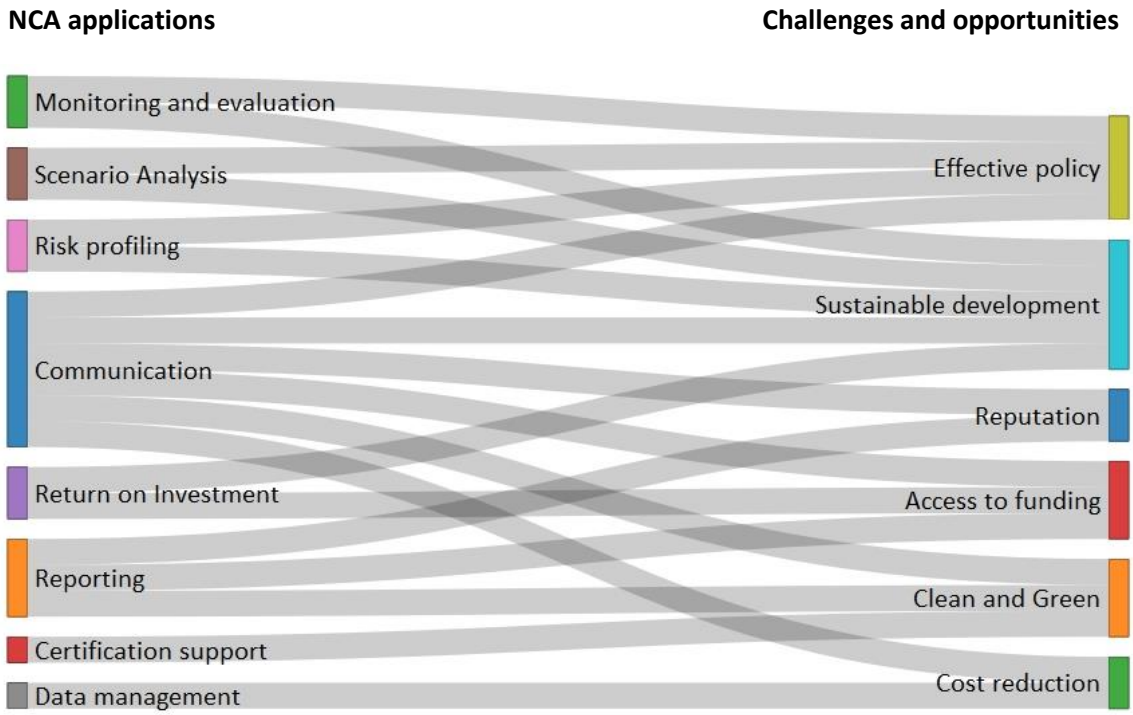
Harmonised - NCA underpinned by the SEEA generates information on natural capital that is compatible with contemporary accounting and finance systems

Credible – NCA underpinned by the SEEA, underpinned by the United Nations' System of Environmental-Economic Accounting (SEEA), generates credible and standardised information on natural capital.

4.1 Bord Iascaigh Mhara

BIM provide a wide range of support to the seafood industry. This includes working with the seafood industry to solve problems, improve efficiency and support to comply with current and future regulation. NCA supports multiple applications that are linked to the challenges and opportunities described in Section 3.1 and 3.2. The matching between the applications and challenges/opportunities is shown in Figure 2 (below). How NCA supports each application is described below in more detail.

Figure 2: Linking NCA applications and BIM challenges and opportunities



4.1.1 Communication and collaboration

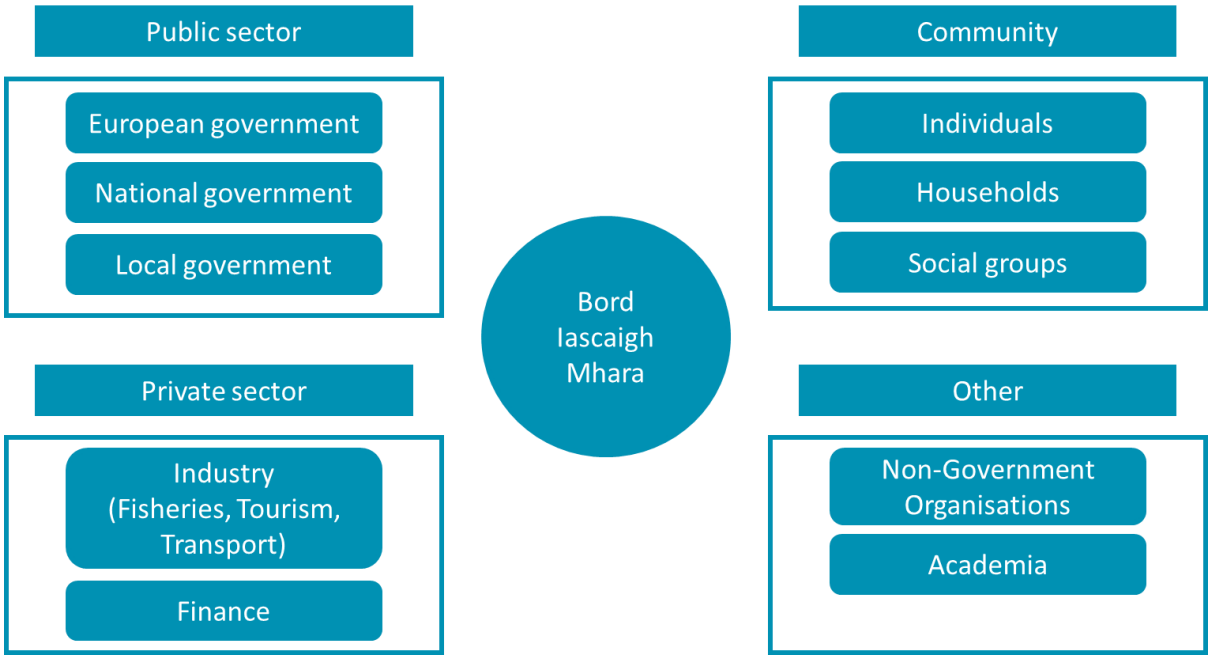
Communication is central to any operation that requires input from multiple stakeholders. Effective communication underpins BIMs operations across the seafood industry. BIM fosters relationships and collaborates with several stakeholders beyond the seafood industry businesses it supports. These include the European Union, government departments and agencies, and academia (see Figure 3). Successful communication will contribute to effective place-based policy, sustainable development, driving clean and green seafood production, managing BIM's reputation, access to funding and overall cost reduction.

The benefits of using NCA to support communication is summarised in Spurgeon, Obst, Santamaria, Gough, & Spencer (2018). At a broad scale, greater reach and comprehensiveness of engagement both within the natural capital community and more broadly, should be possible through jointly developed common language and narrative. Developing a shared vision of success early on will help inform alignment of approaches and all other work areas.

With respect to government, using a common narrative across the different departments and agencies is beneficial. There are multiple departments and agencies that have marine functions (for example, DAFM, DCCAE, DCHG, DHPLG DTTAS and the EPA – see Table 3) and coordination between them is critical. The Inter-Departmental Marine Coordination Group (MCG) was established in 2009 and is a

good forum for such coordination activities. Marine policy is difficult enough without there being disparate pieces of information informing different departments, agencies and their policies. Information on the marine environment should be organised in an integrated way as communication in common terms will support the pursuit of multiple (and sometimes competing) objectives.

Figure 3: Key actors, Irish marine waters



A common language and coherent information can be used to rationalise private sector and community input and respond to emerging issues quickly. Developing common and easily understood language on sustainability outcomes that is relevant (context specific) can be beneficial for stakeholders. Communication between the government and private sector groups such as the Irish Fish Producer organisation (IFPO), Killybegs Fishermens Organisation Ltd (KFO), and the Irish Farmers Association (IFA Aquaculture), can help to understand emerging issues and the implications of new policies. Furthermore, accounts simplify complex research into a format that is easily understood by policy makers. The accounting framework can also be used to identify gaps for the research community – developing fit for purpose information that can be used by policy makers.

4.1.2 Reporting

Reporting is a means of communicating information to interested stakeholders. External reporting aims to communicate information to those who have dependencies on the organisation and their functions (for example, the public), those that regulate the organisation's operations (for example, the European Union) and those that have indirect impact by demanding goods and services (for example, consumers or other businesses). Reporting enables the stakeholder to demand corrective measures if they are unhappy with performance and builds trust and transparency. Reporting can also be for internal purposes, so managers can evaluate performance (described in section 3.1.2, below). Reporting can improve BIM's reputation among its clients, the public, and European, national and local government departments and agencies.

Table 3: Key Irish Government departments and their environmental responsibilities

Department	Description	Relevant Agencies, if any
Department of Agriculture, Food and Marine	In carrying out its mandate the Department undertakes a variety of functions including (i) policy advice and development on all areas of Departmental responsibility (ii) representation in international especially EU and national negotiations (iii) development and implementation of national and EU schemes in support of Agriculture, Food, Fisheries, Forestry and Rural Environment (iv) monitoring and controlling aspects of Food Safety (v) control and audit of public expenditure under its control (vi) regulation of the agriculture, fisheries, and food industries through national and EU legislation (vii) monitoring and controlling animal and plant health and animal welfare (viii) monitoring and direction of State Bodies engaged in the following areas - research training and advice - market development and promotion- industry regulation and development- commercial activities (iv) direct provision of support services to Agriculture, Fisheries, Food and Forestry.	BIM Marine Institute Sea Fisheries Protection Authority Aquaculture Licence Appeals Board Bord Bia
Department of Communications, Climate Action and Environment	The Department of Communications, Climate Action and Environment is responsible for the telecommunications and broadcasting sectors and regulates, protects and develops the natural resources of Ireland.	Inland Fisheries Ireland EPA
Department of Culture, Heritage & the Gaeltacht	The Department of Culture, Heritage and the Gaeltacht's mission is to promote and develop Ireland's arts, culture and heritage; to advance the use of the Irish language and to facilitate sustainable regional and rural development, including the development of the Gaeltacht and Islands.	National Parks and Wildlife Service
Department of Housing, Planning and Local Government	The Department's mission is to support sustainable development, with a particular focus on strategic planning, the efficient delivery of well-planned homes in vibrant communities and the sustainable management of our water resources, and to ensure effective local government.	
Department of Transport, Tourism and Sport	The Department of Transport, Tourism and Sport is responsible for transport policy and overseeing transport services and infrastructure. Its mission is to shape the safe and sustainable development of transport, tourism, and support, to support economic growth and social progress.	Marine Survey Office Irish Coastguard

Source: adapted from TEEB Agrifood

BIM is required to report on their performance both on a statutory and non-statutory basis. BIM report non statutorily in external reports such as the business of seafood and the annual aquaculture survey. The former provides a snapshot of the different elements of Ireland's seafood industry in terms of production and value add, while the latter focusses on aquaculture output. Both reports contain quantitative information for broad spatial areas (for example, the county level). Reporting in relation to sustainability is explored in the BIM Sustainability Atlas. This was a once off analysis of the environmental baseline of activities carried out in 2015. The publication outlines the work undertaken in all aspects of the seafood supply chain under key environmental topics. Sustainability is measured quantitatively from an input perspective.

There are several European policies/directives that require some form of statutory reporting. While this may not be BIMs immediate responsibility, DAFM, BIMs parent and other departments collectively, hold responsibility and look to their agencies for support and input. Table 4 describes key European policies and frameworks. DAFM and other government departments report on each of these policies and directives to the EU as required. For example, European directives such as MSFD have reporting requirements and frequencies incorporated within their implementation timetables.

Further, BIM are part of a group of agencies and departments responsible for implementing the UNs' SDG's. BIM has recently been appointed at the national champion of SDG 14, life under water, but will also work on goals 8, 12 and 2. Their specific role is to promote these SDGs, raise awareness and lead by example in working towards achieving them. Appendix 1 describes the indicators relating to Goal 14, indicators 14.1, 14.2, 14.3, 14.4, 14.5, 14.7.

There are two key improvements that arise from adoption of NCA in relation to reporting. The first is that the accounts support outcomes focussed reporting. The SEEA shifts the focus from inputs – the current area of measurement for sustainability – to outcomes. Second, the accounts can be used to combine narratives on economic growth and sustainability. Currently, narratives on both are provided separately and do not provide a coherent story. Further, using the SEEA to undertake NCA aligns with broader EU reporting standards, statistical standards and a recommendations made by the European Marine Board (M.C. et al., 2019).

NCA can underpin each of the EU reporting requirements. Opportunities to share data and jointly commission data collection and valuation studies could lead to significant cost-efficiencies and avoidance of duplicative efforts. The SDGs can be supported by NCA, which would provide the organising framework for the collection of data. Additionally, the information could be integrated with information on other capitals to further report on SDGs.

Table 4: Key European policies and frameworks.

Policy or directive	Description
Common fisheries policy (CFP)	The CFP is a set of rules for managing European fishing fleets and for conserving fish stocks. The CFP aims to ensure that fishing and aquaculture are environmentally, economically and socially sustainable and that they provide a source of healthy food for EU citizens. Its goal is to foster a dynamic fishing industry and ensure a fair standard of living for fishing communities. The CFP shall implement the ecosystem-based approach to fisheries management so as to ensure that negative impacts of fishing activities on the marine ecosystem are minimised and shall endeavour to ensure that aquaculture and fisheries activities avoid the degradation of the marine environment.
Integrated maritime policy	The Integrated Maritime Policy seeks to provide a more coherent approach to maritime issues, with increased coordination between different policy areas. It focuses on issues that do not fall under a single sector-based policy e.g. "blue growth" (economic growth based on different maritime sectors), and issues that require the coordination of different sectors and actors e.g. marine knowledge. It seeks to coordinate, not to replace policies on specific maritime sectors.
Water FW directive	Objectives seek to prevent the deterioration of and achieve “good” status of groundwater and surface waters in the EU and includes transitional (estuarine) and coastal waters.
EU Maritime Spatial Planning Directive	The aim of the Marine Spatial Planning Directive aims to create a common framework from MSP across the European Union with the definition of MSP being “a process by which the relevant member state’s authorities analyse and organise human activities in marine areas to achieve ecological, economic and social objectives.” The directive was adopted in 2014 and Member states are required to establish Maritime Spatial Plans by 2021. Maritime spatial planning will contribute to the effective management of marine activities and the sustainable use of marine and coastal resources, by creating a framework for consistent, transparent, sustainable and evidence-based decision-making. Maritime spatial planning should apply an ecosystem-based approach as referred to in Article 1(3) of Directive 2008/56/EC with the aim of ensuring that the collective pressure of all activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while contributing to the sustainable use of marine goods and services by present and future generations.
Strategic guidelines for the sustainable development of EU aquaculture	Four priority areas will be addressed in order to unlock the potential of EU aquaculture: administrative procedures, coordinated spatial planning, competitiveness and a level playing field. Aquaculture can contribute to the overall objective of filling the gap between EU consumption and production of seafood in a way that is environmentally, socially and economically sustainable. To this aim, each Member State is encouraged to indicate in the multiannual national plan its own aquaculture growth objective (volume and value) in the period covered by the plan.

EU Blue Growth Strategy	The long-term strategy to support sustainable growth in the marine and maritime sectors. It is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth. It identifies aquaculture as a focus area that has the potential to deliver sustainable growth and jobs in the blue economy.
Data Collection Framework, EU Multi-annual Plan.	Data collection is essential for the implementation of the CFP. The EU fisheries management relies on data collected, managed and supplied by EU countries under the Data Collection Framework. Robust scientific data is required to evaluate the state of fish stocks, the profitability of the different segments of the sector and the effects of fisheries and aquaculture on the ecosystem. It is also used to evaluate EU policies: fisheries management measures, structural financial measures in support of the fisheries and aquaculture dependent areas, mitigation measures to reduce negative effects of fisheries on the ecosystem. Ireland's DCF Programme is supported by the European Maritime and Fisheries Fund (EMFF).

4.1.3 Monitoring and evaluation

Monitoring and evaluation (M&E) involves the design and use of programs and systems that measure the effectiveness of policy design and implementation. Monitoring occurs when the program is implemented and involves tracking key indicators across time. Evaluation occurs at key stages in the project and involves interpreting the information collected the determine the effectiveness of the project. Monitoring and evaluation is linked to effective place-based policy and sustainable development of the seafood industry. It also links to development of a clean green Ireland (described in Box 5).

Box 5: highlighting the importance of monitoring and evaluation – Foodwise 2025

> Foodwise 2025 states that the sustainability credentials of the seafood industry must continue to be measured and benchmarked to underpin their validity and ensure that these credentials can continue to be enhanced, underwritten by strong records and data. This will require continued investment in monitoring systems, investment in science based research which demonstrates that Irish production systems are environmentally sustainable, the rollout of new technologies and production processes, the transfer of knowledge to all actors in the supply chain so that the necessary productivity efficiencies are achieved while being focussed on delivering sustainability and maximising enhanced economic, social and environmental benefits from the sector.

Source: Foodwise 2025

Monitoring and evaluation is central to effective policy across all levels of government (see Table 4 and Table 5). NCA enables the assessment and improvement of policies, programs and investments to improve value add through several pathways (human capital and natural capital) using consistent performance measures. This enables more informed and evidence-based policy development based on consistent monitoring and evaluation approaches across the government. The consistent information baseline provides benchmark information for not only improved decision making by BIM but also for improved regional planning. The accounts are a public good – the information could be used for various purposes by stakeholders at different spatial scales (bay, catchment, county, country).

Initiatives such as Basin management plans, marine spatial planning and harnessing our ocean wealth would all benefit from a common information set.

Value added of the seafood industry is a key outcome metric used to infer BIMs success. Other indicators are input based, such as how many businesses attended a course, or how many businesses are signed up to a certification program. It is unclear how intermediary outcomes, such as human capital development and sustainability improvements are monitored and how these intermediary outcomes are linked to value added. Further, it is not clear how inputs, such as number of certifications are linked to sustainability outcomes (discussed in section 0). The accounts support the measurement of intermediary outcomes and how they contribute to value added (see Figure 4).

The accounts would also support sufficient and reliable data collection as part of the requirements of the common fisheries policy which focusses on maximum sustainable yield, regionalisation (context specific knowledge is required to best apply EU rules in their respective areas), fisheries science (scientific advice is the basis for good policy making) and multiannual plans (containing the goals and tools for fish stock management and the roadmap to achieving the objectives in a sustainable and inclusive way). The accounts would assist the EU to monitor and evaluate the effectiveness of their investments/use of EMFF funds (see section 4.1.5 for more information).

Figure 4: Beyond natural capital

BIM provide support to seafood businesses on numerous issues, not just environmental sustainability. A monitoring and evaluation program for other capitals, such as human and social capital, can be built on top of natural capital.

For example, BIM has a large role in upskilling across all levels and sectors of the Irish seafood industry. They work with industry, stakeholders and education providers on the skills and training programmes required to develop and expand the Irish seafood industry. BIM developed a new Seafood Training Strategy for the period 2018-2020, and a skills strategy implementation programme.

“Human capital will undoubtedly play a central role in the development of the Irish seafood industry and BIM’s commitment to upskilling across all levels and sectors was reflected in a range of investments, training programmes and education initiatives (Bord Iascaigh Mhara, 2017).”

It seems that an accounting system for other capitals could be used by BIM to evaluate all investment.

Source: BIM annual Report 2017

Table 5: Other marine policies and initiatives

Initiative	Explanation
Harnessing our ocean wealth	Three high-level goals, of equal importance, based on the concept of sustainable development have been developed. Goal 1 focuses on a thriving maritime economy, whereby Ireland harnesses the market opportunities to achieve socially inclusive, sustainable growth. Goal 2 sets out to achieve healthy ecosystems that provide monetary and non-monetary goods and services (e.g. food, climate, health and well-being). Goal 3 aims to increase our engagement with the sea. The goal is to strengthen our maritime identity and increase our awareness of the value (market and nonmarket), opportunities and social benefits of engaging with the sea.
Seafood operational program	The Operational Program strategy is designed around the Irish national priorities in the agri-food sector: 'Act Smart' by encouraging knowledge and innovation, 'Think Green' through a responsible and sustainable use of resources, 'Achieve Growth' in order to maintain and create jobs. Funding aims at increasing the competitiveness of the fisheries and aquaculture sectors through innovation and skills, while promoting a more efficient and sustainable use of resources.
National strategic plan for sustainable aquaculture development	Article 34 of the Common Fisheries Policy Regulation requires Member States to prepare multi-annual national strategic plans for aquaculture. The national plans are intended to inform investment priorities for aquaculture under Member States' operational programmes under the European Maritime and Fisheries Fund. They are also intended to identify measures to reduce the administrative burden on operators, to secure sustainable development and growth of aquaculture through coordinated spatial planning, to enhance the competitiveness of the aquaculture sector.
Food Wise 2025 (DAFM)	A guiding principle that Food Wise 2025 will seek to embed at all levels of the agri-food industry is that environmental protection and economic competitiveness are equal and complementary. As the industry embraces new levels of growth, it will be required to show an absolute commitment to the principles of sustainability. Gains in productivity must not be at the expense of the environment.
Draft River Basin Management Plans 2018-2021	The Department published the draft River Basin Management Plan for Ireland 2018 - 2021 in February 2017. The draft Plan sets out our priority objectives for water quality improvement up to 2021 and outlines a programme of measures to achieve these objectives over the intervening period.
CLAMS	The unique Co-ordinated Local Aquaculture Management Systems (C.L.A.M.S.) process is a nationwide initiative to manage the development of aquaculture in bays and inshore waters throughout Ireland at a local level.
Origin green	The overall ambition of the Origin Green programme is that farms and food manufacturing businesses throughout Ireland sign up to the sustainability agenda, making measurable commitments to producing in a sustainable manner, with progress independently assessed and verified.

4.1.4 Certification support

BIM supports the seafood industry to navigate the various certification requirements of different buyers and markets. Many certification schemes require objective information on ecosystems and fish stocks. A standardised information set that is a public good for businesses could be helpful to achieve recognised schemes, including Marine Stewardship Council, Global Seafood Sustainability Initiative, Organic Certification, Fisheries Improvement Plans and BIM's own suite of Assurance Schemes.

BIM could invest in developing a public set of natural capital accounts that could be queried by individual businesses. An interactive dataset where businesses could extract information relevant to their location could streamline the certification process and strengthen applications by providing objective evidence.

4.1.5 Return on investment

Return on investment is a ratio used by organisations to allocate financial capital. It compares the investment to the return across different projects or initiatives. The calculations can be used to make trade-offs across projects and locations to support development of the seafood industry and effectively allocate capital across activities. It is also important for attracting investment/making bids for future funding both within the Irish Government and to the wider EU.

BIM currently use qualitative assessments and input based metrics to allocate capital across different projects. The accounts demonstrate the importance of different projects quantitatively, potentially strengthening assessments which inform capital allocation. For example, with regards to the common fisheries policy, the accounts can be used to calculate comparable figures for 1 (Box 6), and 3, while they could be used as an input in 2.

Box 6: Common Fisheries fund

BIM reports on performance to European Maritime and Fisheries Fund (EMFF) to attract investment. The fund (2014-2020) assists member states to co finance operational programmes and projects, to reach the objectives of the reformed common fisheries policy. The EMFF was allocated €6,400M between 2014 and 2020 to help fishermen adapt to sustainable fishing, create jobs for the sector and diversify economies in coastal communities. 11 per cent of that figure is managed by the European Commission, while the remaining 89 per cent is managed by the member states. The funds are divided amongst EU countries for:

1. Reducing impact of fishing on marine environment
2. More market tools for professionals and consumers
3. Joint stewardship of protected areas and Natura 2000 sites
4. Special support to small scale fishermen.

Source: CFP funding fact sheet

4.1.6 Scenario analysis

The aim of scenario analysis is to estimate the outcomes associated with a number of different future events, or scenarios. The core ecosystem service framework provides the framing for analysing the

links between changes in ecosystem assets (both in extent and condition), either through investment decisions or changes in environmental conditions (higher water temperatures), and how this affects numerous outcomes (yield or climate regulation). It also provides the foundation for understanding dependencies and relationship between different locations which are also important for estimating system wide effects in a scenario.

The accounts support scenario analysis as they reflect business as usual and provide a framing to describe and collect information for the scenario. The accounts can be used to determine whether the scenario analysis was accurate and to describe which path one is on. For example, if one expects higher water temperatures to affect yield, the accounts can be used to monitor that and update expectations, provide the impetus for change in management practices and new technologies/allocation of assets. Current accounts kept by businesses would only keep measures of the financial inputs and outputs (costs and revenue from seafood sales), not on the vital natural capital inputs and the prevailing environmental system.

4.1.7 Risk profiling

Risk profiling is used to objectively determine how different areas of risk effect an organisation's objectives (for example, profit). Risk profiling can be used to make decision regarding the sustainable development of the seafood industry.

Even before any in-depth/complicated numerical risk analysis, the accounts can be used to contextualise a business's operations and identify potential risks. For example, how are fish stocks trending over time and can we relate this to a change in ecosystem condition? After identifying various risks to the entity, the accounts can be used to determine which risk factors are likely to have the biggest impact on the business.

The accounts can be used to determine the likelihood functions for various risk variables. Numbers drawn from these functions would be used to determine a range of values. For example, historical information on temperature and its link to water quality could be used to estimate how changes to temperature affects ecosystem health and the stock of fish under different scenarios and the probability of it occurring.

4.1.8 Data management

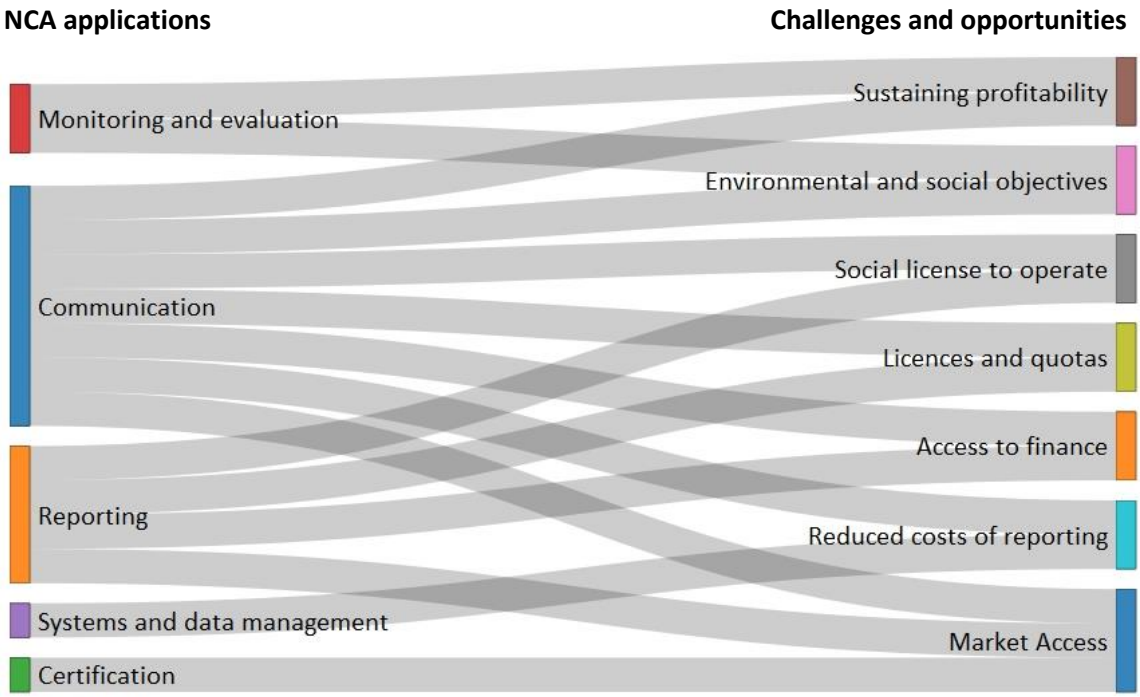
Data management is the process of collecting, manipulating and organising data so that it can be used in various applications. Effective data management can reduce costs of communicating and decision making. Despite government agencies typically spending large amounts of money on data management, much information is not organised for use across multiple applications.

The bottom up approach to NCA means the accounting information can be used across different applications. NCA also allows users to integrate data seamlessly across multiple objectives (environmental, social and economic) to support integrated decision making and reporting. The approach employed to do this is quite simple and quick and can contribute to a reduction in costs.

4.2 Aquaculture and fisheries operators

As for BIM, NCA supports multiple applications for aquaculture and fisheries operators that are linked to the challenges and opportunities described in Section 2.3. The matching between the applications and challenges/opportunities is shown in 5 (below).

Figure 5: Linking information applications and benefits for the seafood industry



4.2.1 Communication and collaboration

Communication can be used by the seafood industry to contribute to effective policy that supports their needs. Effective identification and communication of issues at the local scale will support policy. The seafood industry currently provide input to government processes, but this could perhaps be strengthened with a consistent set of environmental information (see Box 7 for efforts underway to develop a coherent voice). Communication and collaboration supports all opportunities and challenges.

Box 7: Coherent voices are valued in Ireland

The National Inshore Fisheries Forum (NIFF) has been set up to facilitate the development of a coherent inshore sector "voice" by encouraging fishermen to discuss their fishing issues and generate commonly supported initiatives. The National Inshore Fisheries Forum is supported by a network of Regional Inshore Fisheries Forums (RIFFs) based on and linked to the community led Fisheries Local Action Groups (FLAGs) around the coast of Ireland. They have nominated delegates to bring forward regional proposals to NIFF for wider industry discussion.

4.2.2 Reporting

The company, shareholders, management and the board of directors are increasingly interested in the environmental performance of the company, or the status of the resource that the company depends on. Reporting can be used to maintain the social license to operate, access to finance and also the improvement of market access through product differentiation. For example, there is a burgeoning number of investors that are seeking organisations to voluntarily report on their effect on the environment.

Entities and investors acknowledge that Corporate Social Responsibility (CSR), through developing environmentally friendly products and services, offers opportunities to manage risk and create value in a number of ways, including increased loyalty from employees, customers and investors through brand and reputation; increased investment by socially responsible investors; and consequently, reduced risk of backlash from consumers for not acting responsibly.

Business in the seafood industry currently report on financial information. Some may report on environmental information voluntarily. As capital begins to flow to sustainable activities, reporting information on the sustainability outcomes will lead to better business outcomes. Good corporate governance principles and practices such as effective monitoring and transparency through the disclosure of information means shareholders may be protected from divergent behaviour. Importantly, information on sustainability outcomes are central to the supporting a new narrative.

4.2.3 Certification

Certification provides access to markets that are looking for sustainable seafood. It requires the seafood industry to ensure management and processes are best practice and carried out at a level over and above regulatory requirements. A key tool for increasing seafood value is to demonstrate responsible environmental and sustainable performance. This is largely carried out though support to the sector to achieve certification to a range of standards. The seafood industry works with BIM to get certified through different schemes including FIP, MSC, Origin Green etc.

NCA supports the new age of certification schemes that consider outcomes instead of actions. NCA can be applied at various spatial scales to support context specific certification schemes. This would support a movement away from “broad brush” certification schemes which attempt to identify certain sustainable species (in terms of sustainable practices for species) to certification schemes which are farm specific (focus on farm practices which may be better or worse depending on the context). Operators in the seafood industry can use the accounts to provide supporting evidence on areas of their certification scheme (see Box 8). As discussed earlier, public natural capital accounts could streamline a process whereby objective evidence on ecosystems and fish stocks is required.

Box 8: NCA to support current certification schemes

> As part of MSC, operators provide information on stock of fish (PI 1.1.1), habitat outcomes (PI 2.4.1), ecosystem outcomes (PI 2.5.1), and the validity of the information required to measure both.

Source: MSC standards

4.2.4 Monitoring and evaluation

Evaluation of previous decisions can underline and promote successful pathways for the future. The accounts are fundamental to monitoring and evaluation, as without a representation of what happened historically, one cannot determine the effectiveness of interventions, nor can they assess the past to identify and correct deficiencies as quickly as possible. For example, if a farmer is monitoring nitrogen runoff into the bay (because a previous evaluation exercise has deemed it as an important factor influencing yield), then they can act when runoff reaches high levels.

4.2.5 Data management

Data management is the process of collecting, manipulating and organising data so that it can be used in various applications. Effective data management can reduce costs of communicating and decision making. NCA systems also allows users to integrate data seamlessly across multiple business areas to support integrated decision making and reporting. The approach employed to do this is quite simple and quick and can contribute to a reduction in costs.

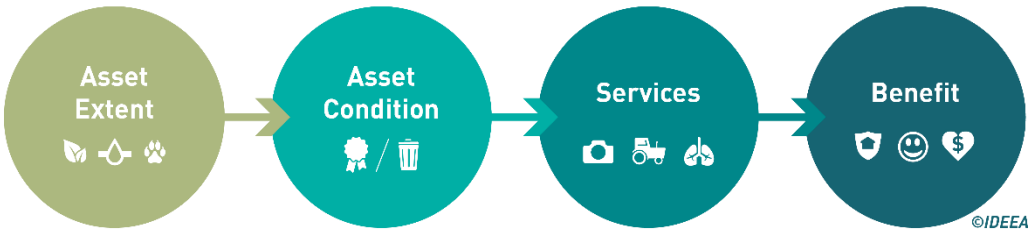
5 POTENTIAL CASE STUDIES

Sections 2 to 4 of this document have focussed on building a case for the application of NCA by describing how it can be applied to address different opportunities and challenges for BIM and the seafood industry. The remaining sections 5 and 6 focus on the practical application of NCA for Irish marine areas.

Case studies are a common starting point for NCA projects and can be used to understand the level of work required and test the value add from adopting NCA. Several potential case studies have emerged from conversations with BIM, ranging from developing natural capital accounts for specific industries within a bay to developing bay wide natural capital accounts (see 5.1 to 5.6 for a description of potential case studies). The context and key stakeholders in each of the case studies are different, and the potential benefits from adopting NCA also differs across case studies.

Data is one of the main requirements for NCA. The Core Ecosystem Accounting Framework (Figure 6) which is described in more detail in Section 6, is the framework used for organising different pieces of environmental and economic data. The known data available to populate the accounts is different in each area (see Table 6). It is our experience that enough data will exist to populate an initial set of pilot accounts, and additional sources of data will be discovered as data collection for account compilation begins. Ultimately, the preliminary data assessment for each of the projects has revealed that the existing data is sufficient for NCA.

Figure 6: The Core Ecosystem Accounting Framework (CEAF)



Source: (IDEEA Group, 2018)

Compilation of ecosystem extent accounts is possible with the known data that is available. Compilation of ecosystem condition accounts requires further investigation and partnerships with ecologists to understand the local context and ecological characteristics that should be used. There exists some information on ecosystem services (mainly provisioning services). Depending on which ecosystem services accounts are prioritised, further work may be necessary to model ecosystem services. The temporal and spatial dimensions of some of the datasets are unclear. Thorough inspection of the data during a case study can describe these elements in more detail.

5.1 Oyster Farm Management System Project

A grant has been provided to IMaR Technology Gateway, Tralee Institute of Technology to develop an oyster farm management/operations system. The project aims to improve farm efficiencies and optimise management. The management systems will be used for stock control, management of the farm and environmental monitoring.

Two farms currently participating in automation trials. One in Shannon Estuary, County Clare and one in Carlingford, County Louth. As this project is at an early stage there is flexibility to incorporate monitoring and data collection systems that could in turn be used for NCA. As the project advances, the process will be rolled out for different oyster farms across the country.

A broader information set could be used as an input into management decisions for oyster farmers trying to sustain profitability. Furthermore, it could improve market access through product differentiation. NCA could support BIM understand and respond appropriately to emerging issues, ensure the sustainable development of the seafood industry, and capture data in a way that minimises cost and is relevant for these decisions.

The accounts demonstrate the spatial dependencies between different ecosystems, for example how terrestrial activities affect marine operations. They can be used to record information on ecosystem services beyond that contributing to current economic profit (that may be monetised in the future). The framing provided in the CEAF links contextual information (i.e. temperature and pollution) to the ecosystem and economic benefits. New information on sustainability outcomes can support a new framing around certification.

The data to support this case study is good, but additional work would be required with respect to ecosystem condition and services.

5.2 Native Oyster Project

Habitat restoration plays in important role in restoring native oyster populations, alongside fisheries management. Native Oysters provide us with a range of ecosystem services: they filter organic matter from the water column and can extract nutrients improving water quality, they also provide a habitat for smaller marine invertebrates to settle on thereby increasing marine biodiversity. Historically, weathered mussel shell has been spread on areas of native oyster beds to encourage settlement. This shell must be replenished annually to have a long-term impact. In Ireland the source of cultch dried up following the closure of Letts mussel canning factory in Wexford in the 1980s.

In 2018 BIM commissioned a study to look at options for cultch supply, including sourcing mussel shell from other countries and trialling other types of cultch: gigas oyster shell and artificial spat collectors. BIM also imported 350m3 of mussel cultch to kickstart some restoration projects. In 2019 BIM commissioned a company with spatting ponds to demonstrate the effectiveness of 3 types of cultch in terms of spat collection. This was to run alongside the distribution of different types of cultch in selected areas of managed fisheries. The key question going forward is what are the most effective, both economically and from the point of view of stock restoration and stock management, techniques for habitat restoration in native oyster fisheries.

This question could be explored following a case study approach, perhaps at a single fishery such as the St. Georges oyster bed. Cultch is also available to other managed fisheries (either within licensed areas or within Oyster Fishery Order areas around the coast). The Clarinbridge Oyster Co-op operates in the area of St Georges Oyster Bed and there are 17 oyster dredge licence holders. Native oysters provide an important income to part time fishermen and small farmers around Christmas time every year. The oysters are generally exported through a local exporter. The Clarinbridge Oyster Festival, held every year in September, brings important revenue into the local area.

The accounts can be used to understand the most effective, both economically and from the point of view of stock restoration and stock management, techniques for habitat restoration in native oyster fisheries. NCA includes information on condition and therefore the effectiveness of activities to restore, rehabilitate and protect. The accounts also demonstrate both private and public ecosystem services. With many interested stakeholders (BIM, Marine Institute, Clarinbridge Oyster Co-op (who leased the fishery in the past) and Cuan Beo (a community-based organisation established with a mission of improving the quality of life, environment, economy and heritage around Galway Bay)), the accounts could provide a common information set for future policy in the area.

More work would be required to measure condition and the ecosystem services provided by native oyster populations. Other contextual information would also be needed.

5.3 Bottom mussel industry

Mussel seed is fished from the Irish Sea and deployed at licenced aquaculture sites within various bays for ongrowing. The seed source is ephemeral, and it is unlikely to survive to adult size in the Irish seabeds from which it is fished. The sector holds MSC certification on an all island basis.

From the perspective of BIM, better information can contribute to the sustainable development of the seafood industry, driving Ireland “clean and green” as a comparative advantage, managing BIMs

reputation, and access to funding. For the seafood industry, there is potential to maintain the social license to operate, improving market access through product differentiation, and access to finance.

The accounts will support an outcome focussed narrative about ongrowing to relevant stakeholders. There is the option to take a wider view than just the bottom mussel industry to see how it operates within a certain area, and if there are any impacts on other ecosystems.

The data to support this case study is good, but more work would be required to describe the ecosystem services that mussel beds provide. Other contextual information would also be needed.

5.4 Tralee Bay fisheries

Located in south west Ireland, Tralee Bay combines fisheries and aquaculture to provide private and public benefits to different stakeholders. From the perspective of both BIM and the Irish seafood industry, Tralee Bay is a good opportunity to tackle many of the challenges and take advantage of the opportunities. Any of the accounting features can be utilised.

The data to support this case study is extensive, but more work would be required to describe the ecosystem services across the whole bay and the link between marine and terrestrial environments. Other contextual information would also be needed.

5.5 Taste the Atlantic

Taste the Atlantic is a tourism initiative linked with the Wild Atlantic Way and encouraging visitors on the route to taste and experience Irish seafood at local restaurants, by visiting farms etc. The route is focused on Irelands natural and dramatic coastline. There is huge value in maintaining the asset for the continued success of the route and the businesses upon which it relies.

From the perspective of BIM, better information can contribute to the sustainable development of the seafood industry, driving Ireland “clean and green” as a comparative advantage, managing BIMs reputation, and access to funding. For the seafood industry, there is potential to maintain the social license to operate, improving market access through product differentiation, and access to finance.

5.6 Carrying capacity

This case study would concern shellfish carrying capacity of various bays and support aquaculture licensing decisions to optimise output.

NCA would be relevant for carrying capacity reporting as there are is an economic and environmental aspect for consideration when carrying out surveys and assessing a particular bay. Convincing operators to follow recommendations can be somewhat challenging and if there was a comprehensive economic benefit built into our reports this would be a big incentive.

From the perspective of BIM, better information can contribute to the sustainable development of the seafood industry, driving Ireland “clean and green” as a comparative advantage, managing BIMs reputation, and access to funding. For the seafood industry, there is potential to maintain the social license to operate, improving market access through product differentiation, and access to finance.

Table 6: Known data for the different case studies

Project	Spatial context	Ecosystem extent	Ecosystem condition	Ecosystem services and benefits	Other contextual information
Oyster Farm Management System Project	Either Shannon Estuary, County Clare or Carlingford, County Louth	Marine - public dataset held by National Parks and Wildlife Service	Water quality	Shellfish production Nutrient assimilation	Water temperature and acidity Shellfish survey data (stock distribution, growth analysis, time to market and economic return)
Native Oysters	St Georges Oyster Bed in Galway Bay.	Marine – public dataset held by National Parks and Wildlife Service			Stock assessments carried out by MI Sidescan sonar survey of in May August and October 2019 to identify sites for cultch deployment Spat collection work in spatting ponds
Tralee Bay	Tralee bay.	**Marine** Public dataset held by National Parks and Wildlife Service Infomar surveys MI Survey DCF MI **Terrestrial** Corine	NPWS SAC reporting MI Oyster fisheries data annual stock estimates Inner Tralee bay Lobster, spider crab MI/BIM Sentinel vessel data Water quality data Inner and outer Tralee Bay Shellfish Production areas MI crayfish tagging population estimation data Elasmobranch data Elasmobranch protection	Fish biomass provisioning Habitat provisioning Recreation including self drive open vessels, wind surfing, sailing schools etc. Tourism	Coastal erosion study Water management and catchment water quality

Taste the Atlantic	West Coast	**Marine** Public dataset held by National Parks and Wildlife Service **Terrestrial** Corine		Biomass provisioning Recreational	
Bottom mussel	Irish Sea, Carlingford Lough, Wexford Harbour, Waterford Harbour, Castlemaine (additional seed source off West Kerry) and Lough Foyle (Also Belfast Lough Northern Ireland)	**Marine** Public datasets held by National Parks and Wildlife Service Annual mussel seed survey	Seed mussel survey	Seed biomass provisioning	
Nutrient runoff and carrying capacity	Various	Public datasets held by National Parks and Wildlife Service		Meat yields	Temperature, salinity, current velocity, phytoplankton depletion

6 THE ACCOUNTING APPROACH

Accounting is an information system that identifies, records and communicates the events of an entity to interested users. Accounting information can assist users to understand the past and current performance of an entity, ultimately enabling insight into future prospects. The purpose of accounting is to assist decision makers (either internal or external to an entity) allocate scarce resources and identify and solve problems.

Accounting has been applied at both the micro (for example, financial accounting) and macro levels (for example, system of national accounts). In both cases, accounting is a means of measuring economic activity and communicating results to decision makers, although the audience may be somewhat different. Both accounting systems employ similar accounting principles (European Commission, International Monetary Fund, Organisation for Economic Co-Operation and Development, United Nations, & World Bank, 2009). However, there may be some differences when business accounting practices conflict with economic principles. In such cases, the SNA adopts principles consistent with the latter, as it is designed primarily for purposes of economic analysis and policymaking.

At a micro level, accounting can be separated into two broad areas of interest: financial accounting and management accounting. Financial accounting is typically concerned with communicating the aggregates of business activity to users in a standardised way. It applies various accounting rules and conventions to standardise the information provided by business so that it is comparable and reliable. Management accounting is concerned with the use of information to make decisions across business activities. It does not require any rules and is more focussed on attention directing and problem solving. Performance measurement systems that support management accounting not only include measures to evaluate the performance of the entity, but also individual managers and employees, customers, products/services suppliers or processes.

6.1 Natural Capital Accounting

Accounting approaches have evolved through time, changing with the needs of society. Concern over environmental (for example, climate change) and social issues (for example, gender inequality) has drawn attention to non-conventional elements of accounting. NCA (otherwise known as environmental accounting, environmental-economic accounting) has developed as an accounting approach to dealing with environmental issues. For example, triple bottom line reporting was established over 20-30 years ago with several companies (for example Ben & Jerry's and Starbucks) subscribing to this or similar notions of reporting. In 2015 the SDGs we approved as a key basis for sustainability reporting across both the private and public sector.

Recent calamitous environmental events have seen more attention directed towards the environment by decision makers across the private and public sector. NCA has continued to evolve since triple bottom line reporting was introduced, with NCA now able to capture a nested relationship between the economy and the environment. The new approach establishes a mind-set that recognises the

complex connections of business activity to changes in the stock and condition of natural capital. An increase in focus on context specific assets has also increased the relevance of natural capital for business decision making. Past approaches remain relevant for analysis of certain questions, but focus has shifted from the negative pressures of business activity towards understanding the sustainability of the relationship between individual businesses, their local natural capital and the surrounding social context.

6.2 NCA supported by the SEEA

The SEEA is the preferred framework for the organisation of environmental information for applications pertaining to natural capital decision making and reporting. The SEEA has been recognised by Governments across the globe, including the European Union. Countries within Europe are legislated to compile six natural capital accounts using the SEEA standard including energy, air emissions, material flows, environmental protection expenditure, environmental taxes and environmental goods and services.

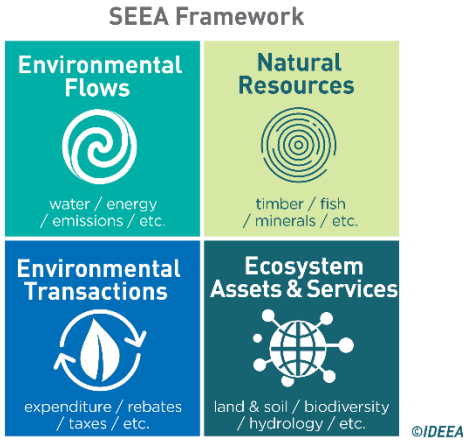
The concept of stocks and flows (see Box 9) is essential to the SEEA and accounting more broadly, both at the national and business level. Complete accounting of environmental stocks and flows has been missing from the standard approach to accounting, although there has been some focus on land and timber assets, and the services they provide where financial payment is received.

Box 9: Stocks and flows

> Stock variables describe the state of the economy at a given point in time, whereas flow variables describe the changes in the economy over a period of time. If one looks at an extremely small period of time, flows will be close to zero, whereas stocks could have a value. Stocks are accumulated or depleted over time by flows, whereas flows represent the rate of movement of items in and out of stocks.
>
> Examples of flows are expenditure, savings, depreciation, interest, exports, imports, change in inventories (not mere inventories), change in money supply, lending, borrowing, rent, profit, etc. because magnitude (size) of all these are measured over a period of time. Examples of stocks are: wealth, foreign debts, loan, inventories (not change in inventories), opening stock, money supply (amount of money), population, etc.

The SEEA fills this gap by providing a framework for measuring the connection between environmental stocks and flows such as land, water, carbon emissions and timber, and human activity. Figure 7 shows the different elements of the SEEA framework. The SEEA principles can be used to account for a range of information at various spatial scales (see Table 7). However, the true strength lies in the combination of the different accounts to tell a coherent story about the environment and human activity.

Figure 7: Elements of the System of Environmental Economic Accounting



A key motivation for the SEEA is to integrate environmental information with economic information. At the national level, environmental-economic accounting is a useful extension to the national accounts – the accounting structures underpinning Gross Domestic Product (GDP) and other macroeconomic indicators – as it can be used to investigate the contribution of the environment to economic activity, and how economic activity affects the underlying stock of natural capital. As a result, macroeconomic measures such as GDP can be adjusted to reflect changes to the environment.

A common misconception regarding the SEEA is that it is only relevant for national level accounts. Although the SEEA principles were originally designed for application at the national level, they can also be applied at finer spatial scales. The definition of basic spatial units is central to the SEEA and allow the user to aggregate information from granular spatial detail to national level. The SEEA principles are also applicable across all realms of the environment (for example, marine, terrestrial, freshwater, and any combination).

The SEEA's standardised approach to measurement means that the framework is transparent and replicable, and that information is comparable across locations and scales (local, regional and country). The spatial units underpinning the approach provides a scalable solution for certification and accreditation (for example, in carbon credit and biodiversity offset markets).

6.2.1 Ecosystem accounting

Ecosystem accounting, one of the four key elements of the SEEA shown in Figure 7, is designed to integrate information on ecosystems, biodiversity, ecosystem services, and the economy. The principles of ecosystem accounting are contained in the United Nations' SEEA Experimental Ecosystem Accounting (United Nations et al., 2014). Ecosystem accounting has four main features:

i. the use of common accounting principles, accounting structures and classifications that enable the measurement of ecosystem condition and ecosystem services in conjunction with each other and also with standard measures of economic activity

ii. the use of a systemic view of the relationships among the various types of environmental assets (for example, timber, water and soil resources)
iii. the capacity to assess the environmental impacts of economic and other human activity on ecosystems to complement the measurement of environmental pressures (such as air emissions)
iv. the use of a rigorous, spatially based approach to measurement that complements the typical national level focus and links to marine ecosystem assets.

Table 7: Information captured by the SEEA

Element	**Description**
Physical stocks	• the stock and changes in stock of different resources, both biotic and abiotic (water, carbon, fish, other species, minerals, gas) • the stock and changes in stock of different ecosystems (for example, mangroves, reefs) • levels and changes in the condition of ecosystems • levels and changes in biodiversity (diversity of key species)
Physical flows	• physical quantities of abiotic flows from the environment to the economy (water, energy) • physical quantities of abiotic flows from the economy to the environment (emissions, waste and effluents) • physical quantities of biotic ecosystem service flows to different human users (within or outside the economic boundary) • physical quantities of biotic ecosystem service flows from and to different ecosystem units
Economic wealth (value of stocks)	• the market and non-market value of stocks of different resources (timber, fish, minerals etc) • the market and non-market value of ecosystem assets (forest, wetlands, agricultural land etc)
Economic flows	• the market value of abiotic flows • the market and non-market value of biotic ecosystem service flows • expenditure (taxes and subsidies) on the environment

Ecosystem accounting is underpinned by the Core Ecosystem Accounting Framework (CEAF) (Eigenraam, M., Obst, C. 2018), which was introduced in section 5, Figure 5. The CEAF can be populated to describe Irish marine waters and the associated flows (both economic and non-economic) between these ecosystem assets and stakeholders. Asset extent and asset condition represent stocks, while ecosystem services and benefits represent flows.

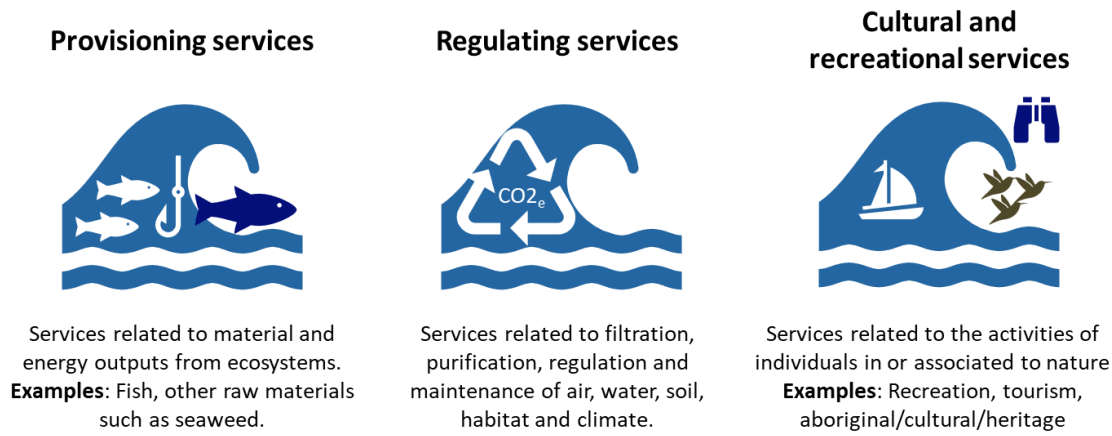
Ecosystem accounting involves accounting for four key components:

1. **Ecosystem extent** reflecting the areas of different ecosystem assets in the Irish marine waters. To classify ecosystem assets, information on ecosystem type can be overlayed with information on land use, land cover and management zones.
2. **Ecosystem condition** concerning the condition (quality or health) of each ecosystem asset in terms of the level or trend in specific characteristics. A condition measure based on various metrics (for example, species diversity) could be measured for each ecosystem asset in the Irish marine waters. Decline in ecosystem condition relates to ecosystem degradation.
3. **Ecosystem services** in which the production from each ecosystem asset is recorded. The focus in ecosystem accounting is on production of ecosystem services (typology shown in Figure 8) directly used by economic units (e.g., the biomass provisioning – fish service harvested by commercial fisheries to provide fresh fish at market) and ecosystem services supplied to other businesses and the community more broadly (for example the regulation of tidal forces by coastal ecosystems used by coastal residents and businesses).

   Although it has been proposed that abiotic natural resources, such as aggregates (sand and gravel for building) and marine energy (wind, wave, tidal), should be included in ecosystem services by some ecosystem service practitioners, they are not explicitly included here. Their exploitation, however, can have impacts on biodiversity and ecosystems and therefore need to be considered in spatial planning and environmental management (Austen, Hattam, & Borger, 2015). The quantity and quality of abiotic resources are not typically affected by the living part of an ecosystem. Where they are (e.g. water quality), this is already captured by other ecosystem services (e.g. waste treatment and assimilation).
4. **Benefits** emerge from the use of ecosystem services by economic units and other ecosystems.[4] The quantity of fish sold is a benefit and the beneficiaries are the commercial fisherman and the consumer on the supply and demand side respectively. The associated ecosystem service was the provisioning of biomass (fish) and was provided by the seagrass ecosystem. Benefits are the result of other capital inputs being added to the ecosystem service – there would be no fish to sell at market without human and built capital as inputs to catch the fish.

[4] Generally, benefits to other ecosystems are not valued and or calculated, but it is important to recognise they do exist.

Figure 8: Ecosystem Service Typology



Source: IDEEA Group

Ecosystem services and benefits – in terms of current and future flows – can be measured in monetary terms. Translating the physical quantity of the service to a monetary denomination requires the use of a transaction value (for example, the price received by a commercial fisher for one fish), or an alternative unit value where markets don't exist. The market value of ecosystem assets can be estimated by discounting the future flow of market ecosystem services to present terms. This estimate can be extended to include non-market values if necessary.

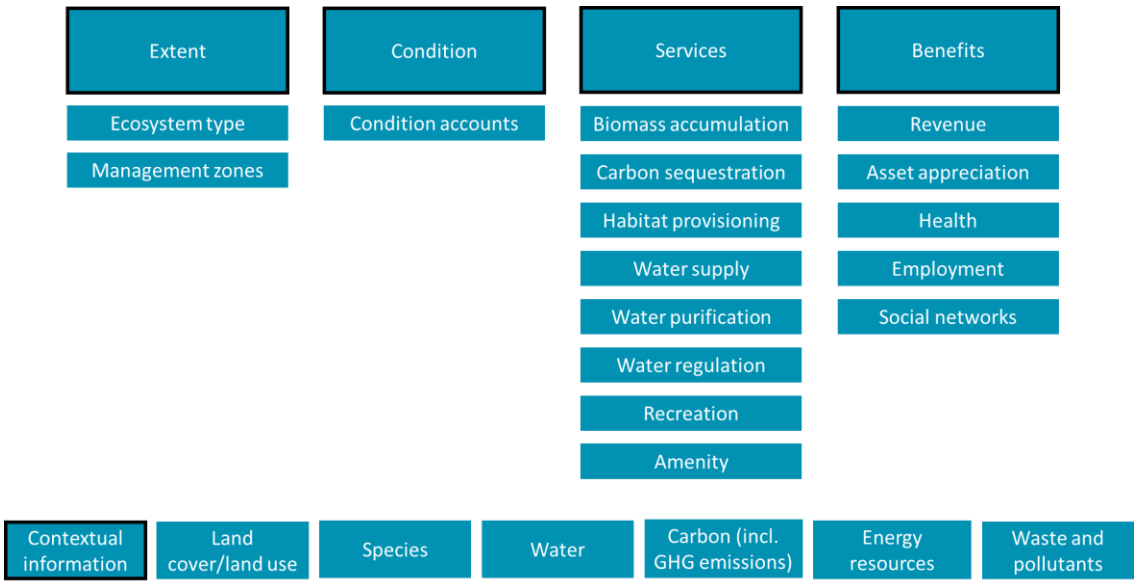
Ecosystem accounting does not necessitate the value of non-market ecosystem services to be estimated, although a singular monetary denomination can be easier for decision makers to understand. Some values are not captured within the economic system and in many cases, estimates of value will be a lower bound estimate with respect to total economic value due to methodological difficulties. For a more complete and richer picture of the relationship between the environment and the economy, biophysical information should be presented alongside monetary information.

Figure 5 contains examples of the types of information that can be gathered using the SEEA principles. There are 6 additional accounts which are not covered by the CEAF that could also be compiled. Taking a multiple capitals framing could extend the accounting system to include other accounts, but the focus here is on natural capital.

Carbon stock accounts are an example of an account that may be compiled. Carbon sequestration can be calculated as the net change in carbon stock or the carbon accumulated (net sequestration) between two periods. Note that some of the other accounts can draw on information from the other accounts (resource and flow accounts).

Species accounts are another account that can be compiled in addition to the core ecosystem accounts. Species contribute to biodiversity and ecosystem service provision; however, it is not necessary to capture this information when delineating ecosystem assets as described in the CEAF. However, in many instances for species to exist they need the underlying ecosystem assets and differing levels of condition influence their numbers (presence/absence).

Figure 9: Potential set of information using the SEEA ecosystem accounting principles



Notes – welfare gained from consumption of ecosystem services is not the focus of the SEEA. The SEEA considers value from the perspective of the production and uses transaction values, not welfare values, to describe the benefits associated with ecosystem services.

Accounts on waves and wind energy can also be compiled as additional information. This information is useful for telling an integrated capitals story. The construction of built capital may disrupt the ecosystem, impacting on its function and the ecosystem services it provides. Alternatively, there may be no disruption and built capital can be combined with natural ecosystems to produce energy without a reduction in ecosystem services.

Information gathered using the SEEA principles can be linked to existing financial accounts such as the profit and loss and the balance sheet account. NCA are designed to be integrated with these existing accounts, rather than as a separate set of accounts. As a result, the information can be presented in a way that decision makers can be confident in trading off across different business activities and revenue and costs associated with the provision of ecosystem services.

6.3 Applying ecosystem accounting to Irish marine areas

As an island nation the marine environment is intrinsic to Irish society and culture, and the Irish economy. Most marine ecosystems are public assets which contribute to common and public goods and services (for example fish stocks and climate regulation).[5] The Irish Government has an active role in the management of marine ecosystems and the regulation of businesses that operate in it to ensure that the public asset is maintained and the goods and services exist for future generations.

The motivation of this section is to discuss the CEAF in the context of marine and coastal areas in Ireland. Ecosystem accounting is yet to be widely applied to ocean environments and there is the

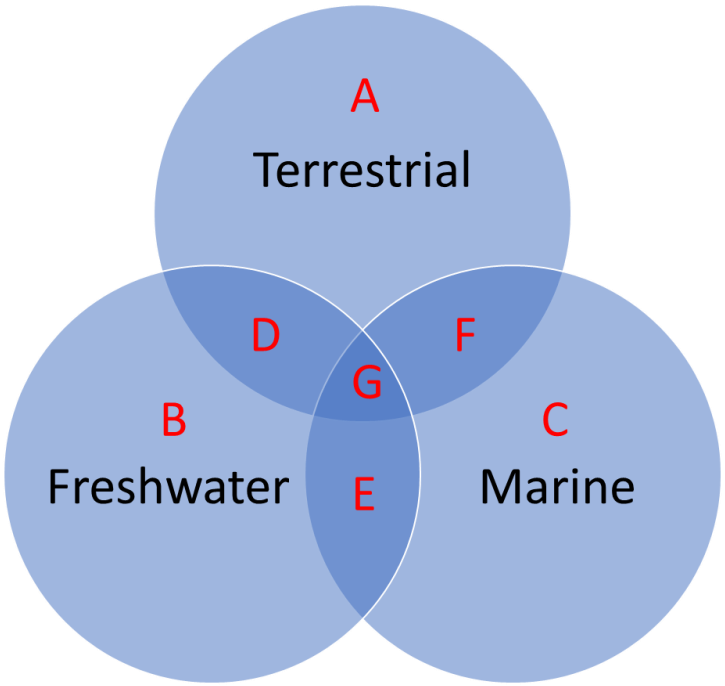
[5] A good can be an asset for they can be kept as a stock (inventory) for a particular period of time. A common good is one that is rivalrous and no-excludable

potential contribute to a growing international network of practitioners that are compiling ocean accounts. There is an opportunity for BIM to be a leader in this developing area and contribute to initiatives on a global scale, such as that run by UN ESCAP in the Asia Pacific.

6.3.1 Ecosystem asset extent

Ecosystem assets are spatial areas of a particular ecosystem type and can be measured in terms of their area. Measuring the extent of ecosystem assets can reveal how the composition of ecosystems are changing, and any substitution between ecosystem types. We distinguish between three broad realms that are important for measuring ecosystem extent; terrestrial, freshwater and marine (Figure 10). Additional classifications are required where the realms overlap.

Figure 10: Broad Ecosystem Realms

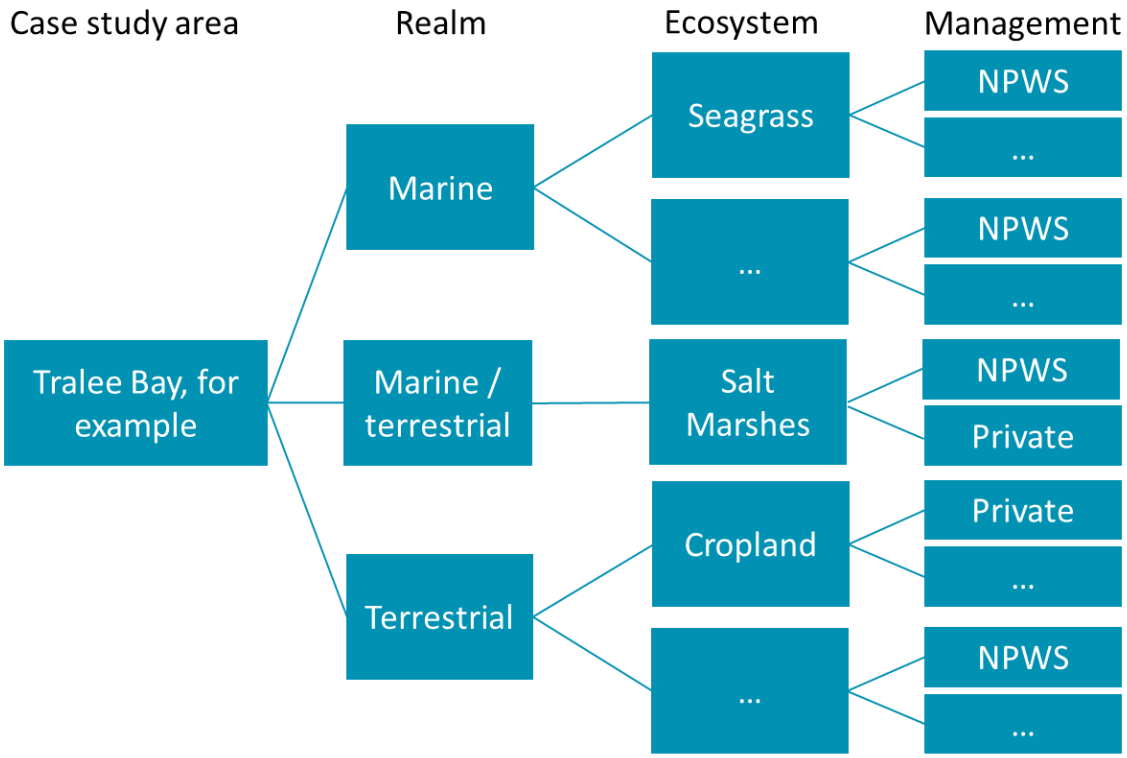


Ecosystems in bay areas can be defined as either marine (C), marine/freshwater (E) or marine/terrestrial ecosystems (F). The boundary for the accounting exercise needs to be broad enough such that substitution between the different ecosystems and realms is captured. Terrestrial ecosystems (A), freshwater ecosystems (B) and those ecosystems in between (D) are also important to the accounting exercise, as they can affect the condition of marine and coastal ocean ecosystems and their capacity to provide ecosystem services. An understanding of the dynamics between land, freshwater, marine ecosystems and human activity is an important consideration for policy makers.

An ecosystem classification should be used to delineate all ecosystems within the project area. The classification should be exhaustive and complete across all realms described in Figure 10. The SEEA suggests that the IUCN ecosystem classification should be adopted. A nested classification could utilise other information to classify the marine area in more detail, potentially combining information on realm, ecosystem type, and management zone if the spatial area covers multiple asset holders (see

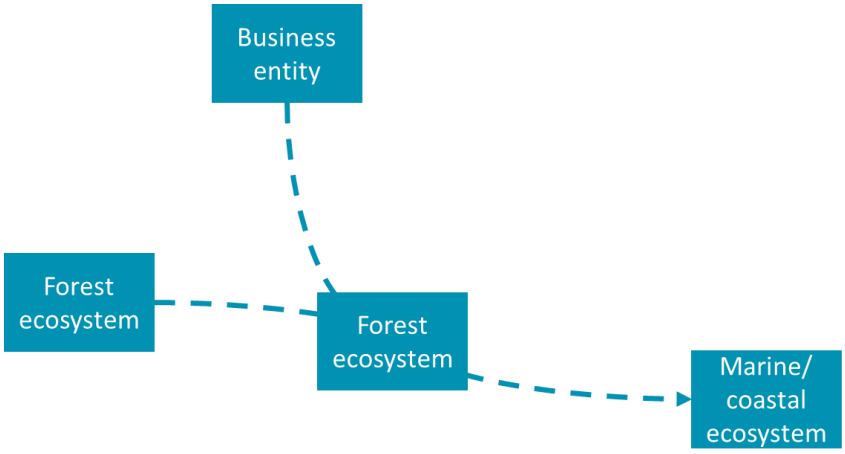
Figure 11). Under this typology there will be a range of ecosystem assets in the project area. An ecosystem asset typology would be refined during a case study, and a decision-based tree diagram would be produced to show how assets are classified.

Figure 11: Potential classification scheme



A key decision in the accounting exercise is defining the accounting area and whether it includes terrestrial ecosystems. Key terrestrial and urban ecosystems should be identified by tracing the supply chain of transactions between ecosystems (see Figure 12). There may be polluted water running into the bay and a need to account for the source of the pollution and any ecosystems that might provide services to reduce the pollution.

Figure 12: Identifying marine and terrestrial dependencies



Prioritisation is required when measuring terrestrial and marine dependencies as additional measurement can be costly and time intensive. Regarding Figure 12, it is likely that one would prioritise the downstream forest asset as a key terrestrial asset and measure the water purification services it provides. The upper most forest ecosystem could be irrelevant if water is already of good quality before passing through it. Specific flows to consider may be:

i. nutrients nitrogen and phosphorus, which are essential building blocks for plant and animal growth. The amount of nitrogen that enters marine areas controls how much plant growth can occur. When there is too much nitrogen the system is eutrophic, which results in excessive algal growth and persistent algal blooms.
ii. Pollutants include sediments and toxicants, which are further classified to include heavy metals, pesticides, industrial chemicals and chemicals of emerging concern (such as endocrine-disrupting compounds, pharmaceuticals and personal care products). Higher loads of sediments can reduce the amount of light available for seagrass growth and may also smother nitrogen cycling bacteria living on the seabed. Sediments also carry toxicants into marine areas. Most toxicants are sediment-bound, and higher loads directly affect fish and invertebrates in inshore areas, as well as marine mammals and waterbirds (through the food chain).

6.3.2 Ecosystem asset condition

Ecosystem asset condition refers to the health of the ecosystem and is usually measured by assessing one or more components of the ecosystem that are important for its functioning. There are three perspectives that can be applied to the measurement of ecosystem condition:

i. relating the condition of the ecosystem to its natural state
ii. relating ecosystem condition to the best attainable condition of the ecosystem given its current state
iii. relating ecosystem condition to the intended use of the ecosystem and the forecasted condition

The option chosen is a question of application. From an ecological perspective, it may be that condition should be measured relative to the natural state. However, it may be unreasonable to expect condition to return to its natural state, especially for something that may take a long period of time to recover. In such a case, it may be best to relate ecosystem condition to the best attainable condition of the ecosystem given its current state.

From a management perspective, it may be that condition should be measured relative to the forecasted condition of the ecosystem where it is reasonable to expect that the condition will not improve beyond that threshold. In these cases, it may be better to relate the condition of the ecosystem to intended use, such as levels of condition set out in Government rehabilitation plans, or condition thresholds set by the EPA.

Regardless of the reference condition chosen, it is critical to choose a metric, or a set of metrics that can be used to correlate ecosystem service provision capacity with the condition of the asset. Together, the extent and condition of the marine and coastal assets determines the capacity of the ecosystem to provide ecosystem services. When information is not readily available, a reasonable proxy can be used.

6.3.3 Ecosystem services

Marine and coastal ecosystems provide a range of ecosystem services. The literature is quite varied with respect to defining and categorising terrestrial, marine and coastal ecosystem services. Table 8 presents a number of different ecosystem services relevant to marine and coastal ecosystems, following the classification set out in Liquete et al. (2013). In the absence of information on ecosystem services, modelling can be used to estimate the biophysical flows and relationships between ecosystems and people. The practical application of NCA will aim to align ecosystem services information with the developing list of ecosystem services in the SEEA and the Common International Classification of Ecosystem Services.

Table 8: Potential Marine and Coastal ecosystem services

Provisioning	**Regulating**	**Cultural**
Biomass provisioning – wild seafood	Air quality regulation	Recreation and tourism
Biomass provisioning – farmed seafood (aquaculture)	Climate regulation	Symbolic and aesthetic values
Biomass provisioning – seaweed	Water purification	Cognitive effects
Other biotic materials, including genetic, medicinal and ornamental resources	Coastal regulation	
Water storage and provision		

The selection and prioritisation of ecosystem services is an important step in the ecosystem accounting process. A good starting point is perhaps fish provisioning, carbon regulation, coastal protection and tourism (see Table 9). Ecosystem assets are likely to provide more than one of these ecosystem services.

6.3.4 Benefits

Consumers, producers and communities each use a combination of natural, human, built and social capital to receive benefits from the marine and coastal assets. Consumers and communities benefit in terms of consumer surplus (not captured by the accounting system), while producers benefit in terms of revenue, reduced costs and ultimately profit (captured by the accounting system). For example, a commercial fisherman gathers benefits in terms of revenue generated by combining built and natural capital, the built capital (marine and coastal assets) providing the biomass provisioning (fish) service.

Identification of the supplier of ecosystem services is generally quite easy (i.e. it is located within the property rights of the entity – in this case the government), while identification of the user of the services is sometimes more difficult. Users of ecosystem services exist on a continuum from local/private to global/public.

A potential feature of a case study will be to link ecosystem services coming from the marine and coastal ecosystems to beneficiaries, whether they are local or offsite (say downstream). Establishing these links formally will present opportunities for ecosystem asset managers to enter discussions with stakeholders (beneficiaries of ecosystem services) to seek co-investment and provide input during the transition period.

As noted above the benefits can be either market or non-market. Measurement of the Irish marine ecosystems, the associated ecosystem services and the benefits can be estimated in both physical and monetary terms. Physical ecosystem asset accounts can be used to characterise Irish marine waters and should include the composition and condition of different marine ecosystems. Physical ecosystem service accounts are designed to describe the flows of services in different units of measurement (for example, tonnes of fish, or Megalitres of water).

Table 9: Description of key ecosystem services

Ecosystem service	Description
Fish provisioning	Coastal and marine habitats generate fish or enhance fish populations that provide nutrition and economic benefits. Production can vary across habitats, space and even across time.
Coastal protection	Marine and coastal habitats offer coastal protection to other ecosystems, built capital and the humans that use them. Coastal ecosystems influence three key process: 1) wave attenuation; 2) storm surge attenuation; and 3) maintaining shoreline elevation. Mangroves, oyster reefs and coral reefs all have a large effect on reducing the impact of coastal storms and changes in ocean forces.
Recreation	Coastal ecosystems are home to many different types of birds, marine mammals and fish that attract visitors. Coastal and marine ecosystems also provide visitors access to reefs and beaches, as well as fresh seafood. Intact coastal and marine ecosystems provide various entry points for the tourism industry.
Climate regulation	Perhaps the most important feature of marine and coastal habitats is the capacity to regulate the amount of carbon in the atmosphere through sequestering and storing carbon. Mangroves, saltmarshes and seagrass beds store large amounts of carbon in their living biomass and sequester it long term in the surrounding soil. The addition of dead plant matter to the soil represents long-term removal of carbon dioxide from the atmosphere.

Note: descriptions adopted from Spalding, Brumbaugh, & Landis (2016)

7 RECOMMENDATIONS AND NEXT STEPS

This report demonstrates how NCA can be used across multiple accounting applications, and how these applications can address different challenges and opportunities for both BIM and the wider seafood industry. We recommend that a case study is developed to test the benefits that may arise from NCA, and to build capacity around the technical aspects of NCA.

A bay scale case study is recommended as it can test the multiple value add propositions made in this report. A bay scale case study supports collaboration between multiple stakeholders (departments, agencies, seafood industry, local communities). The bay scale case study can be inclusive of both fishing and aquaculture activities and can also be integrated with land-based accounting.

The bay scale approach can capture elements of other case studies described in this report. For example, elements of carrying capacity and taste the Atlantic can be covered. The case study could be completed in Tralee Bay or another suitable location with readily available data. BIM will need to consider the stakeholders (for example, other departments and agencies, aquaculture and fisheries operators, local community groups) and their willingness to engage before selecting the case study location.

In terms of next steps, IDEEA Group recommend building support for the case study with relevant stakeholders and taking internal action to select a case study area based on stakeholders, bay context and data availability.

8 APPENDIX

Sustainable Development Goals

Indicators used to measure progress towards sustainable development and to determine if it has been achieved successfully by 2030. Global progress is monitored by the UN and individual countries must provide voluntary national reviews including stakeholder involvement.

	Goals and targets	**Indicator**
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	Index of coastal eutrophication and floating plastic debris density
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	Proportion of national exclusive economic zones managed using ecosystem-based approaches
14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	Average marine acidity (pH) measured at agreed suite of representative sampling stations
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	Proportion of fish stocks within biologically sustainable levels
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	Coverage of protected areas in relation to marine 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 negotiation3	Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing

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	Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries
14.a	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of 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	Proportion of total research budget allocated to research in the field of marine technology
14.b	Provide access for small-scale artisanal fishers to marine resources and markets	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 the United Nations Convention on the Law of the Sea, 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"	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

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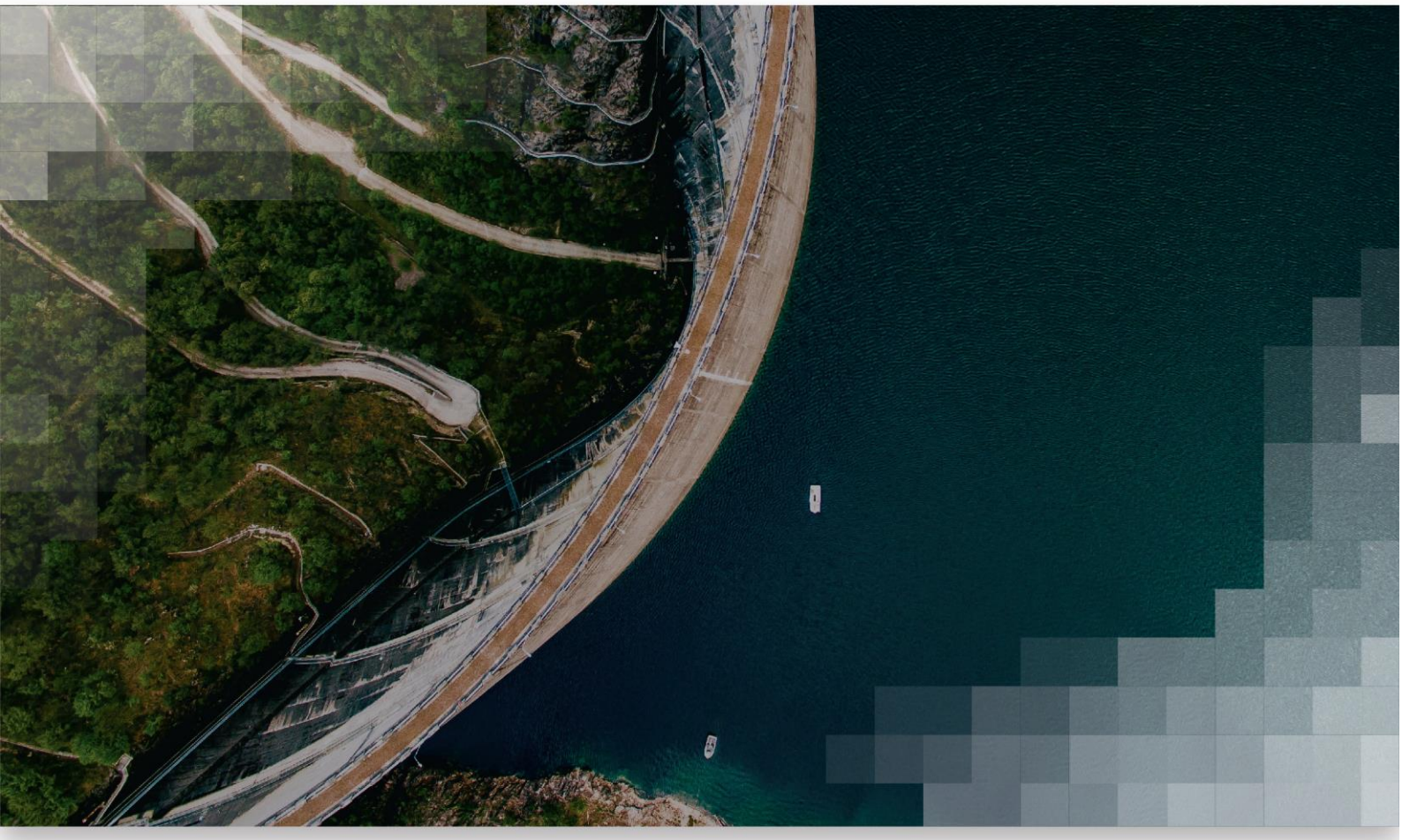

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