Deliverable 7.5:

Industry reactions to ATLAS recommendations

Project acronym:	ATLAS
Grant Agreement:	678760
Deliverable number:	7.5
Deliverable title:	Industry reactions to ATLAS recommendations
Work Package:	WP7: Policy integration to inform key agreements
Date of completion:	30 August 2019
Author:	Matthew Gianni, Maria Adelaide Ferreira, Rachel Boschen-Rose, David Johnson

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

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1 Summary

This report presents results of a component of the ATLAS Project, Work Package 7: Policy Integration to Inform Key Agreements, Deliverable 7.5. This work package is led by Seascape Consultants Ltd. and the Deliverable is coordinated by Gianni Consultancy.

The task consisted of obtaining industry reactions to a series of questions regarding the objectives of the Atlas Project, the findings of the Project to date, and perspectives from ocean businesses related to the work of the Project. These were obtained through a series of structured interviews with professionals working in a variety of blue economy sectors. The questions were designed to solicit industry perceptions of the key ATLAS findings and potential impacts of the findings on their businesses including future plans and activities. The objective of the task was to help shape the way in which industry views, plans and needs are incorporated into the remaining scientific research of the Atlas Project and into the recommendations of the project on policies, future scientific research and other matters in support of a sustainable blue economy.

Altogether fifty-five interviews with professionals working in a variety of ocean industries were conducted. Twenty-seven of the interviews were with professionals working in ten specific blue growth sectors including the aquaculture, blue biotechnology, cables, fisheries, deep seabed mining, oil & gas, offshore renewables (tidal & wave and wind), tourism, and shipping. Another twenty-seven interviews were conducted with professionals working in cross-cutting industries such as underwater survey, monitoring and repair, AUV and ROV manufacture, general offshore service, and data provision and analysis.

All sectors expect to expand their activities in the North Atlantic basin within the next decade. Developments in technology, automation, artificial intelligence (AI) and big data are seen as some of the main enablers of the various types of expansion envisaged. All sectors already collaborate to some degree or another with one or more other sectors of the blue economy and/or plan to expand their range of collaborations in the near future, sometimes with some unusual partners. At the same time a number of the sectors indicated that there is already, or is likely to be, competition and/or conflicts with other sectors, for example fisheries with offshore wind, oil and gas and deep seabed mining in addition the need to accommodate areas set aside for marine conservation (e.g. MPAs).[1] As one industry representative put it, 'it's getting crowded out there'.

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[1] See for example the advice from the Long Distance (Fishing) Fleet Advisory Council of the European Union in May 2019 recommending a moratorium on deep seabed mining at https://ldac.eu/images/EN_LDAC_Advice_on_Deepsea_Mining_R.04.19.WG5_May2019.pdf and the

The main business drivers indicated by the participants for their sectors include technology developments; climate change (various dimensions), policy and regulatory developments, measures and legal requirements; securing independent supplies of energy and food production; public opinion and increases or shifts in consumer demands. Brexit was cited as an issue by a number of participants, both based in the UK as well as in other countries.

A number of additional drivers were cited by respondents working in the underwater technology sector and cross cutting industries. These included increased demand for monitoring, expertise, analysis, technology and equipment – often in response to new regulations (e.g. environmental impact assessment requirements for a variety of sectors; bycatch reduction measures in fisheries); emerging strategic military and national defence initiatives (and concomitant technological needs and developments); and anticipated increased spending for marine scientific research by both the public and private sectors more broadly. While often overlooked, generally speaking, as a 'blue economy' industry, the underwater technology, monitoring, scientific research and environmental assessment industries are likely to be major growth sectors in the coming decades as a greater premium is placed on understanding the biology and ecology of deep-sea and open ocean ecosystems, in particular in response to climate change. This in turn may well prompt further growth in the more obvious 'blue growth' sectors or industries as they use the enhanced technology, knowledge and expertise to adapt to changes in ocean dynamics and regulatory initiatives, feeding a 'virtuous circle' of adaptive blue growth and a better understanding of ocean ecosystems.

Participants referred to many different types of technological developments, many of which are related to advances in automation, digitalization and big data, that will help their businesses address the findings of the ATLAS Project and to adapt to new conditions. At the same time, they also identified technological, economic, regulatory, environmental and social barriers to using such technological solutions.

Despite the specificities of each business or sector, there was a generalized feeling among virtually all of the participants that new regulations are likely and expected, including the adoption of an International Legally Binding Instrument for the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction (BBNJ Agreement), and these will have a significant impact on their future business activities, with many taking the view that further

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recommendation of the South Western Waters Advisory Council from May 2019 on fisheries and oil and gas and deep seabed mining at http://cc-sud.eu/images/img-ccs/avis/Avis-2019-2020/Avis129-Petrole/Avis129-Petrole-FR.pdf regulations (and increased certainty associated with them) are necessary and, for the high seas, a pressing need.

Globally, participants perceived the ATLAS Project as providing relevant and important contributions to the scientific knowledge of the North Atlantic basin, with significant potential to influence policy and management of the area as well as being helpful for their businesses, particularly for longer-term future business planning.

2 Methodology

The task consisted of obtaining industry reactions to a suite of ATLAS' scientific findings, through a series of interviews and questionnaires, to collect information on how different sectors of the Blue Economy perceive the ATLAS Project's research and finding and their potential impact on their business activity. The methodological approach used consisted of a qualitative approach involving semi-structured interviews and questionnaires based on the interview questions, with a range of blue growth industry stakeholders (Saunders et al, 2015)[2]. Furthermore, the methodology employs a subjectivist approach to the study and anonymises the answers (Wahyuni, 2012).[3]

The objective of the task was to help shape the way in which industry views and needs are incorporated in the remaining scientific research of the Atlas Project and the recommendations of the project on policies, future scientific research and other matters in support of a sustainable Blue Economy.

Ten blue economy sectors were initially identified for this study and categorized as follows:

- Cables & pipelines
- Oil & gas
- Shipping
- Tidal & wave
- Wind energy
- Tourism
- Biotechnology
- Aquaculture
- Deep seabed mining
- Fishing (open ocean pelagic and deep-sea demersal)

[2] Saunders, B., et. al, Anonymising interview data: challenges and compromise in practice. Qualitative Research 2015, Vol. 15(5) 616–632
[3] Wahyuni, D. (2012). The Research Design Maze: Understanding Paradigms, Cases, Methods and Methodologies.

Factsheets were prepared for each of these blue economy sectors featuring a short summary of current status and challenges and of ATLAS key findings (see Appendix 2). A list of potential interviewees representative of the different blue economy sectors was identified, contacted and invited to participate. The initial group of participants was expanded by snowball sampling.. Altogether twenty-eight interviews were conducted with respondents for the ten targeted sectors and were carried out between February and July 2019. Results were analysed by the sector of activity. Research results reflect participants' impressions or perceptions without determination of accuracy.

In addition, the Project took advantage of the opportunity to conduct interviews at Ocean Business 2019, one of the world's largest trade shows for ocean businesses and technology, held at National Oceanography Centre in Southampton, UK 9-11 2019. A number of the participants in the ATLAS Project came together as a team to interview select business representatives, focusing on businesses involved in deep-sea and open ocean related services amongst the exhibitors and to host a half-day workshop at Ocean Business to present key findings of the ATLAS Project for the benefit of attendees at Ocean Business 2019.[4] The twenty-seven interviews conducted at Ocean Business 2019 provided interesting and useful perspectives across a number of sectors as many of the representatives interviewed represent companies (e.g. companies specializing in big data, Artificial Intelligence (AI), Automated Underwater Vehicles (AUV) technology) with clients in multiple blue economy industries.

The questionnaires were prepared with the same questions as the structured interviews, but in a format that would enable respondents to answer these questions more rapidly, an important consideration for gathering responses during a busy trade-show, such as Ocean Business. As the questions in both the structured interviews and questionnaires were the same (see Appendices 1 & 3), the results were combined for analysis in this study, providing a total number 55 five responses across the questionnaires and interviews.

For both the interviews and questionnaires, several pages of information were prepared for participants, in some cases tailored to the individual sectors concerned (see Appendices 1 & 3). These included:

[4] EU ATLAS Horizon 2020 project workshop 'Science, Policy and Blue Growth: An Atlantic Assessment'; 10 April 2019 https://www.oceanbusiness.com/conferences-meetings/co-located-events/eu-atlas-horizon-2020-project/ see also https://www.eu-atlas.org/images/press_releases/ATLAS_Ocean_Business_PR_AQUATT_Final_15.04.19.pdf

- 1st page: Information about the ATLAS project and work package 7; privacy notice and consent form;
- 2nd page: Factsheet of the participant's blue economy sector;
- 3rd – 5th page with a two-part questionnaire comprising the following:
  - Questions regarding the company or sector represented:
    - What is your Blue Economy sector?
    - What is your subsector? (if applicable)
    - What is your institution type? Options: Regulatory body; private company; research institute; consultancy; other (please specify).
    - What country is your company or institution based in?
  - Survey questions:
    - Do you envisage new or expanded activities in the North Atlantic before 2030? If so, what sort of activities and where?
    - Do you have any plans to work collaboratively with other sectors to address your business challenges? If so, how and with which sectors?
    - What are your main business drivers moving towards 2030? For example: Brexit, technology developments, business opportunities created by climate change?
    - How will the key findings of ATLAS influence your plans?
    - Are there any current or anticipated technology developments in your sector that may help address some of the issues ATLAS has identified? If so, what are they?
    - Do you anticipate that the development of a new legally binding instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) will influence your sector's business plans?

Interviews were conducted in person, via phone, or video conference. Whenever necessary, additional prompting questions were asked to help clarify the respondent's answers. Responses were written down by the interviewer and when agreed sent back to the interviewee to check for accuracy. All interviews are stored by Seascape Consultants Ltd in an anonymised random number-generated format to guarantee that responses are not individually or institutionally identifiable.

Not all of the participants' work areas fitted neatly within the ten sectors of the Blue Economy considered in this study. Moreover, a number of participants identified more than one sector within which they operate, including most of the participants interviewed at Ocean Business 2019. These latter contributions were bundled under a single category identified as "cross-cutting" (cf. Table 1 for a description of the work areas of these participants).

3 Results

3.1 Characterisation of the participants: questions regarding the company or sector represented by the interviewees

Table 3.1 shows the distribution of interviews by sector of the Blue Economy. Information is also provided concerning specific subsectors. One of the structured interviews was with a respondent whose work spanned multiple blue economy sectors; this was also the case for all of the questionnaire responses obtained during Ocean Business. We considered these responses to all fall within one group ('cross-cutting'), and as a result, this group has by far the largest sample size (28 respondents).

Table 3.1: Distribution of interviews by sector, with a description of subsectors

Sector	No. Interviews	Subsectors
Aquaculture	3	Integrated multitrophic aquaculture; brackish/marine
Biotechnology	3	Bioprospecting & applications, inc. pharmaceutical
Cables & pipelines	1	Submarine fibre optic and power cables
Oil & gas	2	Exploration and exploitation (also renewables)
Shipping	3	Research, education, training; Cargo
Tidal & Wave	3	Optimisation of tidal energy arrays/modelling/assessing environmental impacts; Energy utility developer
Tourism	2	Whale/dolphin watching; oceanic cruise liners
Wind	4	Research; Energy utility developer
Fisheries	3	Bottom/deep-sea fisheries; pelagic, open ocean fisheries
Deep seabed mining	2	Exploration and regulation, predominantly for polymetallic sulphides
Cross-cutting	28	Regulatory body; Underwater technologies and services for multiple sectors.
Total	**55**	

Only one representative from the cables sector was interviewed. Therefore the results pertain solely to this subsector of cables.

Figure 1 illustrates the distribution of participants by institution types. It is important to note that while approximately two thirds of interviewees were from private companies, all other participants (research institutes, consultancies, regulatory bodies, advisory bodies and not-for-profit associations) also work in close proximity with industry.

Figure 2 offers a representation of the geographic distribution of the institutions that participants came from, covering both sides of the N Atlantic basin and 12 countries. Some of these companies have offices in different countries and in different continents, represented here by the category 'multiple'.

Figure 1: Distribution of participants by company or institution type

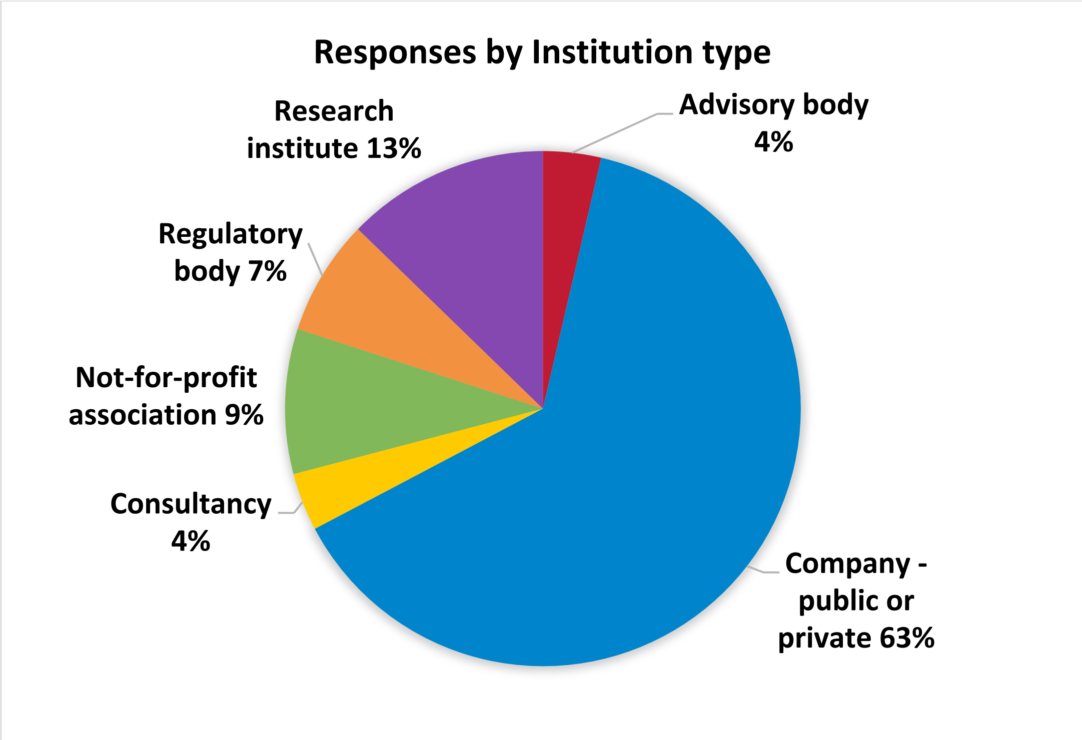
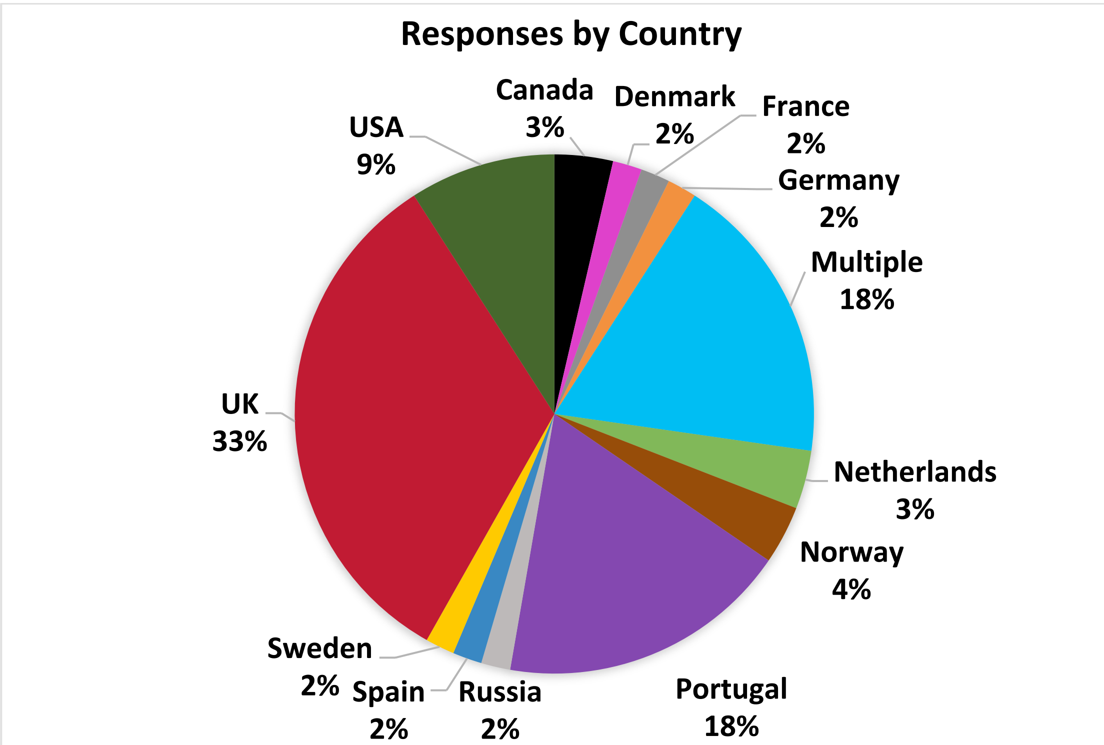


Figure 2: Countries where participants or their companies/institutions are based



3.2 Survey questions

3.2.1 Do you envisage new/expanded activities in the N Atlantic before 2030? What sort of activities and where? (Which locations/routes/species are of interest for expansion?)

All sectors surveyed expect to increase and/or expand their activities or areas of operation in the North Atlantic within the next decade (Cf. Table 3.2.1.).

In aquaculture a shift from monospecific to integrated multitrophic practices is expected, targeting higher trophic level species favoured by consumers around the N Atlantic basin. Blue biotechnology will foreseeably focus on biodiversity hotspots and extreme environments, not all of which are necessarily deep or distant from the coast.

The exploration for, and exploitation of, oil and gas is expected to continue on both sides of the Atlantic, coupled with the development of various types of marine renewables, including wind, wave, tidal, solar, and even eventually hydrogen production.

Shipping is also expected to expand in the N Atlantic in relation to developments in the cargo, fishing, aquaculture, energy, and tourism sectors. The expansion of (nearly) autonomous shipping is mentioned. The opening of the Northwest Passage is seen as an opportunity for shipping related to cargo transport, energy, and tourism, even though that possibility also raises some concerns among participants. Increasing internet traffic will entail an expansion of cables in the N Atlantic.

Changes in the areas fished and species targeted in open ocean and deep-water fisheries are expected primarily as a result of shifts in the migratory patterns and related jurisdictional issues (shifts in location of fish stocks into different countries' waters or onto high seas) and the resilience of fish populations to ocean warming, changes in circulation and other impacts of climate change. In regard to deep-sea mining, expanded activity for prospecting and exploration for polymetallic sulphides and cobalt crust deposits are anticipated along the Mid-Atlantic Ridge and on the Norwegian extended continental shelf.

Developments in technology, automation, big data are seen as some of the main enablers of these various types of expansion.

Table 3.2.1: Summary of results for question 1

Sector	Expected developments	Areas in the N Atlantic/Species
Offshore aquaculture	- expansion to 100-200 m deep into more exposed areas, with favorable environmental/ ecological conditions (O_2, T, etc.) and good access. - lower depth limit determined by physical height of the pen/cage; risk of eutrophication - shift from monospecific aquaculture to integrated multitrophic aquaculture (IMTA)	Norway, North Sea, Portugal, Canada Potential for fish and shellfish. Actual species to be produced will be decided by markets/consumers. Europeans, Canadians and Americans favour species of very high trophic levels, e.g. tuna, salmon, sea bass and sea bream.
Blue biotechnology	- intensification of bioprospecting for new marine compounds in the N Atlantic, through increased partnerships/ collaborations (Norway, Scotland, Ireland, France, Spain, Portugal) - Study of the vast amount of unexplored biological material at the so-called "0 m depth", in the (refrigerated) collections of institutes/universities	Exploration of biodiversity hotspots (inc. microorganisms) and extreme environments: cold, hot, deep, hypersaline, methane sources. Some extreme environments are easily accessible: e.g. hydrothermal vents; methane sources; saltpans.
Cables	- Increasing internet traffic and need to replace aging trans-Atlantic fibre-optic cable systems: projected 85% increase in capacity (installation of new cables with larger capacities). - recovery of old cables for recycling of copper, steel and marine grade polyethylene components.	European side of the Atlantic: deployment of power cables associated with the expansion of offshore renewable energy farms Ocean observatories, underpinned by hybrid fibre-optic/power cables, will continue and expand their present operations.
Oil & Gas	Continued exploration and production of oil & gas in the N Atlantic, including a move to more extreme (deeper) areas. Potential to develop ocean renewables: tidal, waves, salinity gradients, thermal gradients. Biofuels based on seaweeds are another potential field of expansion.	- Europe, Norway (N Sea): 30 new sectors for oil exploration/exploitation - USA, Gulf of Mexico: continued oil exploration/exploitation. - Potential gas extraction: Canada (Jeanne D'Arc basin & Grand Banks), coasts of Portugal, UK and N Ireland, and offshore e.g. Rockall Bank.
Renewable energies	Wind: Currently limited to fixed wind turbines (up to 50-60 m deep); by 2030 likely to expand significantly (area and power) on continental shelves: - 1st half of the decade: technology remain dominated by bottom-mounted fixed structures, principally monopiles. - 2nd half of the decade: expansion and maturing of floating technologies (>60 m) expected to occur. - increasing number of offshore substations connecting windfarms to the grid, and potentially the start of offshore energy storage (e.g., batteries). Tidal: very site specific (95% of the tidal resource in Europe is in the UK and France) but the market is increasing. By 2030 there could be various tidal farms with dozens of turbines with a capacity to produce a few hundred megawatts Wave energy: early stage of development. After initial impetus slowed down due to an incapacity of demonstrating technical viability, at present it is regaining relevance, and there will be progress through 2030.	Wind: - Europe: North Sea, English Channel. Atlantic margins of France, Scotland, eventually Portugal and Spain - USA: NE coast of New England, New Jersey, Maryland. Unitl 2030 it may go as far South as N and S Carolina. Tidal: - Europe: Brittany (France), Ireland, N Scotland (Orkney waters, Pentland Firth), Wales. Some resource in Norway and Portugal (testing sites for small prototypes); - Canada and USA: Nova Scotia/Bay of Fundy; NE coast of the US. Wave: - Europe: greatest interest/activity (mostly R&D; some small scale pilot projects) in Atlantic facing countries: Portugal, Spain and Scotland/UK. - Some interest in the US.
Shipping	Yes, expanded activities in the N Atlantic perhaps by 80%, e.g. transporting cargo between the US and Europe: - Arctic ocean: with melting of Arctic ice, by 2030 the use of routes that are already navigable will be quite conventional. Maybe also some increased military activity in the N Atlantic. - LNG: Yamal Project (Russia/Arctic), North Norway (growing). - Growth in cruise industry - Fishing: some expansion also.	Cargo/LNG: Arctic ocean/N Norway Cruise: Shetlands, Orkney, Iceland, N Ireland, Norway Wind: Isle of Man, Irish Sea, and North Sea Aquaculture: NW (Atlantic) Europe (Europe); East coast of the US.

Sector	Expected developments	Areas in the N Atlantic/Species
	- Renewable energies (wind/solar) - Aquaculture (incl. seaweed farming) - increase in highly automated vessels in N Atlantic routes; debatable if that will happen by 2030; unmanned ships in the Arctic are unlikely: unreliability of required network of sensors and security issues (vulnerability to cyber and physical attacks; lack of a legal regime to determine accountability for issues generated by remotely operated and autonomous ships.)	
Tourism	Cruise tourism: business expanding dramatically, with more modern and bigger ships looking at more varied areas within the N Atlantic basin, including e.g. the Canadian region, depending on how the NW passage opens up. Whale watching: Expected to expand.	Cruise: transatlantic and potentially NW Passage Whale watching: expansion in Portugal (mainland, Madeira, Azores)
Fishing	Changes in migratory patterns of commercial fish already occurring and likely to continue to occur as a result of climate change/ocean warming requiring changes in fishing areas and patterns. Complicated by multiple jurisdictions (EEZs vs high seas). New species may be targeted and new areas fished in response to climate change as well as declines in more traditional species, competition from aquaculture, changes in consumer demand	Examples of changes in stock status and migration patterns: North Sea cod, Barents Sea cod, northeast Atlantic mackerel
Deep seabed mining	In the exploratory phase in the North Atlantic at the moment, primarily focussed on polymetallic sulphides (formed by hydrothermal vent systems) with technology for exploration and exploitation still under development. Expansion of prospecting and exploration activities for polymetallic sulphides along the northern (and southern) Mid Atlantic Ridge and the Mohn's Ridge and potentially for cobalt crust deposits on Norwegian continental shelf. Commercial deep-sea mining could begin by 2030.	Norwegian legal continental shelf, Mohn's Ridge and Mid-Atlantic Ridge
Cross-cutting	- offshore renewables: wind (incl. expansion of floating offshore); Mostly over the continental shelf (shorter cables); - solar (shallow coastal floating farms, probably collocated with aquaculture). - 1st pilot plants for offshore H production well before 2030, alongside solar and offshore wind to store energy from renewables (using the energy to make hydrogen from seawater). Ongoing research into technological changes to adapt pipelines built for natural gas to Hydrogen; - further offshore aquaculture (including algae and refineries); - blue biotechnology; - ocean mining; - Tourism, increasing in accommodation, and use of the sea for different tourism products: whale/dolphin watchin, diving, boat trips, sports (surf, body board); - Ocean robotics and automation/digitalization; - Green shipping (GNL)	Offshore wind: Continental shelves. Atlantic Canada (up to Newfoundland and Labrador). NorthEastern USA Solar: Southern to Northerly Europe Hydrogen: North Sea, Scotland, Norway, Deep-sea mining: mid-ocean ridges

3.2.2 Do you have any plans to work collaboratively with other sectors to address your business challenges? If so, how and with which sectors?

All sectors already collaborate with one or more other sectors of the blue economy and/or plan to expand their range of collaborations in the near future, sometimes with some unusual partners (Cf. Table 3.2.2.).

Companies and/or research institutes with engineering and computing/analytical solutions to challenges faced by the various blue economy sectors are the most frequently mentioned partners.

Other than ongoing collaborations in R&D, some concrete examples of colocation or of shared infrastructures on land were offered: industrial innovation centres (company accelerators), and shared infrastructures in ports related to aquaculture and biotechnology projects. Very few examples of co-location in offshore platforms are known to participants, who attribute it to a lack of actual incentives for collaboration between sectors, and to the fact that opportunities of working with other sectors are limited by consenting processes setup for one application – one activity – at a time and for a number of associated regulatory constraints (including safety/liability issues). There is nevertheless a perception that policies in Europe are shifting towards encouraging co-location and collaboration.

At the same time, collaboration, or potential collaboration, was mentioned in relation to conflict amongst sectors, for example fisheries and offshore oil and gas. In this context collaboration was seen by one participant as more of a dialogue amongst sectors designed to resolve conflicts than a business collaboration, but nonetheless an important type of collaboration in its own right.

Table 3.2.2: Summary of results for question 2

Sector	**Collaborations**	**Concrete examples**
Offshore aquaculture	- Engineering and technology (big data), robotics, telecommunications: required by the ongoing intensification in production. Answers can come from oil & gas, or from the ship building industry. Automation can draw from existing production sectors that have nothing to do with aquaculture. - Biotechnology: domestication of aquaculture species; production of alternative ingredients for feed. - Modelling: identifying suitable areas for aquaculture and prevent conflicts with compatible activities, including, ecotourism, fishing, transportation	- Collaborations between researchers and private companies, sometimes also with governments: Research on feed development, site selection, etc. - Shared infrastructure in ports: already a reality. - Co-location in offshore platforms is often mentioned (e.g. offshore energy and aquaculture), but participants were unaware of existing examples.
Blue biotechnology	Collaborations with usual and unusual partners: fishing, aquaculture, ports and offshore energy. E.g.: **- Aquaculture/Fishing:** feed development; improving aquaculture processes **- Ports:** benefits in issues related to mitigation of environmental impacts of ports **- Robotics/engineering**: drones and SUVs, and sensors to carry out bioprospecting. **- Pharmaceutical industry:** discovery or synthesis of new molecules, based on marine enzymes. **- Venture capital sector;** - **sustainable alternatives to plastic**: **- new generation antifoulants**: new intelligent-release biocides for shipbuilding, offshore (energy) platforms **- Textiles**: development of pigments from algae Biotech, aquaculture and offshore energy will be closely related through multi-use platforms. At present, that is more a concept than a reality.	Concrete collaboration examples: **Port Tech Clusters initiative**: hubs to leverage blue economy sectors: energy, blue biotech, fishing, aquaculture… (**Portugal**) **Industrial biotechnology innovation centre** (IBioIC) (Glasgow, Scotland): interface between industry, academia and policymakers. **BLUE DEMO NETWORK**: a single access point for all the national infrastructures that can serve the blue (bio)economy (Portugal). **Aquaculture/Saltpans** (Portugal): organic production of sea bass and sea bream, and IMTA of algae.
Cables	- Strong collaborations with universities and other research groups, since the first fully operational cable	

Sector	Collaborations	Concrete examples
	came into service in 1858, to improve understanding of how the ocean functions and interacts with submarine cables, including global analyses of (i) various geological hazards as identified from cable breaks, (ii) seabed recovery from cable burial, and (iii) interactions of benthic animals with telecommunication and power cables. Attention is turning to the possible use of cables as sensors of environmental change and hazards in particular tsunami and earthquakes. - close collaboration with various marine industries, mainly commercial fishing, shipping, and oil & gas development - to install, repair and protect submarine cables. - outreach and risk mitigation with offshore renewable energy and deep seabed mining, which are emerging threats to fibre-optic cables; Seabed mining has the potential to significantly harm cables. Note exploration contracts for polymetallic sulphides on the mid-Atlantic Ridge have been issued by the ISA.	
Oil & Gas	Collaboration with technology companies: - Growing digitalization/automation (smart wells) and computing capacity (to generate, process and transmit data). Digital technologies will allow preventive (rather than reactive) maintenance and will help with systems efficiency, streamlining the various operations - Materials engineering (new equipments) and development of smaller equipments (to fit in platforms) - Cables (optical fibre) and pipelines (to transport products) - other energies: prospects of collaboration with renewables (electricity), aquaculture and biotechnology. Co-location with wind energy being contemplated in the North Sea	
Renewable energies	Offshore wind (and wave energy), collaboration with: - technology developers; - fisheries, aquaculture, oil & gas, to ensure stakeholders are informed and support these developments. Room for synergies and win-win cooperation. Envisaged types of collaboration: - Oil & gas: sharing/gathering knowledge/experience related to working at sea. Perceived opposition from O&G industry to the deployment of offshore wind, e.g., in the North Sea, linked to a perception of risk to helicopter transits (transporting people to/from platforms, search and rescue) posed by offshore wind. - Fisheries/aquaculture Tidal: collaboration with: - other offshore energies: e.g., testing floating platforms for tidal turbines and for offshore wind; supply chain providers. - aquaculture: provide energy to power small pumps, e.g. to feed the fish, pump antibiotics, etc. - Research on environmental modelling, to assess wave conditions, best currents, moorings, etc. - Tourism: on-site environmental education, raising awareness on sustainability issues, blue energy, etc.	Currently, no incentive for collaboration between sectors. Opportunities of working with other sectors reduced by regulatory constraints and insurance/ safety/liability issues. Complex consenting process for any one activity. System is setup for consenting one application – one activity – at a time. Policies in Europe are shifting towards encouraging colocation and collaboration. Wind/fisheries/aquaculture: Relatively small trial operation in N Wales; in Belgium one wind farm licensed to work with aquaculture.
Shipping	Shipping relies on collaboration, among different seafarers of different nationalities. Examples: - Many types of associations: shipowners, managers of tankers, employers' associations. - cooperation related to safety at sea. - shipping, offshore wind and fisheries.	IMO: all maritime sectors EU, EC: seafarer groups represented to influence decision-making. Smaller associations: platforms for discussion and cooperation. E.g. Maritime London, Maritime UK, Blue Denmark, Maritime Isle of Man.
Tourism	Cruise industry: Work with other stakeholders e.g. national governments, terminal operators, port operators and with other sectors, including airlines (charter flights to transport guests to the ships) Whale watching: no plans to work collaboratively with other sectors	
Fishing	Collaboration with a range of sectors such as offshore wind energy and oil & gas over citing of installations and marine spatial planning, often through formal consultative processes convened by government. Multisectoral and stakeholder consultation and collaboration through the EU's (regional fisheries) advisory councils.	
Deep seabed mining	As the industry is still in the nascent stages, collaboration with other industries not yet a major issue. However, a recognition that some degree of collaboration may be necessary – e.g. with the fishing and shipping industries and marine conservation interests/organisations.	
Cross-cutting	- Renewables and aquaculture: co-location helps share the costs. For the energy company, aquaculture constitutes an extra line of profit! A few years away from being a reality, but the interest is there. - Desirable collaboration between fisheries/aquaculture/blue biotechnology, and university training/research to promote efficiency and zero waste along the chain of production. - Underwater technology and services working with a range of sectors, collaborating over the development of technology and analytical techniques for underwater research and monitoring.	

3.2.3 What are your main business drivers moving towards 2030? For example: Brexit, technology developments, business opportunities created by climate change?

Table 3.2.3 summarises the main business drivers mentioned by the participants for their respective sectors. The main drivers are:

- Technology developments, in a number of shapes and forms, adapted to the needs of the various sectors, are probably the main driver mentioned by the majority of respondents though in many instances, the types of technology developments cited were those need to respond to markets, shifts in consumer demand or perceptions, new regulations and/or adaptation to climate change.
- Climate change was cited as another main driver as creating both challenges and opportunities for industries. For many participants, addressing climate change represents primarily an economic driver related to ensuring sustainability of businesses and not driven by sustainability concerns sensu strictu. However for some, climate change relates directly to sustainability. Fishing industry representatives all noted that fish stocks are changing migratory patterns in response to ocean warming and changes in ocean circulation. An example cited by two participants is that stocks of mackerel in the northeast Atlantic, which support a large and economically important fishery, have migrated north and west over the past decade, including into Icelandic and Greenland waters. The multi jurisdictional status of the 'shared' or 'straddling' stocks of mackerel found in a number of countries EEZs and on the high seas complicates the management of the fishery and risks driving the fishery to unsustainable catch levels as countries involved may set unilateral permissible catch limits which collectively exceed scientific advice for sustainability. For the biotechnology industry, the loss of biodiversity as a result of climate change impacts (and other impacts) represents potential lost business opportunities. In addition to sustainability concerns, businesses have to adapt to changing environmental conditions (extreme events, pathologies, etc.) and also must respond to consumer or public demands including the climate change impacts of the businesses themselves - CO_2 emissions from fishing vessels, cruise ships and limits to oil & gas exploration and exploitation due to public opposition were cited as examples. Because businesses are driven by markets, which are volatile, very often outcomes are not foreseeable.
- Policy measures, new regulations and legal requirements were cited as significant drivers. National and regional government decisions to enable the next stages of given industries (revenue and market support) will be determining factors for where and how projects happen.

Environmental regulations were also seen as major drivers – mainly the need to comply with environmental regulations.

- Securing independence of supply of energy and food production to meet the increasing demands of a growing world population were also mentioned as drivers, and often related to geopolitical considerations.
- Public opinion and consumer demands were often stated as important drivers. The role of public opinion in molding policy and legislation in relation to climate change and other environmental stressors (e.g. pollution) was recognized by a number of participants. Many participants highlighted the role of the market and consumer demands as drivers as indicated above with participants also citing consumer demand for more and better/healthier food, sustainable fishery products, and the potential demand for cosmetics, nutraceuticals, cosmeceuticals, pharmaceuticals, biomedicine and deep-sea metals derived from ocean resources. Consumer perceptions can also have impacts on the market; for example, one participant stated that consumer concerns over plastics in fish can be detrimental to the aquaculture industry.
- Brexit was cited by a number of the respondents from the aquaculture industry, the fishing industry, cruise industry and renewable energy sectors. Primary concern is uncertainty with specific concerns for each industry; for example access to fish stocks and competing, conflicting or incompatible management regimes for fisheries on shared/straddling stocks (e.g. north sea cod, mackerel) and access to EU research funding for renewable energy technology and development.
- Marine scientific research was cited by the underwater technology, assessment and monitoring industries as a major driver, both public and private sector demand (e.g. government funded research, defence initiatives, private sector compliance with EIA requirements).

Table 3.2.3: Summary of results for question 3

Sector	Drivers
Offshore aquaculture	- **Rapid development of technology:** (engineering solutions and feed development) - **Brexit**: (influence on markets) **- Food production**: high quality protein from the sea for human consumption **- Consumer demands**: more and better/healthier food **- Independence of supply**: decreased dependency from non-EU products **- Cosmetics**: e.g. sponge aquaculture. **- Climate Change (positive impacts)**: faster growth; possibility of suitability of new set of species for a given area. **- Climate change (negative impacts)**: new pathologies; rapid development of diseases; inhospitable environment for some species; extreme weather events. **- Plastic pollution**: any media campaign worrying consumers about microplastics in aquaculture

Sector	Drivers
	products, may be a very strong blow for the sector. - **Governance** (legal framework)
Blue biotechnology	- **SDGs and growing awareness of the urgency of addressing these challenges**; - Sector being at the stage of **demonstrating its potential to industry**: - **Need for sustainable businesses**/circular economy/zero waste. **- Climate change:** Biodiversity loss entails loss of chemical diversity. Conversely, marine organisms are known to adapt to environmental stressors by expressing new molecules which would otherwise be absent. - **Feed growing world population**: new sources of protein. - **Independence of supply**: make Europe self-sufficient in terms of food production. - **Replacing plastics**: discover the next biodegradable plastic. - **Nutraceuticals, cosmetics and cosmeceuticals** (cosmetics with health benefits) - **Pharma/biomedicine**: major advances may be related to ways of carrying out bioprospection, including Artificial Intelligence, and personalized cancer treatments, based on marine enzymes. - **Resistance to antibiotics**: the single last unexplored reserve of chemical diversity is the marine environment.
Cables	- **continuing growth of internet traffic** demanding new cables with markedly higher capacities than earlier systems, although technological advances in signal processing now allows older cables to be upgraded. - **cable protection and security** (cables carry over 95% of internet traffic)
Oil & Gas	- **Technological developments (automation/digitalization)** to give greater sustainability to the industry. New digital oil and gas fields being progressively installed, maximizing production efficiency; Big data storage and processing greatly developed using artificial intelligence algorithms, machine learning; related to preventive maintenance; - **New energy sources to power up platforms** (need to find new sources of energy) - **Energy transition** from fossil fuels to other energy sources. Public opposition to the industry may impose limits to exploration and exploitation. - **Adaptation to CC**, specifically to extreme events, leading to new technological solutions (rapidly shutting down production, which can then be safely resumed when needed). These technological solutions save lives and reduce the risks of environmental accidents. - **Geopolitical changes/dynamics**: need to ensure energy independence from external sources (if they have the resource, countries will continue to exploit it to ensure energy independence); risk of conflicts related to resource availability. - **Petrochemical industry:** raw materials essential for all types of products
Renewable energies	- **Technological developments**: internal drivers (increase in reliability, decreasing cost, cheaper electricity production); Digitalization/automation/forecast (managing assets more efficiently): take advantage of improved computing power to manage assets more efficiently (anticipate/forecast system malfunctions, real-time wind forecasts, etc). - **Decarbonisation:** Political and societal response to CC; - **Independence/security of energy supply**; - **Increasing globalization of industry**: Offshore wind to date has largely been a European endeavor; increased activity in the US and SE Asia will drive business - **Brexit**: either an unknown, a potential opportunity, a challenge, or a concern, as it potentially affects the ability to apply to EU R&D and innovation/pilot projects. - **Policy measures**: dependent on what national/regional governments will put in place to enable the next stage of the industry (revenue and market support). will determine where projects happen.
Shipping	- **environmental regulations/policy (political) drivers**: e.g. ballast water, fuel /sulphur cap. - **Technology developments**: vessel automation, monitoring of human performance - **Business opportunities created by CC**: As the Arctic opens up for trade there will be a greater need to monitor people - Environmental regulations: ship managers adapt and make business out of those challenges
Tourism	**Cruise:** **- Technology:** Business decision of going beyond compliance when it comes to environmental management and of developing new technologies to ensure compliance with new requirements (e.g. new LNG powered ships, waste management technology); - **political/policy/legal requirements**: in many parts of the world (e.g. Norway), legislation will impede, in the near future, conventional powered ships of trading there. Business decisions have to be made now on how ships are going to be powered. **- environmental concerns (also related to CC):** Environmental stewardship is a big selling point as there is a growing awareness of environmental change - **Brexit:** Any shipping company has to adapt based on legislation and to comply. Potential

Sector	Drivers
	problems/unknowns: clearance of ships on arrival, how passport/visa controls will take place. The feeling is that probably not much is going to change. **Whale watching:** Adapting to what the tourist wants – currently, biodiversity, sustainability, pollution awareness, environmental conservation/protection. Clients want to know that companies are doing more than just whale watching: collaboration with other companies, universities, EU funded projects, supporting volunteer work, raising environmental awareness in local schools, social responsibility. That type of differentiation is positive for business.
Fisheries	- **Climate change** and its impacts on migratory patterns and resilience of fish stocks; - **Ongoing developments in regulation of fisheries** related to sustainable management of fisheries, reductions in bycatch, discards etc; - **International cooperation** in the management of shared and straddling stocks, especially as fish populations migrate in response to ocean warming; - **Technology developments,** e.g. to find and target fish stocks more selectively and improve efficiency, including through the use/application of big data and artificial intelligence tools; - **Consumer demands and market developments** for sustainably caught fish products, new markets (e.g. China) and competition with aquaculture products; - **BBNJ Agreement** in regard to fisheries on the high seas and the establishment of marine protected areas (MPAs); - **Brexit** in terms of access to fish stocks in UK waters by foreign (predominantly EU) fleets, competing and possibly conflicting or incompatible management regimes for shared stocks (e.g. North Sea stocks separately managed by UK and EU), uncertainty over future UK role and influence in international/high seas fisheries and marine conservation management. As a general observation, the UK departure from the EU will require more attention from the fisheries sector, particularly the UK sector, to UK policy regarding MPAs, SACs and the types of international agreements the UK signs up to.
Deep seabed mining	**- Science and technology** for finding (exploration) and mining deep seabed deposits/ores; **- Development of regulatory framework (exploitation regulations)** for deep sea mining in international areas by the International Seabed Authority; - **Assessing potential commercial viability** against future metals prices/demand and extraction costs; - **Environmental concerns and scientific gaps and uncertainties** regarding potential impacts of deep seabed mining (destruction of habitat, noise, plumes etc) **- Potential conflicts with other ocean industries** e.g. fishing, shipping
Cross-cutting	- **climate change**: societal need for energy and legal need to reduce C emissions (Paris agreement), countries need to diversify their power/energy sources by 2030 – big business opportunities: wind, solar, nuclear. Probably largely driven by tax regimes: if tax incentives exist to invest in offshore renewables and allow offsetting C (C credits), oil & gas companies producing elsewhere in the world will be interested.

3.2.4 How will the key findings of ATLAS influence your plans? What type of additional scientific information could help you plan for your business heading towards 2030?

Globally, participants perceived ATLAS as being an important and relevant contribution to increase the scientific knowledge base of the N Atlantic basin, with a significant potential to influence policy and management at that scale – perceived as a much needed and desirable role for this (and this type of) project. Even when the spatial or temporal resolution of the findings of the ATLAS project may be inadequate for particular or specific interests or projects, ATLAS findings were perceived as being useful to inform planning in helping to determine where some activities should not take place, areas which would or should require protection, and industry adaptation strategies based on an understanding of current and future trends in climate change impacts on living marine resources and ecosystems (Table 3.2.4.).

Amongst the types of additional scientific information that could be useful for businesses to plan activities over the coming years through 2030, the main aspects mentioned by participants were (Table 3.2.4.):

- physical aspects: mapping the ocean floor (bathymetries, characterisation of the ocean floor); ocean dynamics (incl. currents, temperature); wind speed variability and current weather patterns and changes in relation to historical records;
- ecological aspects: knowledge of ecosystems such as biodiversity hotspots, primary production processes, connectivity, and the location and resilience of VMEs – for example for the management of fisheries for their impacts on VMEs on the Grand Banks and Flemish Cap (one of the study areas of the Project) and the development of a Regional Environmental Management Plan for the management of mining on the northern Mid Atlantic Ridge (an initiative funded by the European Commission);
- socio-economic: mapping of stakeholders, of collections of marine bioresources, of products under development.
- factual information on changes in the N Atlantic system, e.g. changing currents, temperatures, acidification and other natural and anthropogenic forcings and their implications for future ecosystem dynamics, resilience and migratory patterns of marine species and recommendations on policies to adapt to climate change;
- Improved weather forecasting including longer term tends and better predictive models, more reliable forecasts of extreme weather events;
- Identification of areas to be avoided by industry; understanding how the industry can adapt;
- roadmap of what different types activities can coexist in the N Atlantic and the role of marine spatial planning to optimize use of ocean space and avoid future conflict);
- economic forecasts: basic information on economic development from the different sectors;
- Raising awareness on the importance of the interaction between public policies and private entities needing to be based on scientifically verifiable and factual knowledge, so that regulations, for example for marine spatial planning, provide for an integrated and sustainable management of the blue economy.

Table 3.2.4: Summary of results for question 4

Sector	**How will the key findings of ATLAS influence sector's plans**	**Additional scientific information**
Offshore aquaculture	Changing ocean conditions may affect the sector in various ways: - changing ocean conditions (e.g. rising ocean T) will change production conditions, affecting productivity, nutrient availability, etc., may have dramatic negative impacts in existing sites (e.g., increased microalgae blooms), and may entail the	- Current weather patterns: changes in relation to historical records; cyclical events or deviations from a normal pattern? - Which areas are going to be suitable and which are not; understand how

Sector	How will the key findings of ATLAS influence sector's plans	Additional scientific information
	need to relocate the activity. - Extreme weather events/hydrodynamics: increase of extreme conditions will impact the industry, requiring higher insurance, better planning in terms of risk assessment and the construction of much more robust (and costlier) structures. ATLAS findings will be important for 2 types of reasons: - Deciding whether or not to invest, where and using which species. - Determining available spaces for aquaculture and conflict management.	the industry can adapt; - mapping of ocean floor (to support site selection); - ocean dynamics (incl. currents, T); - Ecological information, incl. on primary production processes: adjust seasonal closures (maladjusted to today's life cycles, predict algal blooms, red tides, etc.); - better predictive models: more reliable forecasts of extreme weather events (better infrastructure design); - roadmap of what activities can coexist in the N Atlantic (avoid future conflicts).
Blue biotechnology	Climate change will be very destructive for any research based on biodiversity, particularly in what concerns unusual genes. Two challenges are envisaged in what concerns bioprospecting: - loss of the source; - Replicability. Not much of an influence on what concerns the next steps of the activity, as marine biotechnology rapidly becomes independent from the source environment. Where changing environmental conditions may harm aquaculture, blue biotech can play a part. ATLAS findings will probably be more important in terms of MSP and management. ATLAS needs to continue its work in the policy sphere.	Additional information: - knowledge of ecosystems, e.g., where are the hotspots of BD both in the macro-organism sense (invertebrates) and of microbial biodiversity. Not having that information is a major competitive disadvantage. - mapping of stakeholders, of collections of marine bioresources, of products under development.
Cables	The influence of the Atlas findings will depend upon their nature and how well they are founded in science. Concerning the rapid decline of Arctic sea ice, investigations are underway to install submarine fibre-optic cables across the "top of the world". In 2016 an 1850 km-long repeatered cable system was installed off northern Alaska to provide access to health, education, communications and economic services for isolated settlements. The Alaskan system is the first phase of a plan to link to Japan with Europe via the Arctic.	-
Oil & Gas	Potential changes in environmental conditions, or even on the location of MPAs, will not be a limiting factor: the footprint of oil & gas structures on the ocean floor is very small and the implantation area can easily be adjusted. The mapping of ecosystems by ATLAS is essential and it will provide the basis to say which marine ecosystems need to be protected and tell industry where and how it can operate – this is also key for the industry to regain some credit with the public opinion. Marine life is the base, and its defence is key, but current human needs (PCs, mobile phones, cars, airplanes…) all require strategic minerals that are being consumed (and thrown away) at an unsustainable and unprecedented rate in human history.	Not applicable. The information provided by ATLAS does not have enough resolution for the industry.
Renewable energies	Not expected to influence plans in terms of changes in resource availability. ATLAS recommendations may impact policies, incentives, etc., and the location of MPAs, consenting and permitting. The resolution of the information provided by ATLAS is not as detailed as individual applications require but it may help to adequate engineering solutions to a changing environment. ATLAS may provide early indication of what potential issues might be on the horizon for deeper water, and aspects that need consideration, including how the environment (species and habitats) and other industries (e.g. fishing industry) can be	- Wind speed variability; - bathymetries, characterisation of the ocean floor (sandy, rocky, muddy); - Identification of areas to be avoided by the industry: How nutrients/phytoplankton will change: if renewables are located in a nutrient rich area, it could interfere with fisheries.

Sector	How will the key findings of ATLAS influence sector's plans	Additional scientific information
	impacted by the sector. This will help plan for commercial scale projects. This report will give an idea of the state of the art and of the interests/vision of the entities surveyed and it will be relevant for the industry's action plan.	
Shipping	The industry will adapt to changes (e.g. using different routes). Additionally, the available technology will help the industry to adapt (e.g. building gas carriers which are also ice-breakers).	- Factual information on changes on the N Atlantic system, e.g., changing currents, ecosystems; - Economic forecasts: Basic information on economic development from the different sectors; - Technology in automation; - Weather forecasting (beyond 4 days); - Buoys collecting weather data: water temperature, wave, wind direction, wind speed, humidity, precipitation.
Tourism	**Cruise:** Environmental change can be a business positive. Desire to make it an environmental positive: incl. latest waste management technology; retrofitting exhaust gas systems. Weather routing: new destinations at different times of the year, require monitoring the weather and planning cruises accordingly and amendments made when required. **Whale watching:** undeniable influence. As water temperature increases, a Northward expansion of tropical species is occurring. The business is concerned with cetaceans but it all starts with the smaller animals. Legislation: the possibility of creating, or at least suggesting, new MPAs or areas with increased protection.	Cruise industry: a more accurate method of predicting Atlantic weather systems would be a benefit (Anything that could make things safer would be welcome. Whale watching: more information on migration routes and their constancy.
Fisheries	By providing information on current and future climate change impacts. Helping operators anticipate changes in the migratory patterns and locations of fish stocks and identify future opportunities and impediments to fishing. Identification of areas such as VMEs that require protection. Providing more detailed information on environment parameters in the Atlantic basis such as currents, salinity, temperature changes that could help industry fish more efficiently. Developing and providing marine spatial planning tools and predictive modelling approaches that could help better optimize fishing opportunities and conservation initiatives and manage multiple, potentially competing activities.	More information on impacts from ocean acidification, pollution, and plastics and zonal association (e.g. within/beyond EEZs) of fish stocks as they move north would be helpful. Big data initiatives to help 'smart fishing' efforts. Technology for use of fishing vessels as platforms for collecting environmental data. Real time collection of data on fish catches to improve monitoring and avoiding bycatch, Trophic level interactions between species (e.g. NAFO 3M cod, redfish and shrimp) to assist implementation of ecosystem approaches. Seabed mapping to assist in identification of VMEs. User friendly guides that spell out recommendations for mitigation management measures.
Mining	ATLAS Project findings will be important for International Seabed Authority contractor environmental studies and the development of a northern Mid Atlantic Ridge Regional Environment Management Plan (REMP) given many of the ATLAS findings are at a regional scale, e.g. currents, circulation, habitat suitability, and biogeography. Useful for determining both larger scale APEIs and finer-scale specific sites that merit protection. Scientific findings even at the basin scale will be helpful as the North Atlantic is one big connected system. Basin scale information, for example will be helpful for understanding impacts in Norwegian waters.	Ongoing research conducted by multiple universities on technology, including mining technology and broader scientific survey technology which could help with mineral exploration and establishing environmental baselines. How potential mining sites are connected to each other biologically and the mechanisms for this connectivity.
Cross-cutting	ATLAS findings will certainly influence business decisions: - aquaculture: different environmental parameters may impact	- comprehensive mapping of the seafloor; regularly of remapping to

Sector	How will the key findings of ATLAS influence sector's plans	Additional scientific information
	the choice of which species to farm, probability/frequency of pests/diseases. That may entail changing the cultivated species or relocating the activity into more northerly or cooler waters. - offshore energy: expected storms, 100 y worse waves, extreme event likelihoods, will impact decisions concerning the construction of structures, their capacity to resist extreme events (by today's standards or by future standards), size of the investment. Building a larger, heavier and more robust structure increases the cost of the structure/mooring (many will try build a less expensive structure and hope for the best). - Commercial aspects: drive the levels of investment and the speed of uptake of new technology, e.g. related to insurance: who insures structures, is insurance compulsory, what is the risk regime. - New legal regimes and regulations: impacting almost all sectors, a major issue.	detect change. - are changes likely to increase submarine landslides, turbidity flows? (which might damage infrastructure or affect mining areas) - Recommendations on policies to adapt to climate change. - raise awareness on the importance of public policies and the interaction with private entities being based on factual knowledge, scientifically verifiable so that it reflects on MSP and allows an integrated and sustainable management of the blue economy.

3.2.5 Are there any current or anticipated technology developments in your sector that may help address some of the issues ATLAS has identified? If so, what are they? Are there barriers to finding/using technological solutions in your sector?

Participants referred many different types of technological developments, current or anticipated, many of them related to increasing and rapid advances in automation and digitalization (Table 3.2.5.).

In what concerns barriers to technological solutions, various issues were also mentioned by participants, including technological, economic, legal, environmental, and social barriers:

- harsh ocean environment (waves, wind, tidal, etc.);
- technology costs (weight on business models and profit levels) and other technological challenges (missing links; inadequate tools) and how that affects competitiveness;
- lack of funding: to be viable/explored at a larger scale, these technologies must be made competitive, incl. through private funding, market support and policy incentives.
- lack of collaboration, e.g. infrastructures to support upscaling of production;
- commercial viability: business prospects of some industries may render them uninteresting;
- conservative position/lobby of industries (resistance to change);
- problems with regulations and enforcement: related e.g. with food safety standards;
- outdated regulatory regimes (where technology has moved faster than the legal regime): issues with automated vessels, collisions at sea, robots, etc.;
- confusing jurisdictions and lack of legal framework (international law): number of entities with jurisdiction (extreme complexity) and "blurriness" In international and transboundary areas;
- spatial conflicts between industries;

- ethical issues/consumer awareness: may determine how the sector will develop: sustainability of production; threshold on genetic improvements consumers are willing to accept; acceptance of feed with GMOs; food miles; fish living conditions in cages; CO2 emissions and climate change impacts of industry;
- societal opposition: public may 'decide' against or express opposition to certain industries or types of industrial activities because of their environmental implications.

Table 3.2.5: Summary of results for question 5

Sector	**Current or anticipated technology developments**	**Barriers to technological solutions**
Offshore aquaculture	- Improvements in the design of aquaculture systems: Floating/drifting cages; cages that move up and down in the water column (to seek adequate water temperature); - Integrated/multitrophic aquaculture (IMTA) - Engineering/automation: system maintenance and monitoring with reduced levels of human intervention; structures' engineering adapted to environmental conditions - Biotechnology developments: species' improvement; more efficient feeds, valorisation of production chain (zero waste)	- **cost of the technology** and its weight on business models and profit levels - **ethical issues/consumer awareness** may determine how the sector will develop: sustainability of production; threshold on genetic improvements consumers are willing to accept; acceptance of feed with GMOs; Food miles; fish living conditions in cages - **Legal issues and enforcement**: e.g. Food safety standards.
Blue biotechnology	- **Rapid sequencing technology**: ability to carry out rapid in situ species identification (to know what exists and in near real time). - **Underwater observatories**: to understand what species exist, where, and their function. - **Engineering developments**: may be useful for bioprospecting (e.g. robotics and new sensors).	- **lack of a legal framework (international law)**; - **number of entities with jurisdiction**: complexity and "blurriness" (international/transboundary) - **lack of funding:** private funding is necessary but often not viable; - **lack of collaboration**, e.g. infrastructures to support upscaling of production; - **lack of knowledge**, incl. poor preparation of scientists to deal with markets. - **inadequate molecular biology tools**: tools skewed towards terrestrial environments/don't work with marine organisms.
Cables	Cables have little to no negative environmental effects, especially in the deep ocean (>2000m), where they are laid on the seabed surface. The deployment of a cable within an MPA may not be inconsistent with the status of that MPA. In shallower water depths, cables may be buried (protection from fishing and anchoring).	
Oil & Gas	- **Big data, digitation, digital fields:** can minimize risks and the impact on ecosystems. - **Technological challenges**: separating CO2 from CH4. Currently done on the surface, but structures are big and bulky and not practical. Solutions for separating CO2 on the ocean floor are being studied, so that it can be directly reinjected on the ocean floor. Possibility of making CO2 hydrates and depositing them on the ocean floor also being considered/studied. - New technological solutions under development.	- **Technological barriers**: they exist and can be overcome. - **Political barriers**: they exist and must be dealt with
Renewable energies	- **Wave and wind parks** can be refuges/offer protection to marine species; - **Decarbonisation** (reducing GHG); - Using the industry as a contribution to protect nature	Perceived difficulties, challenges or risks: - **distance offshore and depth**; - **anchoring technology** (deeper waters); - **Harsh ocean environment** (waves, wind, etc.); e.g. tidal energy: very limited window of time to work;

Sector	Current or anticipated technology developments	Barriers to technological solutions
		- **Offshore batteries**: still missing link for renewables; - **potential negative environmental impacts** may lead to opposition and spatial conflicts, e.g. with fisheries; - **Competitiveness/Economic factor**: To be viable/ explored at a larger scale, these technologies must be made competitive, incl. through market support and policy incentives.
Shipping	- **Increasing reliability of automation**: incl. developments in the technology of monitoring human performance (navigation in the Arctic; highly automated vessels). - **Data transfer at sea:** once this technology really arrives to ships, data collection may start being developed and increasing amounts of data can start being collected by those who are actually there. There will be an enormous amount of data regarding tides, water temperatures, salinity, etc. - **wind power, solar, hydrogen, electrification** (electric/hybrid shipping)	Barriers relate to how acceptable things are: - **Legal/regulatory regime**: Sorting out where highly automated vessels can go (legal regimes do not allow Remotely operated ships); linked to: - **societal barrier**: society may decide that it doesn't want remote or autonomous ships, that it is too environmentally dangerous. - **commercial viability**: business prospects of Autonomous Ships may render them uninteresting; - **cost**; - **conservative position of the shipping industry** (resistance to change); - **lobby of the fossil fuel industry**, pushing heavily to stop progress towards a truly sustainable industry.
Tourism	**Cruise**: Weather routing is important for the safety of passengers and ships (anything that contributes to safety is welcome). Rerouting has an impact on fuel consumption. **Whale watching**: Technologies to improve detection of the animals.	**Cruise:** very stringent regulations require careful consideration. For businesses it's a balancing act: a business is there to make money.
Fishing	**- Improved technology for data collection at sea:** use of fishing vessels as platforms for collection of environmental data as mentioned under shipping above, as well as data on fish stocks and population dynamics, non-target species and VMEs. Collection and use of big data for the development of smart fishing technology (already under development in the pelagic trawl sector). **- Technology for real time monitoring catch and preventing bycatch,** e.g. light emitting or acoustic devices that would scare certain species from entering in the nets, underwater cameras for fishing gear. Size recognition software that could be used to better interpret acoustic signals/information while fishing in order to better target wanted species and avoid bycatch. Electronic reporting and cameras on board fishing vessels, including cameras and software for scanning fish on conveyor belts to automatically estimate size and weight of fish.	Resistance/concern from some in industry over use of onboard technology for monitoring, control and enforcement.
Deep seabed mining	**Development of technology for exploration and exploitation:** Improved AUV and sensor technology to detect polymetallic sulfide (PMS) deposits under sediments (to avoid active hydrothermal vent sites); better equipment for assessing the metal content and grade of PMS and cobalt crust deposits; further development of prototypes for mining machines.	**Cost/political opposition:** Commercial exploitation a long way off. Return on investment not short term. Difficult to find investors willing to invest in technology development. Dependent on government funding to a large extent. However, there are political issues, such as the EU-MEP [European Parliament] and EU-LDAC calls for a moratorium on deep-sea mining.
Cross-cutting	- **advancements in marine autonomous systems,**	**Outdated regulatory regimes**: where technology

Sector	Current or anticipated technology developments	Barriers to technological solutions
	including (AUVs) and autonomous maintenance/repair; - **including the circular economy paradigm in the blue economy**, e.g., in fish processing value chain. - **Shipping going digital**: greater efficiency in routes, digital ports, information on the saturation level of the ports in terms of charges/discharges prior to departure; - **management of ballast waters**: via IMO. - **energy revolution in shipping** in the next decade: e.g., LNG, hydrogen fuel cells - **update shipbuilding**: naval engineering schools must promote alternative concepts to render the operation less damaging and more agile. - **Fishing**: developing more environmentally friendly fishing gear.	has moved faster than the legal regime. E.g.: - collision at sea regulations, safety compliancy regulations, pollution regulations, etc., all assume there's a human making decisions on board. The law may take 10-20 y to catch up: E.g., who's responsible, who's insuring? - armed robots (armed surface/underwater warships, incl. drones carrying a warhead) and deepsea mining: situations where decisions are made by robots, not by people. Legally, that is a move into very difficult areas (laws are written on the assumption that humans make the decisions).

3.2.6 Do you anticipate that the development of a new legally binding instrument (ILBI) for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) will influence your sector's business plans?

Representatives from the energy sectors (oil and gas and renewables) and offshore aquaculture do not anticipate that a new ILBI for BBNJ will directly influence the sectors' business plans. Logistical reasons related to the nature of these businesses (location of the resources, distance to shore) were referred to by participants.

Aquaculture sector participants mentioned the possibility that this ILBI might have an impact on the industry upstream, in the sourcing of feed ingredients. Representatives from other activities dependent on biodiversity, such as tourism related to whale-watching and blue biotechnology, anticipate positive results of this ILBI respectively - for the former, related to increased protection of marine mammals, and, for the latter, increased equity and transparency in accessing and using marine resources.

For shipping, the influence of this ILBI on the sector is expected to depend on the actual provisions of the instrument; though an influence on shipping in general is not anticipated. The cruise industry does not anticipate an influence on the sector, as it already complies with MARPOL's regulations and the possible creation of new MPAs (provided the right of innocent passage is maintained) will not be a limitation.

The representatives of the fisheries and deep seabed mining sectors were of the view that the ILBI is likely to affect their sectors. For the fisheries sector, the issues mentioned were that the ILBI could result on the one hand in greater restrictions on high seas fishing, for example through the establishment of MPAs, while on the other hand enhance international cooperation in the management of high seas fisheries and other activities and lead to improved fisheries management. One participant also referred to the CBD post Aichi targets and the UN 2030 Sustainable Development Goals as other types of international developments in law and policy as having an impact on the sector. Another was of the view that the ILBI would more likely affect deep-sea fisheries than the pelagic offshore trawl sector. Participants in both the deep seabed mining and fisheries interviews agreed that whatever the outcome, national governments will be legally bound to implement the Agreement.

The cables sector is concerned that the new ILBI may impinge on freedoms established under UNCLOS. Many in the underwater technology and cross-sectoral industries were unaware of the development of the ILBI negotiations but when informed of the negotiations, they along with most of the others in these industries were of the view that the ILBI would enhance their business opportunities as is the case with many other types of regulatory developments.

Despite the specificities of each business/sector, there was a generalized feeling, among the majority of participants, that this new ILBI is necessary.

Table 3.2.6: Summary of results for question 6

Sector	**Influence of ILBI in BBNJ on sector's business plans?**
Offshore aquaculture	No. Logistical reasons related to maximum depth and distance from the coast. For offshore aquaculture those will be 70-150m deep, and up to 10-20 nm (going beyond 200 nm would be a logistical nightmare); The governance aspect is nevertheless critical: if there aren't laws protecting the business, companies will not want to go there. If the law changes and ABNJ is under a certain type of protection, than aquaculture production can consider going there. May have an impact upstream in the sourcing of feed ingredients.
Blue biotechnology	Positive effect: - sector will not be drastically influenced by this ILBI unless it restricts access to MGR; - Adequate legal framework is critical: one that regulates but doesn't deter the industry from developing; - ILBI can contribute to **transparency:** how the activity can be carried out; how it can be communicated (searchable mechanism with information on people going on collection, areas being studied, by which agencies, requirement to file research cruise reports, in a central location and a standard format, contacts for further information or samples). Requires an access mechanism, or "Obligatory prior electronic notification", to let people know what is being done. - ILBI can contribute to greater **justice** on the capitalisation of the use of biodiversity. Need for a clear model: product origin/location, collection method, authorizations, royalties (stepping stone model?), etc.
Cables	Yes. Concerns regard any regulation and centralised control of marine activities, with the potential to impinge upon freedoms specified for cables by the UN Convention of Law of the Sea.
Oil & Gas	Not a direct concern: deposits associated to the continental crust, not to the oceanic crust. Nevertheless, there must be a legal document on how we can intervene in the ocean and what are the constraints
Renewable energies	Not a direct concern. The industry needs to be as near to its markets as possible (continental shelf).
Shipping	Depends on what the instrument actually says: anything that would impede the economic (viability) of shipping will have an impact. Such an ILBI will not really influence shipping but it will probably influence other types of economic activities such as bottom trawling fisheries or seabed mining. It will be good because we need to restrict certain activities and it will influence certain types of business and the restrictions to prevent destruction of the seabed, for instance, are really important.
Tourism	**Cruise:** doesn't anticipate an influence. Industry has to comply with MARPOL regardless of location, and with regional regulations e.g. concerning whale migration routes. The location of new MPAs won't affect the industry unless there are limitations to the discharge of processed waste water into the ocean. That will pose a problem for ships transiting innocent passage.

Sector	Influence of ILBI in BBNJ on sector's business plans?
	Whale watching: Positive influence for the sector, seen as "an extraordinary step" towards the conservation of biodiversity.
Fisheries	**May lead to more high seas regulations:** may require mitigation measures – e.g. noise reduction, reducing seabird interactions; likely to lead to new EU regulations for high seas fleets. **Better management and enforcement measures:** BBNJ negotiations could result in more multilateral management enforcement measures with positive impact; e.g. could lead to international regulation of the southwest Atlantic high seas hake and squid fisheries. **High seas MPAs will have an impact:** vessels may be required to either move to different grounds or fish more efficiently.
Deep seabed mining	BBNJ could impact the sector. There may be concern amongst biologists about something that may not happen, in terms of mining activities. Industry needs to be in the room to explain processes so that potential environmental impacts can be better understood. The BBNJ process is very important and should be conducted with all stakeholders
Cross-cutting	An ILBI on BBNJ will turn out to be essential. As with UNCLOS, there's will be a transition period: some companies will operate out of the countries who don't sign up to avoid the constraints, while other companies will prefer the legal protection (E.g. those working with MGRs because they know their obligations and know they won't have any market restrictions). One participant questioned the ILBI's interest/effectiveness, arguing that it would be a more pressing need, at the UN level, to capacitate countries to adequately manage their maritime spaces, instead of making conventions on international areas where there's no one.

Appendices

- Appendix 1: Sample structured interview sheet (shipping)
- Appendix 2: Summaries of Blue Economy sectors and ATLAS findings used for interview
- Appendix 3: Sample of questionnaire used for interview

Appendix 1: Sample structured interview sheet (shipping)

Science, Policy & Blue Growth: Industry reactions to ATLAS recommendations

About the ATLAS Project

The EU ATLAS Horizon 2020 Project is a four-year project with partners from multinational industries, Small and Medium Enterprises (SMEs), governments and academia. Together, these partners are assessing Atlantic deep-sea ecosystems to create the integrated and adaptive planning products needed for sustainable Blue Growth. ATLAS is coordinated by the University of Edinburgh and you can find out more about the Project on our website: https://www.eu-atlas.org/.

Industry reactions to ATLAS recommendations

This survey is a component of Work Package 7: Policy Integration to Inform Key Agreements led by Seascape Consultants Ltd. To obtain industry reactions, we would like to share ATLAS scientific findings with you and discuss how findings may impact your Blue Economy sector. Understanding industry perspectives will help to shape the way we incorporate industry needs in scientific research and policy, to support the sustainable growth of the Blue Economy.

The survey will consist of six questions posed during a structured interview conducted in person, via phone, or video conference. We will provide a short summary of your Blue Economy sector & ATLAS key findings (less than 1 page) for you to read prior to the interview. Your responses will be written down by the person conducting the survey, there will not be an audio recording of your responses. To help you to answer a question, we may ask further prompting questions. The survey will take approximately 30 minutes. Participation is strictly voluntary, and you may withdraw at any time.

Privacy notice

The data collected will be used for research purposes only and you may request a copy of your responses. Data collected will be stored by Seascape Consultants Ltd. in an anonymised random number-generated format on a password-protected computer system and will remain accessible to only the researchers involved in the project. Information on your industry sector & sub-sector, institution type and country will be retained alongside your survey responses to enable us to group responses for analysis. Your responses will not be individually or institutionally identifiable. In the unlikely event that evidence of abuse or criminal activity is uncovered during this survey we will be obliged to report it.

We would like to retain your name and email address for 18 months after the survey date, so that we are able to send you the outcomes of our survey. We will not share your contact information with third parties. You are entitled to view any data that we hold on you and you may opt out at any time by contacting the research team: rachel.boschen-rose@seascapeconsultants.co.uk.

This survey complies with the General Data Protection Regulations (GDPR) (2018) and has been scrutinised and granted Ethical Approval through the University of Edinburgh School of GeoScience's ethical approval process. If you have ethical concerns about this survey or the conduct of the researchers involved, you may contact the University of Edinburgh School of GeoScience's Research Ethics and Integrity Committee: ethics.geos@ed.ac.uk.

I confirm that I am over 18 years of age, have read and understood the Privacy Notice, and consent to participate in ☐ this survey

Name: Date:

Email address:

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Shipping

Shipping current status & challenges

Shipping is a mature and growing sector in the Blue Economy, with generally medium presence and low development potential in the North Atlantic. The sector is diverse, consisting of deep-sea shipping, short-sea shipping, passenger ferry services and cruise shipping. Shipping route locations are dictated by the need to take the shortest and safest route, whilst fleet activity is market-driven.

Offshore spatial requirements are driven by operational and safety requirements including access to port facilities, shipping lane widths, sheltered anchorages, areas to be avoided, environmental considerations and safety zones around fixed installations. Increased containerisation and the use of cleaner LNG fuel has led to larger ships with bigger fuel tanks, whilst economic growth has increased vessel traffic. Increased vessel size and traffic requires wider shipping lanes to accommodate safe overtaking and collision avoidance, along with new short-sea shipping routes. Remotely operated and autonomous ships may initially require their own shipping lanes, although in the long-term autonomous shipping should reduce safety distances enabling narrower shipping lanes.

An increase in shipping lane width could cause spatial conflict with other sectors who are also growing. The expansion of offshore aquaculture, renewable energy and oil & gas will increase the number of fixed installations, which could cause spatial conflict, as ships may have to reroute to maintain a minimum safe distance. Extractive activities, such as marine mining, may not be allowed in areas where shipping routes occur. Incorporating the current and future spatial needs of shipping in Marine Spatial Planning (MSP) will ensure routes are maintained alongside multi-sector growth.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where planned or existing shipping routes already occur, which may contribute to spatial conflict. As climate change melts progressively larger sections of Arctic ice, the opening of the North West Passage could create opportunities for new shipping routes. Conversely, the increase in extreme weather associated with climate change may increase the space ships require for weather routing.

Carbon dioxide emissions from shipping will contribute to climate change impacts, such as ocean acidification. Many Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges, are sensitive to changes in ocean pH, and are expected to exhibit declines in their distribution by 2100. Optimizing route selection and the number of vessels could help limit carbon dioxide emissions.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Shipping lanes may be permissible through some existing and future MPAs, or lanes may need to be re-routed. Large offshore MPAs proposed within BBNJ could also have implications for future shipping operation, such as additional greywater or ballast water controls, and observers to reduce ship strikes. Encouraging data sharing opportunities between shipping and the scientific community, such as continued development of onboard data collection, could help in the siting of future MPAs and in the understanding of climate change impacts at the basin-scale.

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Industry reactions to ATLAS recommendations Survey

About you

1. What is your Blue Economy sector? (please select)

Cables & pipelines		Oil & gas		Mining		Fishing		Shipping	
Tidal & wave		Wind		Tourism		Biotechnology		Aquaculture	

2. What is your subsector (if applicable)?

3. What is your institution type? (please select)

Regulatory body		Private company		Research institute		Consultancy		Other (please state):	

4. What country is your institution based in?

Survey Questions

5. Do you envisage new or expanded activities in the North Atlantic before 2030? If so, what sort of activities and where?

6. Do you have any plans to work collaboratively with other sectors to address your business challenges? If so, how and with which sectors?

7. What are your main business drivers moving towards 2030? For example: Brexit, technology developments, business opportunities created by climate change?

8. How will the key findings of ATLAS influence your plans?

9. Are there any current or anticipated technology developments in your sector that may help address some of the issues ATLAS has identified? If so, what are they?

10. Do you anticipate that the development of a new legally binding instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) will influence your sector's business plans?

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Guidance on eliciting more detailed responses (for interviewers only):

1. Do you envisage new or expanded activities in the North Atlantic before 2030? If so, what sort of activities and where?
   - Likely responses: New shipping routes in the Atlantic are unlikely, although expansion into the Arctic is possible. Increased activity within existing regions, especially short-sea shipping.
   - Further questions: Which locations/routes are of interest for expansion?
2. Do you have any plans to work collaboratively with other sectors to address your business challenges? If so, how and with which sectors?
   - Likely response: MSP for shipping keeps sectors that could disrupt shipping at a safe distance, it easier for other sectors to relocate than to move shipping lanes. However, talking to other sectors at early stages of planning expanded activities could lead to better spatial outcomes for all sectors.
   - Further question: Are there any specific examples of collaboration between sectors, for example existing area-use sharing mechanisms or site-specific examples of cross-sector collaboration?
3. What are your main business drivers moving towards 2030? For example: Brexit, technology developments, business opportunities created by climate change?
   - Likely response: Brexit and the influence this could have on import/export cargo flow. Opportunities for new routes through the NW passage. Technology developments to increase efficiency, such as larger ships and autonomous shipping.
   - Further question: How do you think these drivers will influence your business?
4. How will the key findings of ATLAS influence your plans?
   - Likely response: There will be no influence. Or changes in suitability of existing sites for other sectors could impact business through spatial conflict. Possibly BBNJ.
   - Further question: What type of additional scientific information, at the basin scale, could help you plan for your business heading towards 2030?
5. Are there any current or anticipated technology developments in your sector that may help address some of the issues ATLAS has identified? If so, what are they?
   - Likely response: None. Or, reduction in shipping lane width from autonomous ships could reduce spatial conflict with other sensors. Cleaner shipping may make the sector more welcome in MPAs.
   - Further question: Are there barriers to finding/using technological solutions in your sector?
6. Do you anticipate that the development of a new legally binding instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) will influence your sector's business plans?
   - Likely response: What is BBNJ? Or, concern that there will be a new process for obtaining environmental approvals for new routes.

Further details: This can be a question where ATLAS provides information on what BBNJ is, in non-technical terms. The same question can then be asked again.

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Appendix 2: Summaries of blue economy sectors and ATLAS findings used for interview

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ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where planned or existing shipping routes already occur, which may contribute to spatial conflict. As climate change melts progressively larger sections of Arctic ice, the opening of the North West Passage could create opportunities for new shipping routes. Conversely, the increase in extreme weather associated with climate change may increase the space ships require for weather routing.

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ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Shipping lanes may be permissible through some existing and future MPAs, or lanes may need to be re-routed. Large offshore MPAs proposed within BBNJ could also have implications for future shipping operation, such as additional greywater or ballast water controls, and observers to reduce ship strikes. Encouraging data sharing opportunities between shipping and the scientific community, such as continued development of onboard data collection, could help in the siting of future MPAs and in the understanding of climate change impacts at the basin-scale.

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Oil and Gas

Oil and Gas current status & challenges

Oil & gas is a mature sector in the Blue Economy, with overall medium presence and limited potential for growth in the North Atlantic, although this varies according to location. The location of oil & gas is tied to the resource, which only forms under certain geological conditions. The distance to shore and depth of installations depends on rig type, with technological advances in floating rigs making oil & gas extraction feasible in depths of up to 3700m. Installation lifetime is typically 25 years, although this can be extended depending on environmental issues, the size of the reservoir and rig construction. Material transport by ship or pipelines follows the most direct route from collection point to point of delivery.

Many oil & gas extractions are mature, with declining production and rising costs. Although demand for hydrocarbons is generally decreasing, increasing geopolitical uncertainty over supply could encourage development of the sector. Gas is an important part of the transition to a low-carbon economy, which could increase the demand for gas relative to oil. Development of oil & gas will either be through improvements in efficiency, enabling continued operations at declining fields, or pursuing resources further offshore. Efficiency improvements may help manage spatial requirements, for example directional drilling enables multiple wells to be operated from a single platform, whilst extended reach drilling can be used to access offshore reserved from onshore facilities.

Developing new reserves offshore will necessitate new rigs and may lead to spatial conflict with sectors already operating offshore or looking to expand their activities. For example, shipping and fishing are excluded around installations and temporarily displaced during installations of pipelines. The presence of oil & gas may limit the available space for marine renewables and aquaculture, although there is also the possibility of co-location with these sectors, if technological and regulatory hurdles can be addressed. Former gas production sites could be used for carbon dioxide storage, whilst operational and decommissioned platforms can also act as artificial reef structures, which may provide refuge for commercial fish species.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where oil & gas occurs, which may contribute to spatial conflict.

Changes to Atlantic Ocean temperature and pH will place physiological stress on deep-sea fauna, including Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges. The colonization of oil & gas installations by corals and sponges may help maintain the regional connectivity and resilience of these species. Spatial exclusions around installations can also provide refuge to commercial fish species.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Oil & gas activities may not be permitted in proximity to existing or future MPAs. Large offshore MPAs proposed within BBNJ could impact the transportation of oil & gas and associated monitoring of environmental impacts.

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Cables & Pipelines

Cables & Pipelines current status & challenges

Cables & pipelines is a growing sector in the Blue Economy, with medium presence and medium development potential in the North Atlantic. The sector is relatively diverse, consisting of two types of offshore cables (communication and energy/power cables) and four types of pipelines (oil, gas, disposal and connection). The siting of cables & pipelines is very location driven and governed by the existence of a given resource or the necessity of connecting to onshore terminals. Stable long-term locations are needed with installation lifetimes spanning 20 – 50 years, depending on installation type.

Telecommunications growth will see increased demand for communication cables, whilst the siting of marine renewables further offshore will require more power cables. Offshore oil & gas expansion, alongside any future carbon dioxide storage, will increase demand for pipelines. Laying new cables & pipelines will require more protection measures where cables & pipelines cross.

Laying new cables & pipelines will increase spatial requirements of the sector, which may lead to spatial conflict. Whilst bundling or parallel routing of cables & pipelines may reduce spatial requirements, this increases the risk of simultaneous damage to multiple structures. Some cables & pipelines have associated exclusion zones on the seafloor, which may impact extractive activities, such as marine mining. Exclusion zones do not apply in all locations, and the cable industry has had to develop new cable protection systems in response to the migration of fisheries into deeper water. Knowing the location of cables & pipelines and the spatial requirements of sectors whose activities could damage these installations (such as slow set fishing anchors or ship anchors) will greatly support Marine Spatial Planning (MSP). This knowledge will also enable pre-emptive measures to be taken, such as exclusion zones, re-routing or armouring.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where cables & pipelines are already active, which may contribute to spatial conflict.

As climate change melts progressively larger sections of Arctic ice, the opening of the North West Passage will create opportunities for cable & pipeline routes. Polar regions could develop rapidly as the transition towards a low carbon economy increases dependence on gas and the need for pipelines.

Climate change will also impact the distribution and diversity of Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges, the location of which may need to be considered when laying future cables & pipelines. Pipelines laid along the surface of the seabed could provide additional hard substrate that may also be colonised by corals and sponges.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Cables & pipelines may be permissible within some existing and future MPAs, or they may need to be rerouted to avoid them. Large offshore MPAs proposed within BBNJ could have implications for future cable & pipeline siting. Developing further data sharing mechanisms between the cables & pipelines sector and scientists could improve the understanding of basin-scale climate change impacts at the seafloor, and help inform the siting of future MPAs.

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Biotechnology

Biotechnology current status & challenges

Biotechnology is an emerging sector with low presence and high development potential in the North Atlantic. Biotechnology requires access to marine organisms and their Marine Genetic Resources (MGR); the under-explored nature of the marine environment means MGR spatial distribution is not well known. Growth in marine biotechnology is largely driven by political factors, such as contributing to multiple United Nations Sustainable Development Goals through aspects of sustainable food production systems, regulating the harvesting of marine bioresources, and ending overfishing. There is growing interest in deep-sea organisms, as their ability to withstand extreme temperatures and pressures and grow without light could be harnessed to develop new industrial enzymes or pharmaceuticals.

The spatial needs of biotechnology are uncertain. However, complementary arguments to those advocated for Marine Protected Areas (MPAs) can be made for protecting areas likely to contain biotechnology resources (e.g. sponge grounds). Biotechnology could help enable the move offshore for other Blue Growth sectors, such as aquaculture, through contributing to the production of sustainable and healthy aquaculture products. Biotechnology could also increase the value of aquaculture through developing biofuels, chemicals and bioactive compounds from cultured marine algae, which will be needed for a low-carbon future with reduced reliance on petrochemicals. The fisheries sector could also benefit from biotechnology solutions for transforming waste and residues into valuable by-products.

Continued generation of fundamental knowledge of marine organism's chemical composition, life cycle and biography will be needed to drive biotechnology product innovation. Next generation biotechnologies, such as high-throughput screening, "–omics" technologies and bioinformatics, are set to broaden derived products and end-uses. New generations of autonomous underwater vehicles (AUVs) may facilitate MGR sample collection from more inaccessible locations, such as the deep sea and polar regions, whilst pairing with remote systems for *in situ* analysis could enable more rapid screening of MGR. Developing bio-marine clusters could also help the biotechnology sector develop critical mass.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for marine organisms and their associated Marine Genetic Resources (MGR). ATLAS is contributing to greater understanding of habitat suitability and biogeography of species of interest to biotechnology, such as deep-sea sponges. ATLAS research indicates that by 2100, many Vulnerable Marine Ecosystem (VME) indicator taxa, such as sponges, will have severely reduced geographic distribution.

As climate change melts progressively Arctic ice, the opening of the North-West Passage could create new sampling opportunities for MGR in previously inaccessible locations. ATLAS scientists have also discovered new hydrothermal vents off the Azores, that could be of interest for MGR adapted to extreme conditions.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Biotechnology activities may be permissible in some existing and future MPAs, if potential environmental impacts are acceptable. The outcomes of BBNJ will have profound impacts on the legislative environment and development of the biotechnology sector.

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Aquaculture

Aquaculture current status & challenges

Aquaculture is a growing sector in the Blue Economy, with high presence and high development potential in the Atlantic. In the North Atlantic, aquaculture is a relatively diverse sector with a wide range of fish and shellfish production species; algae aquaculture is less developed. The location of aquaculture is highly dependent on the environmental requirements of the production species.

Aquaculture generally requires stable long-term locations, and increased competition for space in inshore waters may lead to aquaculture expansion offshore. The move to offshore, and accommodation of larger production species (e.g. tuna penning), will involve the development of larger, more robust systems, which require more space. Expansion may lead to conflict with existing offshore sectors, such as fisheries, as some fishing gear types will not be permitted around offshore wind and aquaculture installations. Synergies between aquaculture and other sectors are also possible, such as colocation with renewable energy in multiuse platforms, and aquaculture areas as wild fish stock refuges potentially benefitting fisheries.

Understanding the best location for aquaculture is a key part of ensuring it has a place in Marine Spatial Planning (MSP). For example, moving towards Integrated Multi-Trophic Aquaculture (IMTA) systems could reduce effluent and make aquaculture acceptable for a greater range of sites. However, there are considerable knowledge gaps on siting criteria for the cultivation of different species. Without this information, it is difficult to manage aquaculture sustainably, and in line with the principles of the Ecosystem Approach to Aquaculture (EAA).

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of offshore sites for aquaculture. Some existing sites may no longer be suitable for the species cultured there, whilst additional areas could become suitable. Changes in ocean circulation could lead to aquaculture moving into areas where other sectors are already active, which could contribute to spatial conflict.

Different aquaculture species may respond to ocean circulation and pH changes differently, and wild stocks used to seed aquaculture could also shift in response to ocean circulation changes. This could lead to issues with supply and demand, for example, shellfish will be highly sensitive to ocean acidification, yet the perception of shellfish as low-carbon food could lead to increased demand.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Aquaculture may be permissible within some existing and future MPAs, if environmental impacts are appropriately managed, for example through the use of IMTA systems.

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Fisheries

Fisheries current status & challenges

Fisheries are considered a mature sector in the Blue Economy, with high presence in the Atlantic sea basin. In the North Atlantic, fisheries are a highly-diversified sector in terms of target species, gear types and vessels. Trends in fisheries presence and potential vary by nation, whilst future trends are expected to vary amongst fleet type.

Increased competition for space in inshore waters may lead to some Blue Growth sectors extending offshore. The expansion of these sectors could lead to spatial conflict with fisheries, for example, some gear types will be permitted around offshore wind, oil & gas, and aquaculture installations, whilst others may not be.

Understanding the most important locations for sustainable fisheries production is a key part of ensuring they have a place in Marine Spatial Planning (MSP). However, this can be complicated by specific knowledge gaps regarding some aspects of areas valuable to fisheries, such as breeding grounds, nursery areas, and feeding grounds. The fishing industry is often in the best position to know the locations of these areas but may often be unwilling to share this information for commercial reasons.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in where commercial fish species occur, including breeding grounds, nursery areas and feeding grounds. Species may respond to this change in different ways, and as a result some fisheries may be affected more than others, depending on location and target species. Species distribution models for several commercially important fish species have been produced by ATLAS, and could help inform Marine Spatial Planning decisions for fisheries.

Changes in ocean circulation could potentially lead to fish stocks relocating into areas where other sectors are already active, whilst the development of new offshore sectors, such as deep-sea mining, could place additional stressors on deep-sea ecosystems and may impact fisheries. However, there may also be the opportunity for synergies, for example, oil & gas rigs can provide artificial habitat for coral species, which may help to improve connectivity between coral habitats damaged by fishing activities. These artificial habitats may provide refuge for commercial species that in turn could recruit to fisheries in the region.

Cold-water coral reefs are expected to be some of the most sensitive habitats to climate change impacts, with the potential that current areas designated as Vulnerable Marine Ecosystems (VMEs) may face significant degradation from climate change impacts in the future. Some areas, which are not currently designated VMEs, may require protection to serve as refuges for corals. As VMEs can also act as refuges for commercial fish species, degradation of these habitats by climate change may impact the health, location and sustainability of fish stocks and fisheries. ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Fisheries activities may not be permitted in proximity to existing or future MPAs, whilst large offshore MPAs proposed within BBNJ could impact fisheries activities.

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Wind

Wind current status & challenges

Wind energy is a growing sector, with high presence and high potential in the North Atlantic, although this varies by region. The location of wind farms is place-based, driven by resource potential and the availability of suitable infrastructure, such as grid connection and port services.

Political incentives, such as reducing emissions, increasing renewable energy contributions, and improving energy security have facilitated growth in the wind sector. Increasing demand is fuelling the design of larger, higher capacity turbines, which will require more space to maintain efficiency. The development of floating (tethered) turbines could enable wind farms to seek space in deeper waters offshore. Fixed foundations are usually located in <60m and tethered turbines in 50-200m requiring average wind speeds of >9m/second.

Moving offshore could bring wind energy into conflict with other sectors, such as fisheries, shipping and oil & gas, who are likely to be excluded within and around wind farms. Ships may need to re-route to avoid installations and wind turbines could interfere with navigation radar. Certain fishing gear types may be restricted to protect submarine cables transmitting energy from farms. Siting of wind farms may also impact seismic surveys, exploration, drilling and production of the oil & gas sector.

Synergies may be possible with sectors that can share equipment, installations, infrastructure and skills base, such as tidal & wave. Synergies with the cable sector will be needed to deliver obtained electricity to energy grids. Co-location with aquaculture or tidal & wave could reduce spatial conflict, if technological and regulatory hurdles can be overcome. More studies are needed on the risks and benefits of co-location and multi-use platforms. Conservation benefits, such as installations acting as artificial reefs, need to be balanced with environmental impacts, including risk of wildlife colliding with infrastructure, electromagnetic disturbance, and potential decommissioning impacts

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas with the potential for future or existing offshore wind farms, which may contribute to spatial conflict.

Infrastructure from offshore wind could act as a refuge for commercial fish species, with fishing exclusions in close proximity to both tethered and fixed foundation turbines. Turbine foundations could also be colonised by Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges, and act as artificial reef structures for these species.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Wind farms may be permissible in some existing and future MPAs, or installations may need to be located away from MPAs. Large offshore MPAs proposed within BBNJ could also have implications for the location and environmental impact monitoring of future offshore wind farms. Environmental data collected by ATLAS researchers could help inform and strengthen wind energy Strategic Environmental Assessments and Environmental Impact Assessments.

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Tidal & Wave

Tidal & Wave current status & challenges

Tidal & wave energy are the main technologies within the emerging ocean energy sector, which also includes ocean thermal, ocean current and salinity-based technologies. Tidal & wave are separate subsectors, with their own site requirements and equipment types. Both are place-driven, depending on the resource potential of a given location. Tidal stream technology requires >1.5m/second at mean spring tides and water depths >5m. Annual mean wave power should be >20kw/m and water depth of 10-200m. Tidal barrages and arrays are usually sited closer to shore in shallower waters, although tidal stream could occur offshore in some locations. Wave energy collection can occur offshore in deeper waters, with high potential in the North Atlantic. Both tidal & wave energy have high development potential; although tidal is currently more developed, wave has a greater number of possible sites in the North Atlantic. Within the ATLAS working area Canada (Bay of Fundy), UK (Bristol Channel) and France (Normandy) are among the world's highest tidal ranges.

Tidal & wave require specific devices, for wave energy conversion this includes a range of technology types adapted to different conditions. Devices will have different spatial characteristics and potentially different environmental impacts. As an emerging sector, not all the technology for tidal & wave is proven, and the sector relies on other sectors for creating critical mass and synergies. Working with offshore wind could facilitate grid connection and the development of technology for storing surplus energy. Co-location with aquaculture and wind may be possible, if technological and regulatory hurdles can be overcome. Sharing infrastructure, such as vessels, with other sectors could reduce costs. Synergies with the cable sector will be needed to deliver obtained electricity to energy grids.

Political interest in generating renewable energy may encourage sector growth and increased spatial demands. Wave energy currently has modest space requirements but if technology breakthroughs, upscaling and cost-reduction can be achieved, there could be major spatial implications in the long term. Expansion in tidal & wave could lead to spatial conflict with fisheries and shipping, as both sectors are likely to be excluded around wave converters and tidal arrays. The impact of tidal & wave on environment is not completely understood, although there could be potential conflicts with conservation.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where planned or existing tidal & wave installations already occur, which may contribute to spatial conflict.

ATLAS found that water column dynamics and food supply are important to the biodiversity of Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges. Expansion of the tidal & wave sector will need to consider potential impacts on these taxa through environmental assessments. ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Tidal & wave installations may be permissible in some existing and future MPAs, or they may need to located outside of MPAs. The large offshore MPAs proposed within BBNJ could also have implications for the location and environmental impact monitoring of future tidal & wave installations.

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Tourism

Tourism current status & challenges

Coastal and maritime tourism is a mature and growing sector in the North Atlantic, but other than the cruise industry, offshore tourism is largely an emerging sub-sector. The location of the cruise industry is dictated by the location of home ports and ports of call and the need to take the shortest and safest routes between suitable destinations, with many routes and destinations being seasonal. Economic growth has brought financial opportunities to travel, increasing the number of passengers and increasing cruise liner numbers and size. The growth of high-profile tourism could also see increased numbers of luxury liners.

Offshore spatial requirements of the cruise industry are driven by operational and safety requirements including access to port facilities, shipping lane widths, sheltered anchorages, areas to be avoided, environmental considerations and safety zones around fixed installations. Increased vessel size and traffic requires wider shipping lanes to accommodate safe manoeuvring and collision avoidance, whilst diversification in tourist destinations may necessitate new cruise liner routes. Changes to routes could cause spatial conflict with fishing, and fixed installations used by aquaculture, renewables and oil & gas.

Growth in niche and low-profile tourism may see increased interest in new offshore tourism opportunities, such as sport fishing and pesca-tourism, or visits to offshore installations. Ecotourism is also expanding, such as interest in whale watching and other nature cruises. Growth in nautical tourism may require additional safe routes for sailing vessels, with potential conflict between sail craft and offshore wind farms. There may also be opportunities for tourism to co-locate with other sectors, such as using decommissioned oil & gas platforms as artificial reefs for SCUBA diving. Future developments may see dedicated offshore platforms as a base for tourism, integrating leisure facilities with renewable energy generation and aquaculture and potentially bespoke deep-sea tourism using hi-tech submersibles.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other sectors. Some sectors could move into areas where planned or existing tourist activities already occur, which may contribute to spatial conflict.

As climate change melts sections of Arctic ice, the opening of the North-West Passage could create opportunities for tourism. Conversely, the increase in extreme weather associated with climate change may reduce the appeal of some current tourist destinations. Climate change will also have negative impacts on the diversity and distribution of Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges. Some ATLAS Case Study areas, such as the Norwegian continental shelf and Mingulay Reef, could become climate refuges for VME indicator taxa, making them attractive for tourist activities, such as SCUBA diving. Degradation to VME indicator taxa from a growth in tourism could impact other sectors, for example corals reefs can support the early life stages of sharks targeted by deep-sea anglers.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future Marine Protected Areas (MPAs). Tourism may be permissible in some existing and future MPAs; in some areas, tourism may be restricted to manage environmental impacts. Large offshore MPAs proposed within BBNJ could have implications for future offshore tourism, including monitoring of activities for environmental impacts.

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Deep-Sea Mining

Deep-Sea Mining current status & challenges

Deep-Sea Mining is an emerging sector in the Blue Economy. In the North Atlantic, the International Seabed Authority has issued three 15-year exploration contracts for polymetallic massive sulphide (PMS) mining along the Northern Mid-Atlantic Ridge (MAR). There is currently no interest in exploration for other deep-sea mineral resources in the North Atlantic. Mining activities for PMS in the North Atlantic are still at the exploration phase, with exploitation not expected for at least 5-10 years when the first of the ISA exploration contracts are due to expire. Most of the interest has been in mineral resources on the seabed beyond national jurisdiction, although economically viable PMS deposits may occur within the national jurisdiction of some Atlantic States.

PMS deposits only form through hydrothermal activity, making them very spatially constrained. Many PMS deposits support specially adapted biological communities that only occur at hydrothermal habitats, which has led to concern amongst some conservation groups. Technological constraints mean that only hydrothermally active PMS deposits, and inactive deposits that are either exposed or buried under a shallow layer of sediment, can currently be detected. Improving the ability to detect buried deposits may enable mining to move away from hydrothermally active areas and reduce potential impacts on hydrothermal habitats.

Multiple submarine cables cross the MAR, which is the region of current interest for PMS mining. Growth in the submarine cable sector may see increased spatial overlap with deep-sea mining in the future. Bottom fishing areas, exploratory fishing areas, and areas closed to bottom fishing, all occur along the MAR; changes in the spatial footprint of either the fishing industry or deep-sea mining could lead to spatial overlap of these two sectors. If the deep-sea mining sector grows, further exploration contracts may be granted along the MAR, increasing the spatial needs of the sector.

ATLAS key findings

Atlantic Ocean currents, such as the Atlantic Meridional Overturning Circulation (AMOC) connect deep-sea ecosystems and move vast quantities of heat, salt and energy across the Atlantic basin. ATLAS researchers have discovered that the AMOC is weakening, which may lead to a change in the suitability of existing areas for other Blue Economy sectors. Some sectors could move into areas where deep-sea mining exploration contracts already occur, which may increase spatial overlap between sectors.

Changes to Atlantic Ocean temperature and pH will place physiological stress on deep-sea fauna, such as corals and sponges. Mining impacts, such as sediment plumes, could compound the stress on this deep-sea fauna, which may result in localised biodiversity loss.

ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help to inform the siting of future Marine Protected Areas (MPAs). Potential impacts from Deep-Sea Mining, such as sediment plume generation, may need to be constrained if mining is to be permitted in proximity to existing or future MPAs. Large offshore MPAs proposed within BBNJ may impact the location of future deep-sea mining areas and any monitoring requirements regarding mining impacts.

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Appendix 3: Sample of questionnaire used for interview

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About the ATLAS Project

The EU ATLAS Horizon 2020 Project is a four-year project with partners from multinational industries, Small and Medium Enterprises (SMEs), governments and academia. Together, these partners are assessing Atlantic deep-sea ecosystems to create the integrated and adaptive planning products needed for sustainable Blue Growth. ATLAS is coordinated by the University of Edinburgh and you can find out more about the Project on our website: https://www.eu-atlas.org/.

Industry reactions to ATLAS recommendations survey

This survey is a component of Work Package 7: Policy Integration to Inform Key Agreements led by Seascape Consultants Ltd. To obtain industry reactions, we would like to share ATLAS scientific findings with you and discuss how findings may impact your Blue Economy sector. Understanding industry perspectives will help to shape the way we incorporate industry needs in scientific research and policy, to support the sustainable growth of the Blue Economy.
The survey will consist of seven questions posed during a questionnaire, the survey will take approximately 15 minutes. Participation is strictly voluntary, and you may withdraw at any time.

Privacy notice

The data collected will be used for research purposes only and you may request a copy of your responses. Data collected will be stored by Seascape Consultants Ltd. in an anonymised random number-generated format on a password-protected computer system and will remain accessible to only the researchers involved in the project. Information on your industry sector & sub-sector, institution type and country will be retained alongside your survey responses to enable us to group responses for analysis. Your responses will not be individually or institutionally identifiable. In the unlikely event that evidence of abuse or criminal activity is uncovered during this survey we will be obliged to report it.

We would like to retain your name and email address for 18 months after the survey date, so that we are able to send you the outcomes of our survey. We will not share your contact information with third parties. You are entitled to view any data that we hold on you and you may opt out at any time by contacting the research team: rachel.boschen-rose@seascapeconsultants.co.uk.

This survey complies with the General Data Protection Regulations (GDPR) (2018) and has been scrutinised and granted Ethical Approval through the University of Edinburgh School of GeoScience's ethical approval process. If you have ethical concerns about this survey or the conduct of the researchers involved, you may contact the University of Edinburgh School of GeoScience's Research Ethics and Integrity Committee: ethics.geos@ed.ac.uk.

I confirm that I am over 18 years of age, have read and understood the Privacy Notice, and consent to participate in this survey ☐

Name: Signature: Date:

Email address:

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ATLAS key findings

North Atlantic Ocean temperature, pH and currents are changing, which will impact Blue Growth

- Ocean change will alter the suitability of marine areas for certain species, including Vulnerable Marine Ecosystem (VME) indicator taxa, such as corals and sponges. Some areas designated as VMEs for fisheries may become unsuitable, whilst others not currently designated may require protection.
- Location of commercial fish species may change, including breeding grounds, nursery areas and feeding grounds.
- The suitability of sites for aquaculture could change, as could the location and availability of wild stocks used to seed aquaculture.
- Climate change could open up the North-West Passage for Blue Economy activities, such as shipping, tourism, cables & pipelines and biotechnology.
- Changes in faunal distribution will alter the location of Marine Genetic Resources (MGR), which are essential to the developing biotechnology sector.

Interactions between Blue Economy sectors and the marine environment will impact biodiversity

- Complicated interactions between environmental impacts could occur across Blue Economy sectors.
- Synergies between sectors, such as co-location, sharing of infrastructure and co-operative working could help reduce environmental impacts of Blue Growth.
- Colonisation of artificial structures, such as wind turbine foundations and oil & gas rigs by corals and sponges may help maintain regional connectivity and resilience of these species.
- Spatial exclusions around offshore installations could provide refuge to commercial fish species.
- Water column dynamics and food supply are important to the biodiversity of VME indicator taxa, which may need to be considered by sectors that could impact these dynamics, such as tidal & wave.

New policy instruments, such as the legally binding instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) could shape how Blue Growth interacts with the environment

- BBNJ may alter environmental approval processes, or introduce additional environmental monitoring requirements for sectors operating in marine areas beyond national jurisdiction.
- Large offshore Marine Protected Areas (MPAs) proposed within BBNJ could impact some sectors.

ATLAS scientific contributions to support Blue Growth

ATLAS research is helping to understand North Atlantic Ocean change and the implications for Blue Growth

- ATLAS is contributing to greater understanding of habitat suitability and biogeography of commercially important fish species and species of interest for their MGR.
- ATLAS research on ocean circulation changes, habitat suitability, biogeography and connectivity will help inform the siting of future MPAs. Some Blue Economy activities may be permitted in proximity to existing or future MPAs, whilst others may need to locate away from MPAs.

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- Environmental data collected by ATLAS researchers could help inform Strategic and Regional Environmental Assessments, and Environmental Impact Assessments, for Blue Economy sectors.
- ATLAS is improving environmental data-sharing opportunities between science and industry to support better understanding of environmental baselines and impacts, particularly at the basin-scale.

Industry reactions to ATLAS recommendations Survey

About you

1. What is your Blue Economy sector? (please select)

Cables & pipelines		Oil & gas		Mining		Fishing		Shipping	
Tidal & wave		Wind		Tourism		Biotechnology		Aquaculture	
Other (please state):									

2. What is your subsector (if applicable)?
………………………………………………………………………………………………

3. What is your institution type? (please select)

Regulatory body		Private company		Research institute		Consultancy	
Other (please state):							

4. What country is your institution based in?
……………………………………………………………………………………….

Survey Questions

1. Do you envisage new or expanded activities in the North Atlantic before 2030? (please select)

•

Yes		No		Unsure	

If yes, what sort of activities and where?
………
………

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2. Do you have any plans to work collaboratively with other sectors to address your business challenges?

Yes		No		Unsure	

If yes, how and with which sectors?

……

……

3. What are your main business drivers moving towards 2030? (please select)

Technology developments		Climate change		Brexit		Legislation developments		Other	

If other, what are your main business drivers?

……

……

4. How will the key findings of ATLAS influence your plans? (please select)

Create new opportunities		Modify existing plans		Have no influence		Unsure	

If new opportunities will be created or existing plans will be modified, please provide more detail:

……

……

……

5. What type of scientific information could help you plan for your business heading towards 2030?

……

……

……

6. Are there any current or anticipated technology developments in your sector that may help address some of the issues ATLAS has identified?

Yes		No		Unsure	

If yes, what are these technology developments?

……

……

……

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If no, are there any barriers to finding/using technological solutions?

………

………

7. Do you anticipate that the development of a new legally binding instrument for the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ) will influence your sector's business plans?

Yes		No		Unsure	

If yes, how will BBNJ influence your plans?

………

………

- **END OF SURVEY. THANK YOU VERY MUCH FOR YOUR PARTICIPATION -**

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Document Information

EU Project N°	678760	**Acronym**	ATLAS
Full Title	A trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe		
Project website	www.eu-atlas.org		

Deliverable	**N°**	7.5	**Title**	Industry reactions to ATLAS recommendation
Work Package	**N°**	7	**Title**	Policy Integration to Inform Key Agreements

Date of delivery	**Contractual**	Month 40	**Actual**	Month 40 (Aug 19)
Dissemination level	x	PU Public, fully open, e.g. web		
		CO Confidential restricted under conditions set out in Model Grant Agreement		
		CI Classified, information as referred to in Commission Decision 2001/844/EC		

Authors (Partner)	Gianni Consultancy	Seascape Consultants Ltd		
Responsible Authors	**Name**	Matt Gianni (GC)	**Email**	matthewgianni@gmail.com
		David Johnson (SC)		david.johnson@seascapeconsultants.co.uk

Version log			
Issue Date	**Revision N°**	**Author**	**Change**
30 August 2019	0		

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