COLUMBUS
KNOWLEDGE TRANSFER FOR BLUE GROWTH

Acronym: COLUMBUS
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Deliverable 3.3

Mapping Report of possible inter-relationships, inter-linkages and dependencies of prioritized knowledge gaps and needs of the focus areas combined

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EXECUTIVE SUMMARY

As COLUMBUS aims to identify relevant knowledge outputs from EU funded projects which meet the knowledge gaps in the respective focus areas. In this context the document is providing an overview on common gaps and needs in the marine and maritime field. Based on the feedback from the Competence Nodes (CNs), which represent the COLUMBUS focus areas, linkages and common needs have been identified between nearly all CNs. However, the respective links turn out to be labelled with different intensity flags. Strong links can easily be identified by several topics/subthemes the particular CNs are sharing and in an ideal case these issues or gaps are mentioned by both CNs. In a few circumstances there are no obvious links between CNs or a linkage has only been mentioned by one CN but not by the counterpart.

The above mentioned gaps and needs can also be labelled as hot or emerging topics which have to be addressed as cross-cutting issues. Often mentioned topics are e.g.

- sustainable use of marine resources
- adaption of/establishing the appropriate legal framework
- free and open-access *multi-purpose data repositories* and portals
- innovative and envionmentally friendly technological solutions
- intelligent management of our seas and coastal zones

Objectives

This report focusses on interactions and dependencies between the Competence Nodes with regard to knowledge gaps. The required knowledge for a particular marine or maritime sector covers a wide range of gaps and even if the knowledge might be availiable somewhere it does not automatically cross sectors. In order to map the required knowledge gaps and needs WP3 collected the information detailed in this report through questionaires filled by the nine CN groups, desk-top research and e.g. discussions during projects meetings.

Rationale

The use and pressure of different societal/economical interest groups like tourism, fisheries, the energy sector or transport on our seas and coastlines increased significantly during the last decades and thus usually is in conflict with our goal to secure healthy seas and oceans for sustainable future use. Besides the obvious conflict with marine conservation the different marine and maritime economic sectors are experiencing that the maritime space – especially near the coastline - is limited and thus even generates conflicts between economic sectors. To overcome these issues, **advanced knowledge** on the functioning of the marine ecosystems for educated decisions in marine spacial planning as well as **innovative technological solutions** are required to optimise a sustainable use of our seas and oceans.

Identifying the needs, linkages and dependencies between sectorial knowledge gaps can help to solve the most urgent problems and will, hopefully, lead to cross-sectorial solutions.

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1 INTRODUCTION

Since times of ancient wall carvings or papyrus documents, our seas and oceans have been subject of our hopes and threats, dreams and fears and once mankind started settling near the seaside we started making use of its resources and began to sail shorelines to explore new settlements or transport goods. The seas vastness did not force mankind to accept limitations in the early days of seafaring and the slowly cristalising maritime economic sectors like fisheries, transport or naval warfare developed quite independently. But with ongoing population growth and more and more people moving to the coastlines, we are experiencing severe over-exploitation of marine resources and spacial limitations and competition among too many interest groups. Although developed quite independently, marine and maritime sectors started recognising that they have to intensify collaborations to solve the problems caused by the societal pressure on our seas and coastlines.

As the terms *marine and maritime* have slightly different meanings in different cultures and languages, it is difficult to draw clear lines between marine and maritime research. With regard to a strategy for marine and maritime research, the European Commission defines these terms as follows:

Marine research *addresses a branch of earth science that studies the oceans and seas including their flora and fauna as well as their interaction with coastal territories and with the atmosphere. It covers a wide spectrum of scientific knowledge and phenomena such as marine organisms, ecosystems dynamics, ocean currents, plate tectonics and geology. These diverse topics involve multiple disciplines to understand the underlying processes and the complexity of their interaction. Nowadays, one of the major concerns of marine research is the preservation of marine ecosystems.*

Maritime research *aims at technologies and innovative solutions for a better exploitation of sea and ocean resources such as the design, building and operation of vessels, harbours, oil platforms and more widely any kind of human related activity centred on sea and ocean resources (e.g. tourism).*[1]

The COLUMBUS project will meet the interdisciplinarity and complexity in research and innovation and aims to cover both, marine and maritime issues even with a trans-sectoral approach. This is ensured through a strong consortium of 25 partners throughout Europe and with different professional backgrounds (academia, industry, administration, tech transfer).

COLUMBUS structured itself into 9 Competence Nodes which aim to cover all relevant marine and maritime sectors and interest groups:

- Fisheries
- Aquaculture
- Monitoring & Observation
- Marine Biological Resources
- Maritime Transport & Logistics
- Marine Physical Resources
- Maritime Tourism

[1] EU-COM (MEMO/08/553): EU Strategy for Marine and Maritime Research: Frequently Asked Questions, Brussels, 3 September 2008, http://europa.eu/rapid/press-release_MEMO-08-553_en.htm

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- Marine Governance & Management
- Marine Environment & Futures

Each of the Competence Nodes (CNs) provided a profile in which the topics as such but also R&D knowledge gaps and needs, challenges or bottlenecks are described. These profiles are supposed to be living documents and will be updated in the course of the project. A first status was provided though deliverable D-3.2: Knowledge Demand: *Assignation of Knowledge needs to Competence Nodes.*

The process of defining interactions was started at the 2nd partner meeting, July 2015 in Berlin. However, it turns out to be an ongoing discussion and the deeper the partners are involved in the project - especially in the knowledge transfer process - the more interactions and possible overlaps are identified.

But why is this important and what is the impact on the further progress within the project? COLUMBUS is engaged to transfer marine and maritime research results to the respective target user. The COLUMBUS database is defined by over 1250 EU funded marine projects – all of them international, interdisciplinary collaboration projects, all of them in the marine and maritime field. To define the most relevant CN for a certain project and to avoid duplication it is essential to identify the connections between the marine and maritime world respectively and to learn more about the goals and needs of each CN. In order to achive this, each CN defined subgroups and subthemes as well as a keyword list so that the projects could be assigned to the respective CNs. These listings as well as a short questionnaire on possible interactions are the building blocks for this report. Furthermore, the results summarized in this report are supposed serve as the basis for WP4, knowledge supply.

2 METHODOLOGY

The thematic nodes consider aspects of some of the most important EU strategies in the marine and maritime sectors: Marine Strategy Framework Directive (MSFD), Maritme Spacial Planning Directive (MSPD), Common Fisheries Policy (CFP), Blue Growth and Sea Basin strategies. To reflect the main European strategies and to clearly define the Terms of Reference of the Competence Node, each node leader/ fellow provided a node profile (see deliverable D-3.2).

In the course of the project, each node team was asked to fill a second questionnaire to identify possible interactions and overlaps with other CNs based on the formerly defined node profiles. The results are presented in the form of mind-maps for each CN in the following chapter.

3 RESULTS

One would expect specific inter-relationships between CNs to be identified from both competence nodes. However, this is not true in all cases and depends on the individual point of view and focus (industrial, scientific, governmental) and if that particular linkage is identified as essential for the respective node. E.g. the CN *Marine Biological Resources* has not identified a linkage to the CN *Marine Physical Resources* but vice versa. The following results are provided by each of the CN teams and thus reflect their node specific views and assessment.

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3.1 Fisheries

The CN *Fisheries* is connected to all other COLUMBUS CNs, however, some of the interactions are more obvious than others. Fisheries provide feed for aquaculture as well as swine, poultry and mink production. It also provides feed for pets. Furthermore, fish for human consumption is beneficial for human health due to high contents of omega 3 fatty acids and proteins, making interlinkages to the CN *Marine Biological Resources*.
Fish proteins and omega 3 play a major role in nutrition supplements and are known as beneficial for health. All interactions described above are more or less economically driven relations with fish as a commercial product.

In terms of biodiversity, fisheries in linked to the food web of the oceans as a top predator. Furthermore, fishing activities may have negative impacts such as sea bed damages during bottom trawling. Therefore, there are inter-relationships to the CNs *Monitoring & Observation*, *Marine Environment & Futures* and *Marine Governance & Management*. In return the CN *Monitoring & Observation* to some extent relys on data provided by fishing or research vessels. In the EU, there is focus on the balance between fleet capacity and fishing opportunities in order to achieve sustainable fisheries (STECF-15-15). This makes interlinkages between *Fisheries* and *Marine Environment and Futures.*

European guidelines like the CFP and given fishing quota are important to guide the fishing industry and to preserve the fish stocks, but more efforts are needed in the near future with regard to sustainable fishing, agreed regulations as well as responsible customers. A different aspect is the impact of climate change on the fishery's sector: global warming is already impacting species distribution and migration as well as their reproduction. Therefore, fisheries research has been mentioned as one of the urgent needs within the sector.

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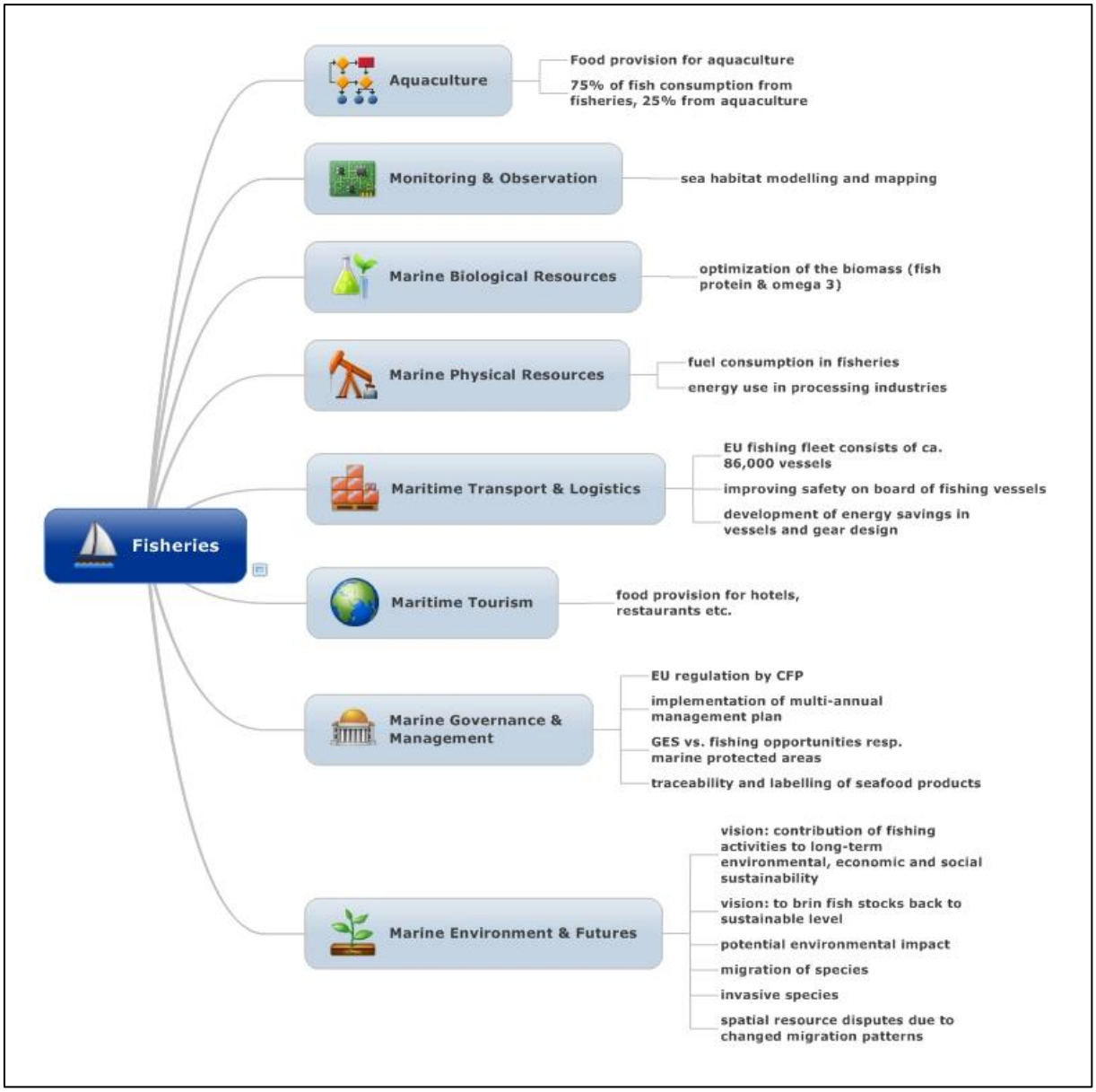
Figure 1: Interactions between Fisheries and other COLUMBUS Competence Nodes



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3.2 Aquaculture

Fish and seafood products play an important role in our nutrition while it is well known that the increasing demands cannot be covered by the fishing industry alone and overfishing is even worsening the effect. Thus, a sustainable and ecologically responsible aquaculture seems to be the best solution to the actual societal demand. However, this requires more research, flexible and innovative technological solutions, societal acceptance as well as political will as an enabler (providing the legal framework conditions).

There is an obvious and close link between fisheries and aquaculture - particularly with regard to economic competition but also with respect to food provision and competition about marine space. Actually roughly 25% of the global fish consumption is provided through aquaculture while still 75% is covered through traditional fisheries. However, the market-share and total production of the aquaculture sector is increasing. The quality of the aquaculture products were improved within the last years, the prices for fish production could be reduced and the (negative) environmental impacts like eutrophication or the occurance of antibiotics (e.g. in waste water) were reduced. Furthermore aquaculture – especially in land-based production units - is less vulnerable to climate change impacts.

With regard to Maritime Tourism, e.g. visits of aquaculture farms could be included in touristic concepts of a region while any possible conflicts with e.g. leisure boat activities should be solved beforehand e.g. through public participation proceedures.

A quite strong relationship is given between the CNs *Aquaculture* and *Marine Biological Resources*. The role of individual species in marine ecosystems, the application of biochemical techniques as well as innovative technologies are required for implementing a sustainable and environmentally friendly aquaculture.

There is also a strong link to *Marine Governance and Management* which is mainly based in the need for clear and controllable regulations in this relatively new and emerging economic sector. There are synergies between Aquaculture and Marine Physical Resources. Multi-use offshore platforms combine renewable energy with aquaculture to optimise the efficiency of energy use of aquaculture.

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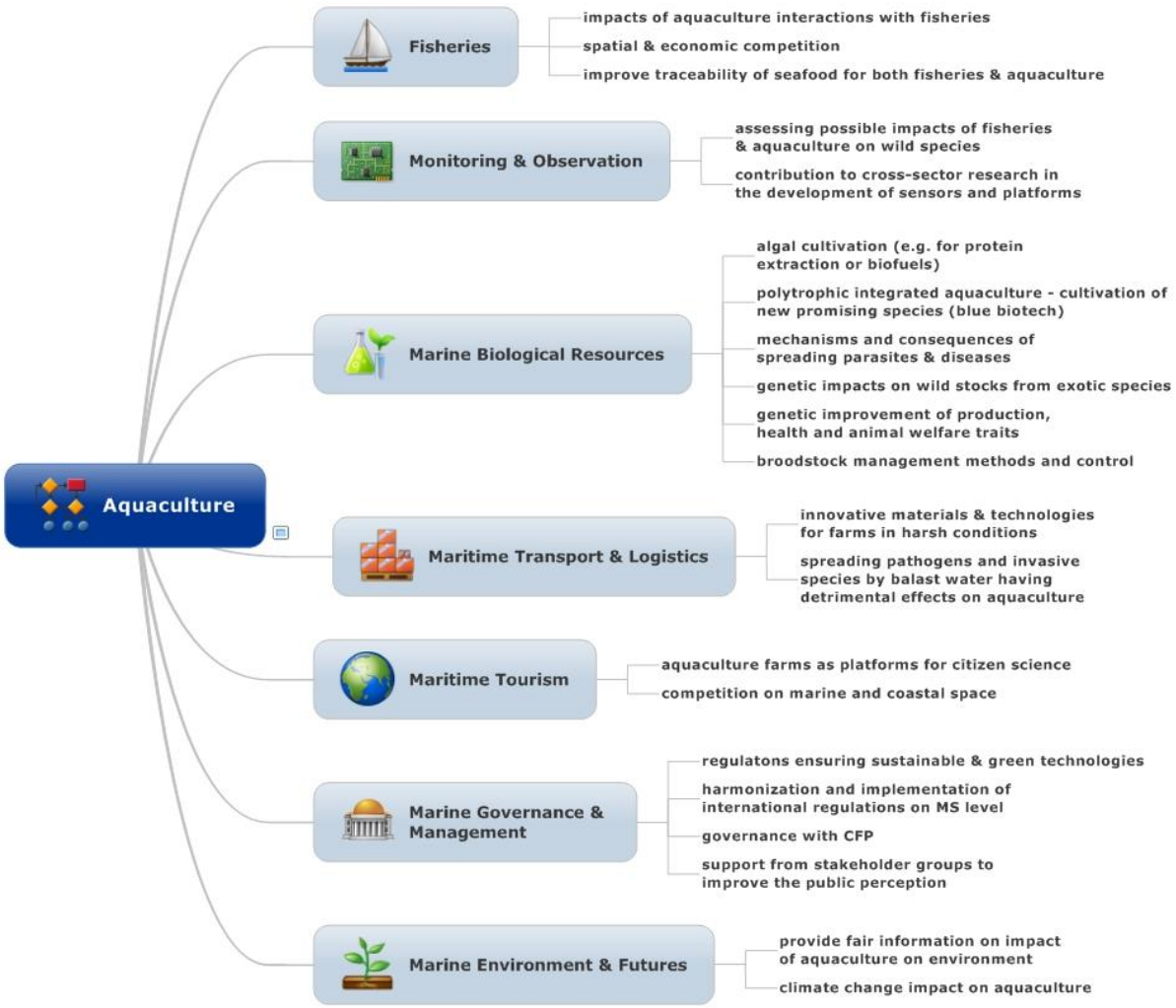
Figure 2: Interactions between Aquaculture and other COLUMBUS Competence Nodes



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3.3 Monitoring & Observation

This Competence Node is dealing with standardised, high-precision measurements of relevant variables, harmonised data storage and accessability across institutions and member states. Information on the state of the environment through advanced observing systems is essential for integrated and knowledge based marine and coastal management and governance. The obvious challenges in the near future are: (1) to identify and address gaps in current EU observations and monitoring activities (2) to collate and make available already collected –but not yet shared – data, (3) to process the collected data, (4) to avoid dublication in data collection, (5) to ensure free access to marine data and (6) to have data on demand available.

As harmonised and high-quality marine data are a prerequisite for all CNs, *Monitoring & Observation* plays a central and evenly distributed role with most interactions to other Competence Nodes.

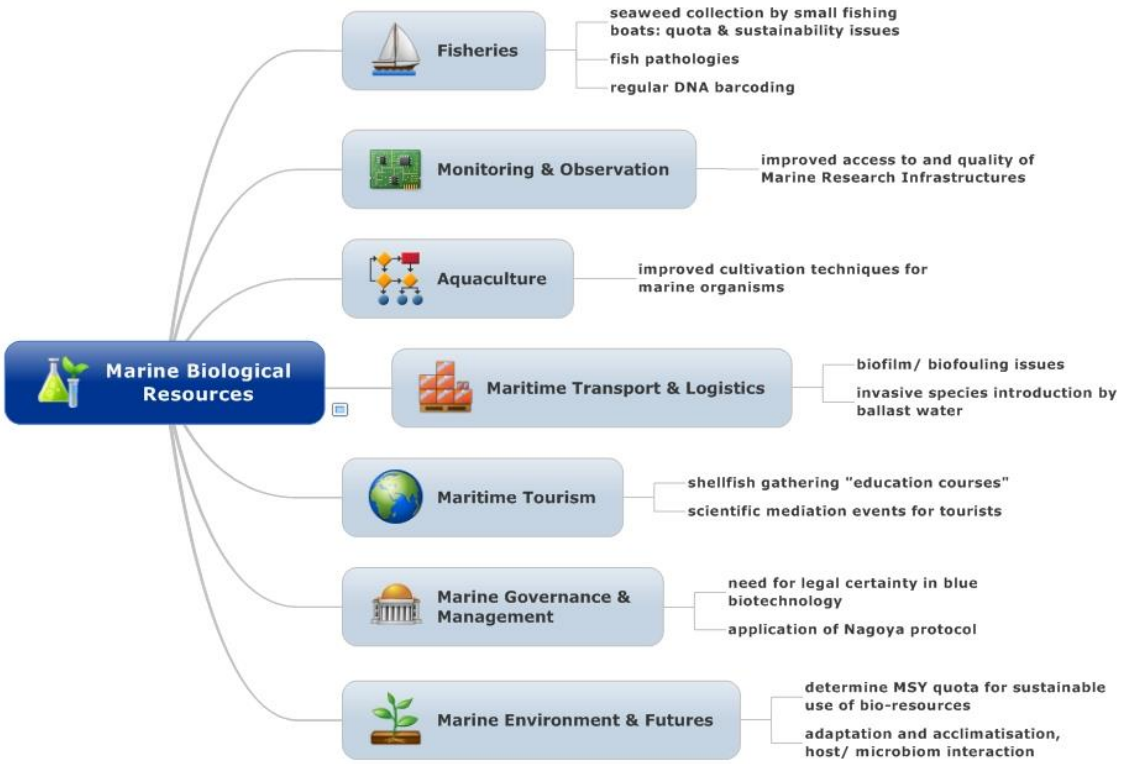
Figure 3: Interactions between Monitoring & Observation and other COLUMBUS Competence Nodes

3.4 Marine Biological Resources

Marine Biological Resources provides basic and applied research results for all marine and maritime applications. Using biotechnological methodologies this CN is directed to enhance marine biotechnology in Europe as one of the emerging industries mentioned in the Blue Growth strategy. There is a broad variety of industrial applications for the marine biotech sector like health, nutrition, environment, cosmetics or aquaculture. The chart below indicates various relationships to other CNs while *Fisheries* seems to be the most prominent partner. As the marine biotech sector is still developing and enterpreneurs are exploring potentials there are some obstacles to overcome (e.g. technical, environmental impact, legislation). However, the sector has a great potential to provide solutions for e.g. pharmaceutical and technological challenges (e.g. new drugs, biocides or material sciences).

No obvious links between this CN and *Marine Physical Resources* have been identified so far.

Figure 4: Interactions between Marine Biological Resources and other COLUMBUS Competence Nodes



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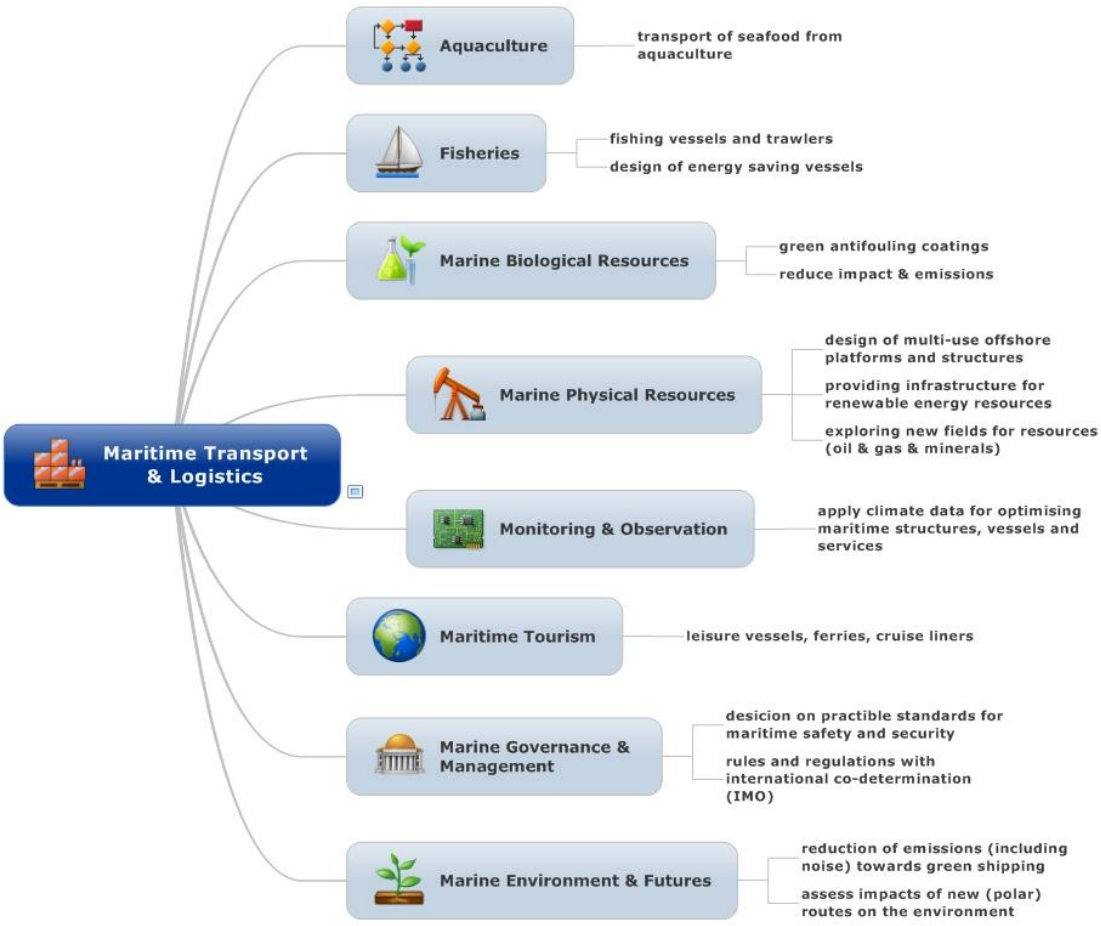
3.5 Maritime Transport & Logistics

This CN represents a quite broad industrial sector with long traditions and many competitors. Challenges like new environmental guidelines, economic frameworks or climate conditions force this branch to be flexible and dynamic. This might be the reason why the *Maritime Transport & Logistics* CN has more linkages to other marine and maritime sectors than one would expect in the first place.

E.g. there is a close relationship to the CN *Biological Resources* with respect to innovative antifouling substances. The need to apply antifouling materials which are both, environmentally friendly and which are able to prevent biofouling is a task which can only be achieved by interdisciplinary approaches. But also the reduction of noise or new polar shipping routes play a prominent role in connection with *Marine Environment & Futures*.

Figure 5: Interactions between Maritime Transport & Logistics and other COLUMBUS Competence Nodes



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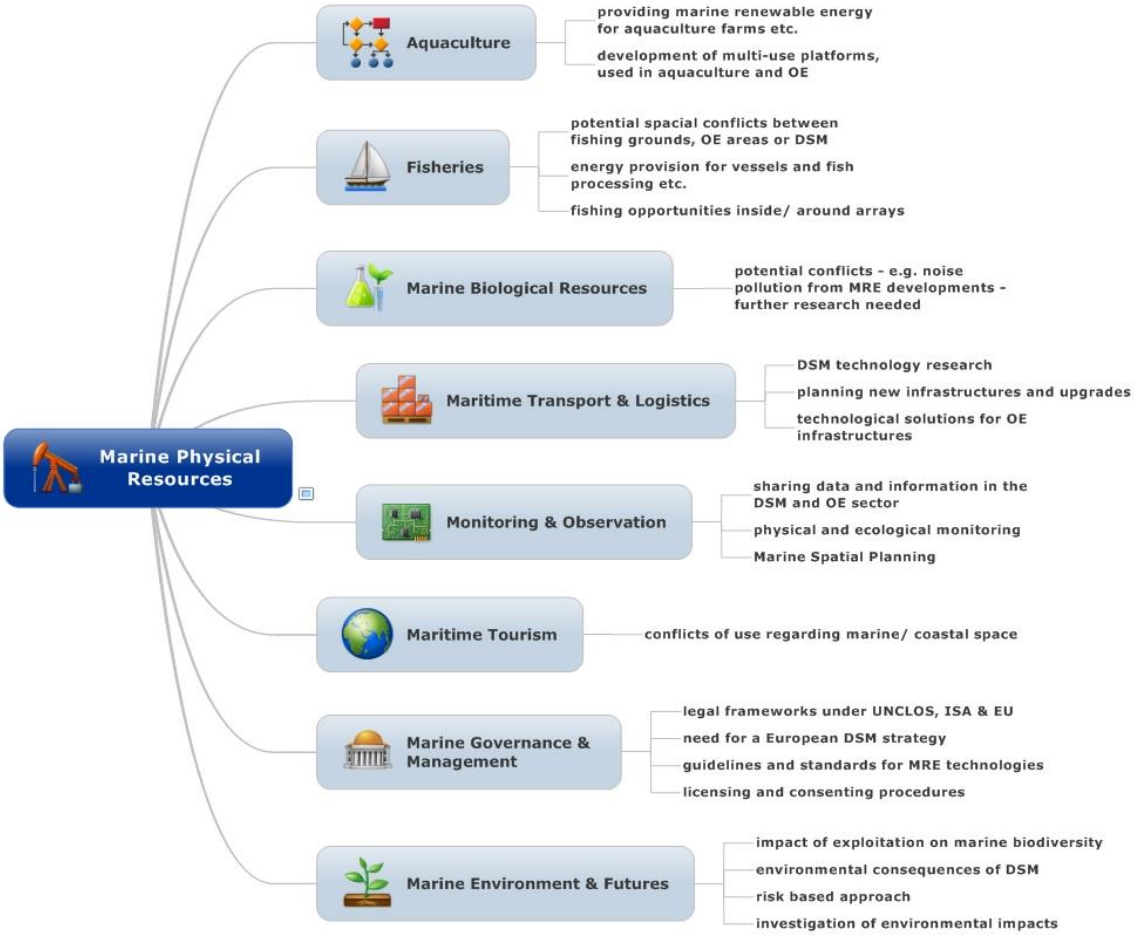
3.6 Marine Physical Resources

With the depletion of oil and gas fields worldwide and the impact on climate change, renewable ocean energy are emerging sectors in our energy-craving world. Furtermore, the need for rare earth elements raises interest for Deep Sea Mining (DSM). Besides cooperation with other marine sectors (transport, aquaculture, governance) this sector experiences also competition, especially on marine space (tourism, transport, fisheries) and generally impacts the marine environment. Consequently several linkages to other sectors could be identified.

The basis for e.g. maritime energy activities are data: ongoing exploration efforts should feed into better maps of seabed ecosystems and the results of monitoring the first extraction projects should be made widely available in order that appropriate lessons be learned for subsequent activities. In light of the widespread concern about the potential environmental impacts of deep-sea mining, there is consensus amongst the research community that more research is needed to help inform the development of appropriate legal frameworks and to contribute to DSM technologies that minimize the environmental risk while maximizing the economic mining efficiency. The connection to marine governance is determined by the ISA decision on a future DSM code of conduct. Innovative technology, adequate port facilities and specialized vessels for DSM and ocean energy activities have to be provided by the maritime technologies sector.

Figure 6: Interactions between Marine Physical Resources and other COLUMBUS Competence Nodes



3.7 Maritime Tourism

The most obvious links for *Maritime Tourism* are the ones to *Maritime Transport* (cruise ships, yachting) but also to e.g. to *Fisheries* or *Aquaculture* (seafood or fishing as leisure activity).

Furthermore there are close relationships to the *Marine Governance* CN. The implementation of MSFD has major implications on touristic activities; and the qualitative descriptors for a 'Good Environmental Status' directly encourage and enable tourism activities: biodiversity; contaminants; disturbances (marine litter).
Achieving a good environmental status encourages coastal tourism. The tourism sector could e.g. develop 'Citizen Science' and 'Crowd Sourcing' programmes to contribute to the MSFD monitoring and socio-economic analysis challenges. One other example is marine litter. Tourism actors and users (e.g. hotels, beach users) are contributing to the pollution of beaches. It is necessary to raise awareness and to provide concrete solutions (e.g. hotels should use reusables or biodegradables; involve tourists in beach clean-up campaigns).

Tourism activities depend severly on a healthy environment. Unsustainable use of marine resources or destruction and degradation of coastal habitats increases the risks to coastal communities from natural and human-induced hazards. Coastal pollution and habitat degradation endanger economies of coastal areas that depend on tourism.

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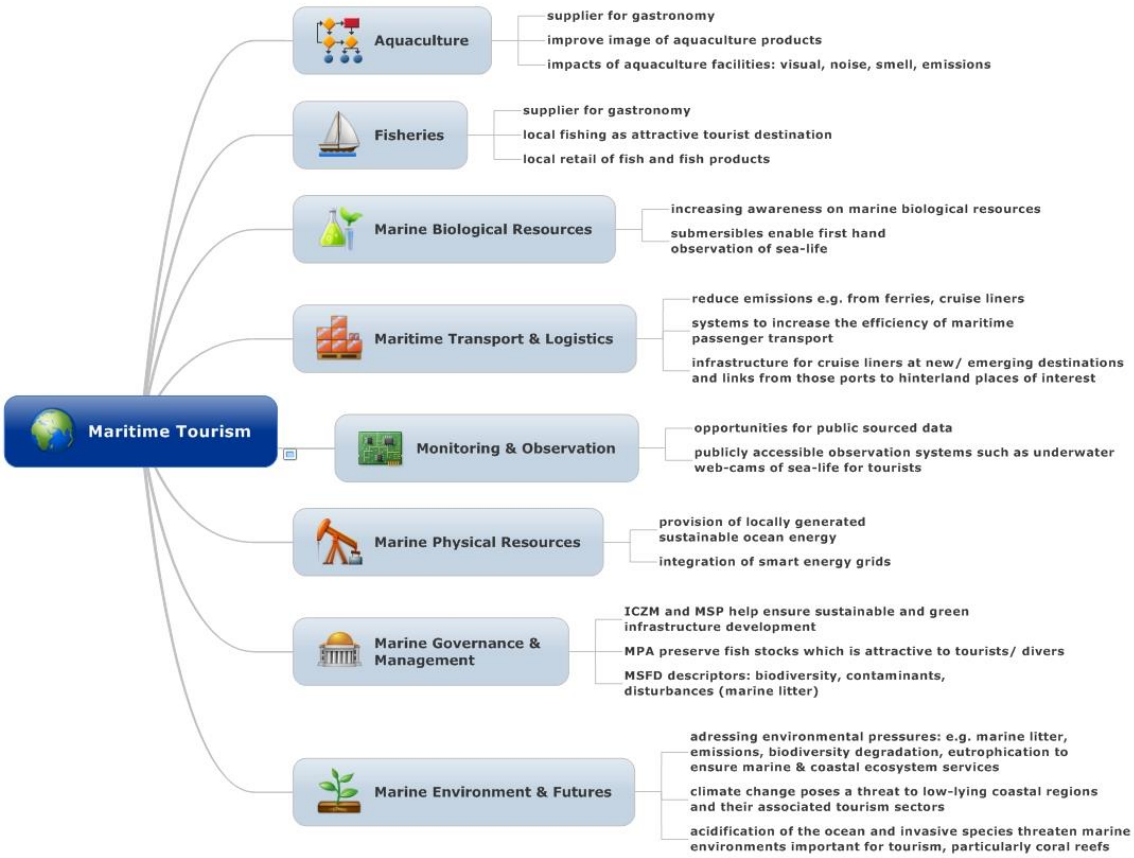
Figure 7: Interactions between Maritime Tourism and other COLUMBUS Competence Nodes



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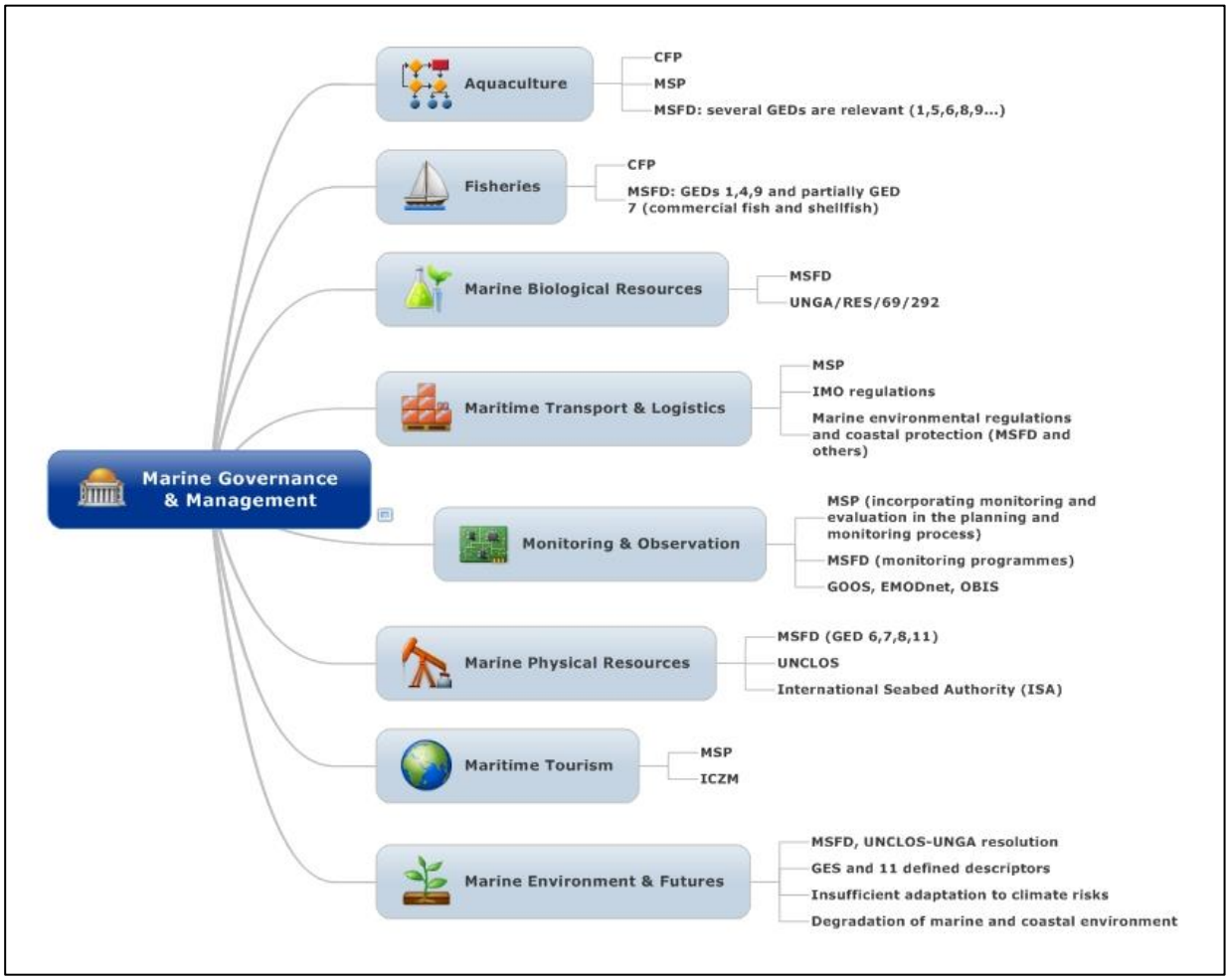
3.8 Marine Governance and Management

While the societal pressure on the marine space is constantly increasing, clear regulations and guidelines especially in conflicting situatations are required. While in the Open Ocean, outside national EEZs, intergovernmental regulations are agreed upon by UNCLOS-UNGA, IMO, IOC or ISA, within the European Union - besides national regulations – MSFD, MSP and CFP are providing a legal framework for marine and maritime activities.

The UN Convention in Rio de Janeiro in 2012 agreed upon that regulating access and benefit sharing to biological resources beyond national jurisdiction was a matter of urgency regarding sustainability and of major importance for poverty alleviation and for generating opportunities for development. There is an importance of not deterring scientific research: research on marine genetic resources was a relatively new and quickly evolving field and innovation could be hampered by cumbersome and excessively bureaucratic procedures. This declaration states a quite close connection to both, the CN *Marine Environment* as well as *Monitoring & Governance*.

Figure 8: Interactions between Marine Governance & Management and other COLUMBUS Competence Nodes



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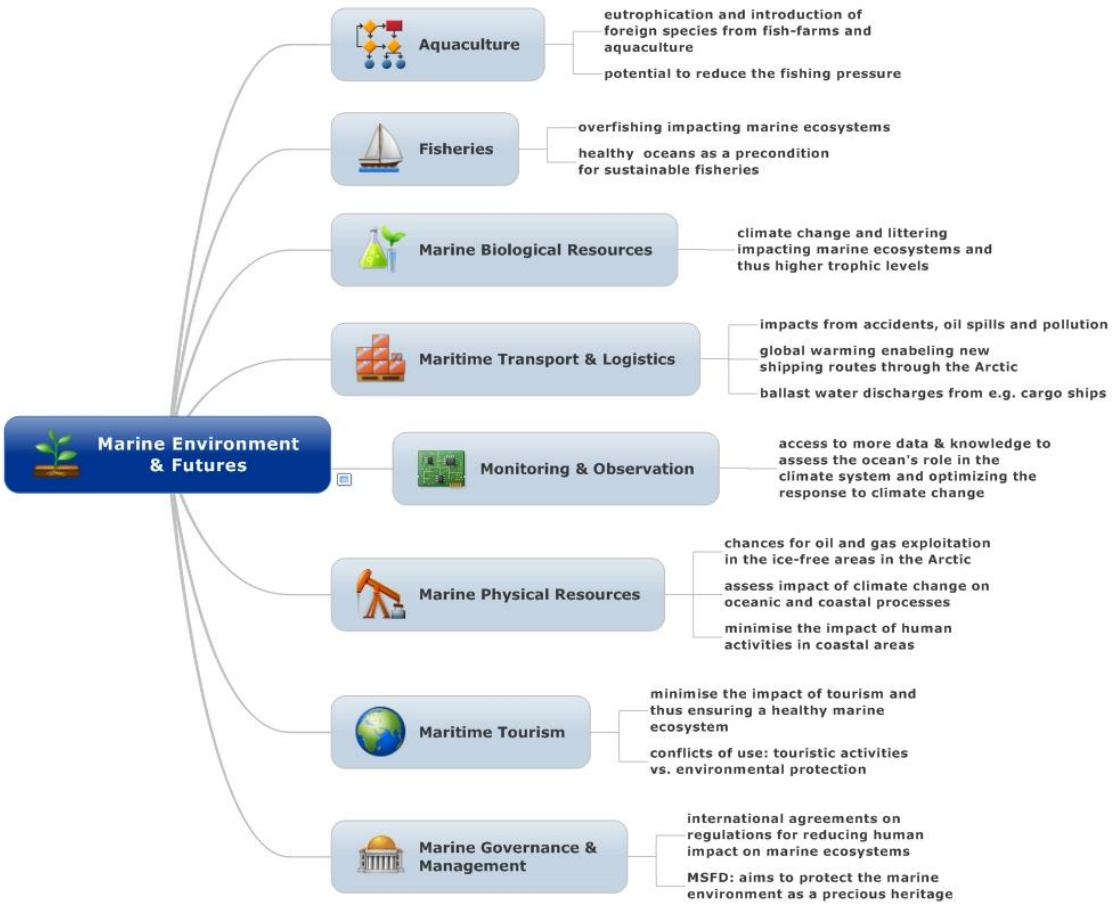
3.9 Marine Environment & Futures

Healthy and productive seas and oceans are a precondition and essential for a sustainable development of many maritime activities like fisheries & aquaculture, tourism and the exploitation of marine resources. Besides all these activities, also mirrored in the above mentioned competence nodes, our seas and oceans are experiencing additional pressures from man-made climate change impacts or e.g. marine littering. These pressures are causing severe, mainly negative effects – even in Marine Protected Areas as these secondary pressures on the ecosystem do not stop on pre-definded artificial borders, however, these multiple pressures are mirrored in the nearly evenly distributed relationships to other sectors. It is already challenging to assess the economic value of our seas and oceans but taking into account that e.g. 75% of the atmospheric oxygen is produced in the global ocean while annually 2.5 billon tons of man-made carbon dioxide are taken up in deeper waters, their role in enabling us, and all other animals, to breathe and exist is priceless.

Figure 9: Interactions between Marine Environment & Futures and other COLUMBUS Competence Nodes



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4 CONCLUSION

Given the historically independent development of the marine and maritime sectors the actual pressure on our seas and oceans forces interest groups to collaborate and jointly investige possible sollutions for imminent threats e.g. on the marine ecosystems. These sectors and groups are mirrored in the COLUMBUS Competence Nodes.

Based on the feedback from the CNs, linkages for collaboration on urgent issues have been identified between nearly all CNs, however, the respective links turn out to be labelled with different intensity flags. Strong links can easily be identified by several topics/subthemes the specific CNs are sharing and in an ideal case these issues are mentioned by both CNs. In a few circumstances there are no obvious links between CNs or a linkage has only been mentioned by one CN but not by the counterpart.

Recurring needs and gaps throughout most CNs are

- **sustainable use** of marine resources
- adaption of/establishing the **appropriate legal framework**
- free and **open-access** *multi-purpose* ***data repositories*** and portals
- **innovative** and **envionmentally friendly** technological **solutions**
- **intelligent management** of our seas and coastal zones

While these seem to be already well covered in the major European and international RDI strategies and funding priorities (see D3.1). This implies that the actual funding programmes are obviously tackling the right topics. However, there is no indication if the respective projects are effectively providing the required knowledge output to address the needs and gaps in the marine and maritime sector.

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5 ACRONYMS

CN	Competence Node
DSM	Deep Sea Mining
MSP	Marine Spatial Planning
ICZM	Integrated Coastal Zone Management
CFP	Common Fisheries Policy
MSFD	Marine Strategy Framework Directive
MSPD	Maritme Spacial Planning Directive
MSY	Maximum Sustainable Yield
MPA	Marine Protected Areas
EBSA	Ecologically or Biologically Significant Marine Areas
OE	Ocean energy
MRE	Marine Renewable Energies
UNCLOS	United Nations Convention on the Law of the Sea
ISA	International Seabed Authority
GED	Good Environmental Descriptors (in connection to MSFD)
GOOS	Global Ocean Observing System
EMODNET	European Marine Observation Data Network
OBIS	Ocean Biogeographic Information System

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