



COLUMBUS STORIES OF MARINE AND MARITIME KNOWLEDGE TRANSFER ACTIVITIES VOLUME 0.2 (24 JANUARY 2018)

THIS IS A COMPILATION OF 48 STORIES DETAILING THE JOURNEY TAKEN BY COLUMBUS TO CARRY OUT KNOWLEDGE TRANSFER ACROSS EUROPEAN MARINE AND MARITIME SECTORS.

AS KNOWLEDGE TRANSFER IS IN SOME CASES STILL ONGOING, PLEASE VIEW THE DETAILS OF EACH STORY AS DRAFT. THE COLUMBUS STORIES WILL BE FINALISED AND UPLOADED TO THE COLUMBUS WEBSITE BY THE END OF THE PROJECT (28/2/18).

AQUACULTURE



FISHERIES



MARINE
BIOLOGICAL
RESOURCES



MARINE
ENVIRONMENT
& FUTURES



MARINE
GOVERNANCE
& MANAGEMENT



MARINE
MONITORING
& OBSERVATION



MARINE
PHYSICAL
RESOURCES



MARITIME
TRANSPORT
AND LOGISTICS





CREDITS

Content has been provided by the **COLUMBUS** Knowledge Transfer fellows, who carried out the Knowledge Transfer activities.

Editing, proofing and design was carried out by AquaTT.

Please note that the information contained in the case studies is correct to the best of our knowledge. If you notice any omissions or factual mistakes, please notify the **COLUMBUS** Project Manager, Cliona Ní Cheallacháin (cliona@aquatt.ie).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652690. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.

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AN OVERVIEW: COLUMBUS KNOWLEDGE TRANSFER STORIES

This book comprises 48 **COLUMBUS** stories of Knowledge Transfer activity. Please note that these are still draft versions at the time of publication (24 January 2018) and will be further updated. The entire collection of finalised COLUMBUS stories will be made available at the end of the project (28 February 2018).

The following stories are included in this booklet.

AQUACULTURE

1. Improving fish texture evaluation using non-destructive assessment of fish flesh freshness
2. FishShape mobile app to identify malformations in commercial fish species in European aquaculture
3. Creating sustainable abalone aquaculture across Europe
4. Novel veterinary treatment to reduce bacterial caused mortalities in larval aquaculture
5. Improving fish nutrition through novel fish feed premixes
6. Mitigating negative dietary side effects of changing to plant-based feed for sea bream
7. Convenient vaccination of small fish against harmful diseases

FISHERIES

8. Influencing Danish law to accept integrated multi-trophic aquaculture schemes
9. Improving inspections of underwater structures using laser imaging systems
10. State-of-the-art innovations in energy for offshore aquaculture
11. Optimisation of fishing gear selectivity using underwater imaging
12. Underwater camera for improving the assessment of the small lobster nephrops

MARINE BIOLOGICAL RESOURCES

13. Highlighting the importance of access and benefit-sharing of marine biological resources
14. Exploring the use of seaweed-derived biopolymers in biomedical technology
15. Low-cost marine microbial sampling kit for the next generation
16. Novel low-cost respirometer for measuring coral health
17. Mitigating microplastic pollution with waste water treatment technology
18. Harmful algal bloom (HAB) forecast and warning system
19. Using human diagnostics technology to screen for chemicals in the environment

MARINE ENVIRONMENT AND FUTURES

20. Engaging regional policy makers in marine litter prevention
21. Educational material on the impact of plastic littering in marine environments
22. New exhibition on the environmental impacts of plastic waste
23. Innovative solutions for the packaging industry using material made from crustaceans

MARINE GOVERNANCE AND MANAGEMENT

- 24.** Innovative tools combined to support quality environmental impact assessments in marine environments
- 25.** Achieving good environmental status in maritime ports
- 26.** European research's contribution to the achievement of good environmental status and a stronger blue economy in Europe
- 27.** Specialised database to assess the status of non-indigenous species in European seas
- 28.** Furthering the integration and harmonisation of existing information systems on marine non-indigenous species
- 29.** Clustered knowledge on marine litter used to fulfil EU policy needs
- 30.** Incorporating knowledge management and transfer methodologies in a publicly funded project to maximise its uptake and impact
- 31.** Discards data sharing: An outcome from dialogue between discards-focused projects and the European Fisheries Control Agency
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- 33.** Using performance data of selective fishing gears to reduce fishing discards

MARINE MONITORING & OBSERVATION

- 34.** Best practice in use and sharing of marine observations and data by industry
- 35.** New innovative marine data applications by building on existing resources and services

- 36.** Advancing state-of-the-art technology in sensing marine pollutants
- 37.** Using marine tourism to increase access to European marine biodiversity data

MARINE PHYSICAL RESOURCES

- 38.** Reference turbine overcomes bottleneck in offshore wind development
- 39.** Sensors for measuring large scale hydrodynamics
- 40.** State-of-the-art mutually supporting systems for offshore aquaculture
- 41.** New environmentally-friendly biofouling and corrosion prevention coating for marine renewables
- 42.** New model propels the development of floating vertical axis wind turbines
- 43.** Multimedia e-learning tool promoting education of aquatic renewable energy technologies
- 44.** Developing a consistent and proportionate approach to Environmental Impact Assessment of marine renewable energy in the UK

MARITIME TRANSPORT AND LOGISTICS

- 45.** Environmentally-friendly anti-fouling paint for marine observation devices
- 46.** Novel solution for composite-steel joints
- 47.** Application of new innovative composite materials for river cruise ships
- 48.** Self-healing coatings as corrosion protection in maritime shipping

AN INTRODUCTION TO THE COLUMBUS PROJECT

Funded under the EU Horizon 2020 programme, **COLUMBUS** (www.columbusproject.eu) is a Blue Growth initiative with a budget of €4 million, duration of 36-months (March 2015 - February 2018) and comprising a partnership of 26 organisations. **COLUMBUS** is coordinated by the Irish Fisheries Board (BIM), closely supported by the Strategic and Operational Leader, AquaTT.

With a view to achieving optimal exploitation and enhancing the impact of research funded by the European Commission (EC), the **COLUMBUS** project was designed to deliver the widest range of benefits to society from marine and maritime research. **COLUMBUS** focused on developing robust structures and methodologies to facilitate carrying out a large-scale pilot of Knowledge Transfer across the marine and maritime sectors of Europe, to simultaneously contribute to Blue Growth and the implementation of marine and maritime legislation such as the Marine Strategy Framework Directive (MSFD).

To achieve its objectives, **COLUMBUS** established a “Knowledge Fellowship”, a distributed network of eight Knowledge Transfer Fellows embedded in different types of organisations across Europe whose role was to carry out Knowledge Transfer using the **COLUMBUS** Knowledge Transfer methodology. These fellows worked within eight Competence Nodes led by a node leader (from the same organisation as the fellow) and further supported by other partners with expertise in the thematic

area. The 8 Nodes are: Aquaculture; Fisheries; Marine Biological Resources; Marine Environment and Futures; Marine Governance and Management; Marine Monitoring and Observation; Marine Physical Resources; and Maritime Transport and Logistics.

A major objective of **COLUMBUS** was to produce evidence that the **COLUMBUS** methodology works and that it was possible to show demonstrable impact from **COLUMBUS** activities within the duration of the project. To that end, this compilation is an extract of some of the **COLUMBUS** Knowledge Transfer stories and it is intended to illustrate how the **COLUMBUS** Knowledge Transfer methodology was implemented step by step by the different nodes and the outcomes of the efforts.

To learn more about the **COLUMBUS** Knowledge Transfer Methodology, watch our video on the **COLUMBUS** website (www.columbusproject.eu) or on vimeo (<https://vimeo.com/203077016>).


*All **COLUMBUS** results and publications will be made publicly available through the **COLUMBUS** website.*

IMPROVING FISH TEXTURE EVALUATION USING NON-DESTRUCTIVE ASSESSMENT OF FISH FLESH FRESHNESS

**IN THIS CASE STUDY, AN ANALYTICAL PROTOTYPE
DESIGNED TO MEASURE THE ELASTICITY AND
FIRMNESS OF FISH MUSCLE WAS MANUFACTURED.**

The **ARRAINA** project (Advanced Research Initiatives for Nutrition and Aquaculture) was coordinated by l'Institut National de la Recherche Agronomique in Paris, France. Its aim was to “define and provide complete data on the quantitative nutrient requirements of five major fish species.” From this “sustainable alternative aquaculture feeds” were developed, which are essentially formulated feed consumed by fish in aquaculture systems. These feeds were to be tailored to the requirements of these species with “reduced levels of fishmeal and fish oil.”

**OVERALL IMPACT OF COLUMBUS:
SPIN-OFF COMPANY SET UP**



“The **COLUMBUS** project has supported us in proceeding to the construction of a prototype instrument to test our methodology on an industrial scale. We would like to thank **COLUMBUS** for its strong facilitation.”

Dr Dimitrios Dimogianopolous and Dr Kriton G rigorakis, Intellectual Property Holders

Knowledge Need

The texture of fish flesh changes over time. This can be because of a decrease in freshness or due to its dietary history. Existing methods, to check fish flesh quality, measure spoilage instead of degree of freshness – a subtle difference, but an important one. Fresh fish is favoured by consumers, creating a demand for non-invasive techniques to measure freshness. Making this technology available at a wholesale or retail level, could allow for fresher fish to be identified with greater accuracy. As a result, consumers and traders alike will be able to agree on best prices for products, favouring local producers and businesses. This technology could also be widely adopted within the aquaculture industry, as a method for fish farmers to evaluate quality between different batches of fish. This could inform different feeding regimes to achieve different categories of market.

Knowledge Output

The fish texture evaluation tool (**FTET**) reliably measures physical changes in fish flesh, even when very fresh. The **FTET** prototype is a conceptual installation that measures the elasticity and firmness of the fish muscle as an indication of freshness and quality. This experimental tool consists of a platform where the fish is placed, a falling weight which lands on the fish surface, and a force gauge which is directly connected to the platform. This force gauge records the excitation as well as the energy absorbance of the fish tissue (fillet). The signal received from the force gauge is then modelled through a patented proprietary algorithm, the conclusions of which determine the textural quality of the fish. This in turn can then estimate the day of harvest and, with further development, could indicate the impact of diet on the fish quality.

STEP 1

Collection
Aug 2016

STEP 3

Analysis – Profiling
Target User
Oct 2016

Knowledge Transfer Activity and Target Users

An industrial designer was identified and contacted by **COLUMBUS** to secure their participation in the development, testing and validation of the **FTET** prototype. The designer was fast in understanding the concept and effective in producing the industrial prototype. This participation meant the designer would become a partner in the IP generated, along with the equity created from the founding of a spin-off company.

STEP 4

Transfer –
Developing a KTP
Nov 2016 –
Dec 2017

Knowledge Output Pathway

To commercialise the FTET, it would need to be modified by an industrial designer to become a validated, transportable analytical device still capable of taking accurate measurements of fish texture, prior to testing and validation in both the lab and field.

The intended eventual impact of this Knowledge Output Pathway is: to develop a commercial, easy-to-use, transportable fish texture/freshness evaluation device for fish markets and shops.

STEP 2

Analysis –
Developing a KOP
Sep 2016

The pathway to achieving this eventual impact would require:

1. Identification of an industrial designer, in consultation with the intellectual property (IP) holders to inform the design.
2. Sourcing funds to support the development of a prototype.
3. Assembly and final development of a FTET prototype for sea bass and sea bream.
4. Validation of the FTET prototype in the lab and in the field.
5. Showcasing the prototype FTET to market.
6. Expanding the algorithm to assess other food products.



STEP 5

KT activity and
measure impact
Nov 2017

Measured Impact

The **FTET** prototype was designed in December 2016 and the components were sourced in July 2017, by **COLUMBUS** partner, BIM (Ireland). The prototype was presented at the **COLUMBUS** Aquaculture Brokerage Event "Aquaculture Knowledge Transfer – Facilitating the pathway from research outputs to industry products" in Dubrovnik in October 2017 and the final assembly of the **FTET** prototype was completed in December 2017.

Next Steps

The industrial prototype will be tested in a lab (Jan – Mar 2018) and tested in the field (Apr – Jun 2018). After this, the prototype will be market-ready and launched at the Greek Mariculture event in December 2018. The current prototype is designed to measure the freshness of sea bream and sea bass, but a further prototype is being developed for salmon. This prototype is set to be validated in the field by the end of 2019.

PROJECT

ARRIANA | Advanced research initiatives for nutrition and aquaculture | www.arriana.eu
FP7 – KBBE | Project ID: 288925

Value: €8.1 million (European Commission contribution: €6.0 million)

Timeline: Jan 2012 – Dec 2016

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

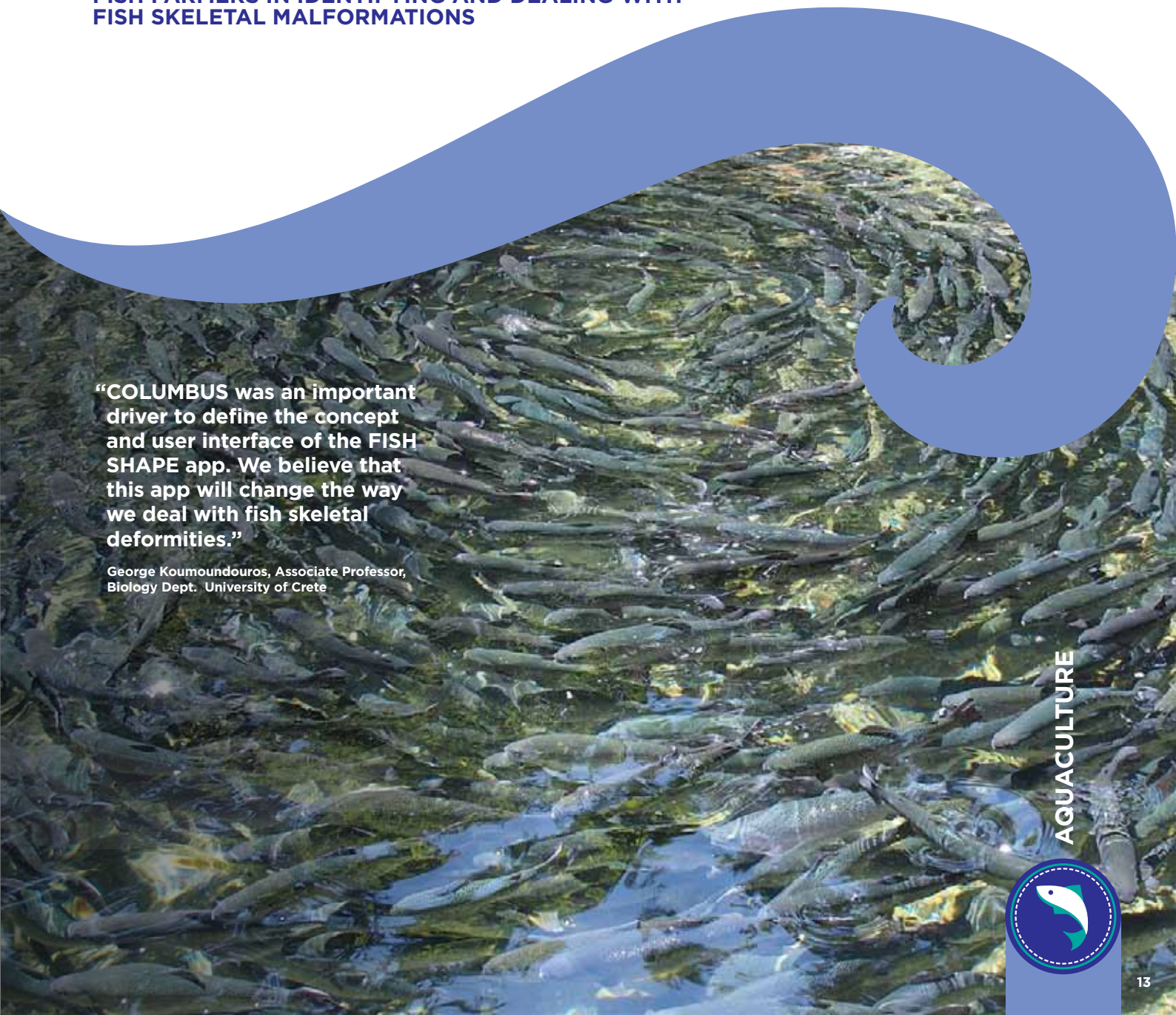
Panos Christofilogiannis, Joanna Tavla (**AQUARK**), Dimitrios Dimogianopoulos (**Piraeus University of Applied Sciences**), Kriton Grigorakis (**HCMR**), Emmanouel Tzevelekakis (**Industrial Designer**)

FISHSHAPE MOBILE APP TO IDENTIFY MALFORMATIONS IN COMMERCIAL FISH SPECIES IN EUROPEAN AQUACULTURE

THIS CASE STUDY SAW KNOWLEDGE ON SKELETAL MALFORMATIONS FOR THE MAIN COMMERCIALLY PRODUCED FISH SPECIES IN EUROPE PACKAGED INTO AN ACCESSIBLE MOBILE PHONE APP FOR EUROPEAN FISH HATCHERY MANAGERS.

The **FineFish** project, coordinated by the Federation of European Aquaculture Producers, was a collaborative research project funded by the European Commission under the 6th Framework Programme (FP6). The project aimed to generate new practical knowledge on how to reduce the incidence of malformations in the major fish species used in European aquaculture and to apply this to the commercial sector.

OVERALL IMPACT OF COLUMBUS: THE DEVELOPMENT OF A BETA VERSION OF A MOBILE APP TO ASSIST FISH FARMERS IN IDENTIFYING AND DEALING WITH FISH SKELETAL MALFORMATIONS



“COLUMBUS was an important driver to define the concept and user interface of the FISH SHAPE app. We believe that this app will change the way we deal with fish skeletal deformities.”

George Koumoundouros, Associate Professor,
Biology Dept. University of Crete

Knowledge Need

Skeletal malformations are a common occurrence in farmed fish. This is currently a major problem in aquaculture, resulting in economical, biological and ethical issues. At FineFish's final workshop in 2009, the project coordinator estimated that skeletal malformations cost European aquaculture more than €50 million annually. A reduction in skeletal malformations would significantly increase production and profitability; hence, there is a demand for solutions that reduce or remove the negative consequences of skeletal malformations.

Knowledge Output

The Knowledge Output constitutes **FineFish's** in-depth knowledge on skeletal malformations of the main commercially-farmed fish in European aquaculture. This knowledge can be used to inform and improve management practices in aquaculture hatcheries.

Knowledge Output Pathway

Fish malformations are a fish welfare issue and also negatively impact the economics of a fish hatchery. Providing up-to-date and instantaneous knowledge on skeletal malformations at a hatchery, could assist in the improved production of commercially-relevant species. **COLUMBUS** recognised that this knowledge could be packaged in the form of a mobile app designed to be applied by fish hatchery managers across Europe. To do so, collaboration with an expert in the development of mobile apps would be necessary to ensure that an appropriate

STEP 1

Collection
Feb 2017

STEP 3

Analysis - Profiling
Target User
Jul 2017

Knowledge Transfer Activity and Target Users

The initial Target User was a mobile app developer who was able to transform the concept into a 'beta app', an app in that is still at development stage. The developer agreed to develop, test and validate the app in exchange for partnership rights over the intellectual property of the end product. The user interface was presented to an international audience at the **COLUMBUS** Brokerage Event "Aquaculture Knowledge Transfer - Facilitating the pathway from research outputs to industry products" on 18 October 2017 in Aquaculture Europe 2017, Dubrovnik.

STEP 4

Transfer -
Developing a KTP
Aug - Oct 2017

system is designed that is both user-friendly and correctly represents the knowledge. This app could also be used to collect further data on skeletal malformations.

The intended eventual impact of this Knowledge Output Pathway is: to reduce the economic, ethical and biological issues affecting fish hatcheries resulting from skeletal malformations.

The pathway to achieving this eventual impact would require:

1. Research and identify potential mobile app developers.
2. Develop the app's user interface.
3. Raise awareness of the concept and user interface with fish farmers.
4. Source national and/or international funding for the "FishShape" app development.
5. Create an industrial partnership with fish hatcheries to develop and validate the mobile app.
6. Develop a commercial, easy-to-use, mobile application to monitor and record skeletal malformations in marine fish hatcheries around Europe.

STEP 2

Analysis –
Developing a KOP
Jan – Jun 2017



STEP 5

KT activity and
measure impact
Nov 2017

Measured Impact

The beta app including user interface was developed and has been presented to fish farmers with several showing interest in the product and requesting further information.

Next Steps

Future steps will include the sourcing of funding to finalise the development of the app and field validation through an industrial consortium, the Greek Aquaculture Federation, with the active participation of marine fish hatcheries.

PROJECT

FINEFISH | Improving sustainability of European fish aquaculture by control of malformation
| FP6-SME | Project ID: 012451

Value: €4.8 million (European Commission contribution: €3.0 million)

Timeline: Oct 2005 – Oct 2009

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

Panos Christofilogiannis, Joanna Tavla (**AQUARK**), Dr George Koumoundouros
(**University of Crete**)

CREATING SUSTAINABLE ABALONE AQUACULTURE ACROSS EUROPE

THIS CASE STUDY CONCERNS THE SUSTAINABILITY OF EDIBLE SHELLFISH, KNOWN AS ABALONE, ACROSS EUROPE THROUGH THE USE OF INTEGRATED AQUACULTURE. IT HAS COMBINED KNOWLEDGE ON ESTABLISHING A PILOT-TESTED EUROPEAN ABALONE FARM WITH THE PRODUCTION OF ABALONE ALONGSIDE SEA BASS AND SEA BREAM.

The **SUDEVAB** project (Sustainable Development of European SMEs engaged in Abalone Aquaculture) was coordinated by Aqua-Gold (Fisheries) GmbH in Germany. Its aim was to improve the production of abalone in Europe by bringing together two different factions of abalone aquaculture: small and medium-sized enterprises (SMEs) and research and technological development providers. In order to improve abalone production and strengthen world-wide competition, technological problems facing European abalone producers needs to be tackled. The goal, therefore, was to help solve these problems for SMEs, by harnessing some of the best shellfish aquaculture research facilities in Europe.

OVERALL IMPACT OF COLUMBUS: INDUSTRY AWARENESS OF NEW PRODUCT POTENTIAL

“The collaboration with COLUMBUS allowed us to define specific knowledge outputs and their applications through the exchange of research results and information. It also allowed us to define interest and opportunities of development for the sector, and identify target users and potential impacts.”

Dr Gercende Courtois de Vicoise, IU-ECOQUA

Knowledge Need

The viability of the Mediterranean mariculture industry could be strengthened through the diversification of novel species to reach new markets. According to the Food and Agriculture Organisation, in 2010 world abalone production reached 65,525 tonnes with approximately 88% from aquaculture. As a result, aquaculture is being viewed as the best option for efficient and maintainable provision of abalone. In Europe, demand for abalone is increasing for domestic and export markets, however production is seen as being restricted. This is due to the lack of access to young abalones and certain technological problems, including pathology, genetics, nutrition and sustainable production technology. On top of this, there are also legislative issues which hinder producers from increasing production and therefore competitiveness.

Knowledge Output

SUDEVAB explored how the use of integrated multi-trophic aquaculture (IMTA) systems – where nutrients released from one species can be utilised by another – could be used to support the sustainability of abalone production in Europe. SME partners designed a new, less expensive, more energy efficient abalone production system called “Abblox” which is now patented and commercially available. The Abblox system includes an abalone hatchery setup coupled with a specialised seaweed-growing system.

An important aspect of the development of the Abblox system was to consider optimal nutrition.

SUDEVAB found that the nutritional makeup of seaweed was similar to macroalgae normally consumed as a food source by abalone (*Haliotis tuberculata coccinea*). Furthermore, it was shown that seaweed can be successfully and efficiently

STEP 1

Collection
Nov 2016

STEP 3

Analysis – Profiling
Target User
Feb 2017

Knowledge Transfer Activity and Target Users

The Target Users are individual sea bass and sea bream fish farms within the Mediterranean area. A technical brief describing the Knowledge Output was developed and distributed to fish farmers in the European aquaculture sector. This was done during

the **COLUMBUS** Node Brokerage Event at Aquaculture Europe 2017 in Dubrovnik – an event attended by 1700 delegates from 62 different countries. The technical brief was accompanied by an invitation to a training event.

STEP 4

Transfer –
Developing a KTP
May 2017

grown in biological filter systems whilst capturing all waste products. Sea trials also showed that abalone reached commercial size in only 18-22 months. These optimal growth rates were within the range of those observed for other abalone species fed with similarly formulated feeds.

Knowledge Output Pathway

The IMTA concept – combining abalone, seaweed, sea bass and seabream production – is ready to be pilot-tested in an industrial setting. If successful, this technology could contribute significantly in the environmental and financial sustainability of the Mediterranean aquaculture industry.

The intended eventual impact of this Knowledge Output Pathway is: is to successfully pilot an abalone, sea bass and sea bream IMTA system.

The pathway to achieving this eventual impact would require:

1. Identification of potential sea bass and sea bream farmers who could implement abalone IMTA on their existing farms.
2. Preparation and provision of training on abalone IMTA techniques to sea bass and sea bream farmers.
3. Sea bass and sea bream farmers to purchase the commercially available Abblox system and begin abalone production alongside their current activities.

STEP 2

Analysis –
Developing a KOP
Dec 2016 – Jan 2017



STEP 6

KT activity
(Athens) and
measure impact
Jan 2018

STEP 5

KT activity
(Dubrovnik) and
measure impact
Nov 2017

Measured Impact

The Abblox system was recognised as having potential by the attendees of the brokerage event. Over 20 interested sea bass and sea bream farmers were provided details of the training course which will be held on 16 January 2018, responding to its announcement at Aquaculture Europe 2017. Impact of this case study will be measured based on the number attending the training course and the number who apply the knowledge.

Next Steps

The next step in the Knowledge Output Pathway is to provide training on an abalone IMTA system to interested fish farmers. This training event is taking place in January 2018 in Athens. It is in collaboration with the Federation of Greek Mariculture.

PROJECT

SUDEVAB | Sustainable Development of European SMEs engaged in Abalone Aquaculture
FP7 - Research for SMEs | Project ID: 222156

Value: €1.2 million (European Commission contribution: €1.0 million)

Timeline: Jun 2008 - Dec 2010

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

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NOVEL VETERINARY TREATMENT TO REDUCE BACTERIAL CAUSED MORTALITIES IN LARVAL AQUACULTURE

THIS CASE STUDY INVOLVES THE TRANSFER OF A METHOD FOR TREATING BACTERIA IN LIVE FISH CULTURES (FOR SEA BASS AND SEA BREAM) TO REDUCE INFECTION AND FACILITATE INDUSTRY VALIDATION AND LICENSING OF THE REVOLUTIONARY TREATMENT.

The **FISHPHAGE** project was set up to develop innovative strategies for the prevention of transmissible diseases in marine aquaculture using bacteriophages specific to bacterial pathogens. The aim was to create strong alternatives to aquaculture that are environmentally friendly and help reduce the use of antibiotics.

OVERALL IMPACT OF COLUMBUS: FIELD TRIALS OF NOVEL VETERINARY TREATMENT ORGANISED



AQUACULTURE



Knowledge Need

Marine aquaculture requires marine fish in the early development phase, when they are called larvae, to be fed live feed before they are weaned onto a commercially-formulated juvenile feed. These live feeds are added to the larval tanks to simulate the natural food chain in the marine environment. Bacteriophages (or simply “phages”) are viruses that infect and replicate within a bacterium. Phages constitute the most populous group of microorganisms in the planet and occur naturally in the marine environment so when using live feeds from a marine environment, the likelihood of infection by pathogenic bacterial strains is increased. This can cause mortalities and affect the survival and robustness of marine fish juveniles.

Phage treatment could reduce this bacterial load and subsequent viral infections and vastly contribute to the sustainability and productivity of marine fish hatcheries by improving survival and robustness of the fish juveniles.

Knowledge Output

The Knowledge Output is a revolutionary medical treatment for sea bass and sea bream that offers cost-effective control of pathogenic bacterial load, allowing for increased larval survival and more robust juveniles. In essence, it is a phage treatment for live feed which can vastly decrease the infections caused by bacterial pathogens such as vibrio and pasteurella, thus improving the survival of fish larvae. These pathogens affect a very wide range of fish species worldwide and are responsible for the majority of bacteria-related mortality in aquaculture.

STEP 1

Collection
Jun 2017

STEP 3

Analysis – Profiling
Target User
Oct 2017

Knowledge Transfer Activity and Target Users

Initial contact was made with sea bass and sea bream fish hatchery managers in September 2017 to inform them of the Knowledge Output and of the **COLUMBUS** project. They were invited to the **COLUMBUS** Brokerage Event in Dubrovnik, Croatia, in November 2017. The event was entitled “Aquaculture Knowledge Transfer – Facilitating the pathway from research outputs to industry products”. This was a part of “Aquaculture Europe 2017” – an event designed to boost the growth

and sustainability and of aquaculture across Europe. Following the circulation of a technical brief outlining the technology by the intellectual property holders, a meeting was arranged to train stakeholders on the technology on 16 January 2018.

STEP 4

Transfer –
Developing a KTP
Nov 2017

Knowledge Output Pathway

To improve the survival and strength of sea bass and sea bream juveniles – and improve profitability of the hatchery production as a result – awareness of the existence of this treatment needs to be raised among sea bass and sea bream fish farmers. Firstly, the knowledge needs to be validated in a field trial before the process of compiling and submitting a market authorisation dossier, to support the commercialisation of any medicinal product, can begin. If successful, commercialisation would allow for widespread utilisation.

The intended eventual impact of this Knowledge Output Pathway is: to provide a commercially

available medical treatment to control the bacterial load of sea bass and sea bream larvae to reduce mortalities and reduced growth due to bacterial caused infections.

The pathway to achieving this eventual impact would require:

1. Signing a non-disclosure agreement with the intellectual property owners.
2. Present the Knowledge Output to sea bass and sea bream hatchery managers.
3. Carry out field validation of the Knowledge Output.
4. Carry out training for industry on use and benefits of medicinal treatment.
5. Prepare and submit a market authorisation dossier.

STEP 2

Analysis –
Developing a KOP
Sep 2017



STEP 5

KT activity
and measure
impact
Jan 2018

Measured Impact

Initial discussions resulted in several fish farmers expressing their interest to participate as industrial partners in field trials. These are expected to be carried out in 2018. Furthermore, over 20 sea bass and sea bream farmers will attend a training course on 16 January 2018, following its announcement at Aquaculture Europe 2017. Impact on their uptake and application of the Knowledge Output will be collected in due course.

Next Steps

Following the completion of the field trials, an application for market authorisation as a novel veterinary treatment is needed for the treatment to become commercially available.

PROJECT

FISHPHAGE | Biological control of bacteria in fish hatcheries using bacteriophages
www.fishphage.weebly.com | NSRF 2007-2013

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

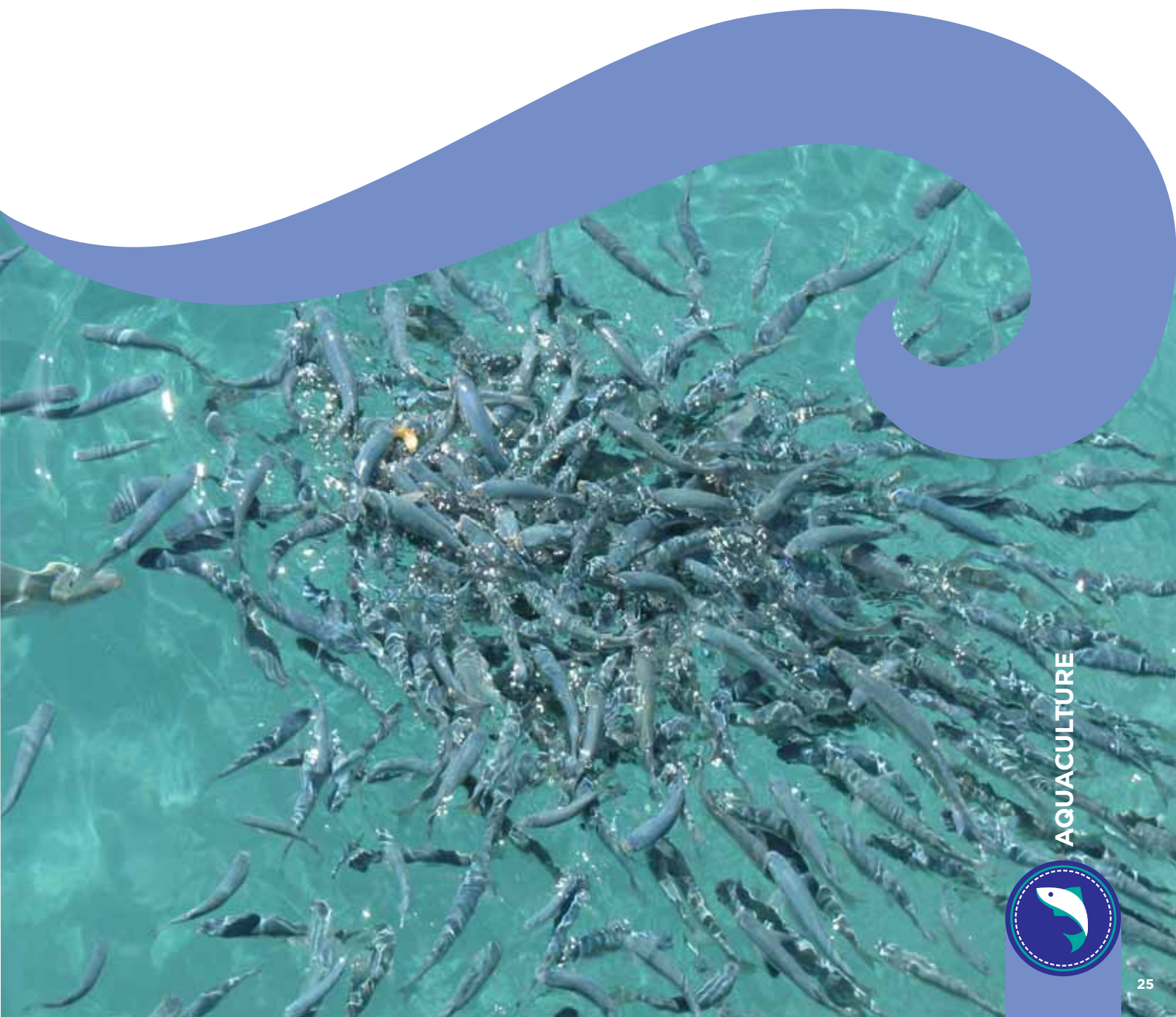
Dr Panos Christofilogiannis (**AQUARK**), Dr Pantelis Katharios (**HCMR**) katharios@hcmr.gr

IMPROVING FISH NUTRITION THROUGH NOVEL FISH FEED PREMIXES

THIS CASE STUDY SAW THE KNOWLEDGE OUTPUTS OF MANY EUROPEAN PROJECTS PACKAGED TOGETHER TO IMPROVE FISH NUTRITION THROUGH THE VALIDATION OF ENHANCED FISH FEED PREMIXES.

The Knowledge Output of this project is the outcome of long research following many national and European Union-funded projects, including the **ARRAINA** project – a project that aimed to define and provide complete data on the quantitative nutrient requirements of five major fish species. From this, sustainable alternative aquaculture feeds could be developed.

OVERALL IMPACT OF COLUMBUS: FIELD TRIALS OF SPECIES-SPECIFIC FISH FEED PREMIXES ORGANISED



AQUACULTURE



Knowledge Need

Research on fish nutrition of marine species has been carried out across Europe for several decades, resulting in a large evidence base of nutritional requirements and benefits that informs the aquaculture industry. These results have been analysed and classified for different species and trials, comparing them with the natural behaviour, feeding and general movement of specific fish species.

All groups of species need specific formulated diets as well as specific formulated supplements or additives. This means that these groups of fish can be fed using premixes – a mixture of the necessary dietary requirements for a given species. However, existing commercial premixes do not always address the in-depth metabolic requirements of specific species, as determined through research. Subsequently, there is a demand for new novel fish feed premixes that match the discrete requirements of given species.

Knowledge Output

Four farmed species of fish were identified to have distinct nutritional requirements based on their growth rates and their fillet composition: sea bream, sea bass, meagre and greater amberjack. Sea bream and meagre both have low lipid concentration in their fillet (intramuscular fat) yet sea bream shows moderate growth and meagre is a fast-growing fish. Meanwhile, sea bass and greater amberjack have high lipid concentration in their fillet, but sea bass exhibits moderate growth while greater amberjack is faster-growing.

The Knowledge Output is a series of novel fish feed premixes tailored to the specific requirements and discrete metabolic requirements of these four species. These premixes will help fish feed companies to better adapt their products to the specific requirements of fish. They will also help fish producers to obtain better whole fish cycle growth and product quality.

STEP 1

Collection
Feb 2017

STEP 3

Analysis – Profiling
Target User
Sep 2017

Knowledge Transfer Activity and Target Users

Fish feed companies, cage farm managers, fish nutritionists, and fish additive and premix companies were invited to the **COLUMBUS** Brokerage Event in Dubrovnik, Croatia, in November 2017. The event was entitled “Aquaculture Knowledge Transfer – Facilitating the pathway from research outputs to industry

products” and the Knowledge Output was presented to these Target Users. This brokerage event was held at the “Aquaculture Europe 2017” – a sector-specific event designed to boost the growth and sustainability and of aquaculture across Europe.

STEP 4

Transfer –
Developing a KTP
Oct 2017

Knowledge Output Pathway

Field trials would be required to validate the benefits of using these species-specific premixes over the best-performing commercial premixes. COLUMBUS reached agreement with the intellectual property holders to package this knowledge and trial these premixes within the Mediterranean.

The intended eventual impact of this Knowledge Output Pathway is: to enable the commercialisation of species-specific premixed feed formulations allowing for exact nutritional requirements to be met.

The pathway to achieving this eventual impact would require:

1. Sign a non-disclosure agreement with the intellectual property holders to initiate the exchange of information.
2. Present the concept to industry stakeholders to generate interest.
3. Organise a field trial in a fish farming company in Greece.
4. Collaborate with fish feed companies to create commercially-available premixes.

STEP 2
Analysis –
Developing a KOP
Jun 2017



STEP 5
KT activity
(Dubrovnik) and
measure impact
Nov 2017

Measured Impact

A fish feed company immediately expressed interest to field-validate the sea bream premix at a fish farm in Greece. A non-disclosure agreement was signed in early January 2018 and the field trial is expected to be organised in the summer of 2018.

Next Steps

Once completed, the field trial's results are expected to stimulate demand from fish farmers; which, in turn, will drive fish feed companies to commercialise this knowledge.

PROJECT

National and various EU projects including **ARRIANA** | Advanced research initiatives for nutrition and aquaculture

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

Panos Christofilogiannis (**AQUARK**), Lidia Esther Robaina Robaina lidia.robaina@ulpgc.es
(**University Las Palmas Gran Canaria**)

MITIGATING NEGATIVE DIETARY SIDE EFFECTS OF CHANGING TO PLANT-BASED FEED FOR SEA BREAM

THIS CASE STUDY SAW COMBINED KNOWLEDGE OUTPUTS DETERMINE THAT INCLUDING A FATTY ACID TO THE FISHES' DIET CAN MITIGATE THE ADVERSE DIETARY EFFECTS OF MAKING CHANGES IN FEED FORMULATION FOR SEA BREAM.

The **ARRAINA** project (Advanced Research Initiatives for Nutrition and Aquaculture) was coordinated by l'Institut National de la Recherche Agronomique (France). Its aim was to "define and provide complete data on the quantitative nutrient requirements of five major fish species."

The **ParaFishControl** project is coordinated by La Agencia Estatal Consejo Superior de Investigaciones Cientificas (Spain). Its aim is to increase the sustainability and competitiveness of European aquaculture by improving our understanding of fish-parasite interactions.

The **AQUAEXCEL** project (AQUAculture infrastructures for EXCELlence in European Fish research) is coordinated by l'Institut National de la Recherche Agronomique (France). It comprises a large group of leading European aquaculture research facilities working towards advanced integration and standardisation of tools for aquaculture research to support the sustainable growth of the aquaculture sector in Europe.

OVERALL IMPACT OF COLUMBUS: INDUSTRY TAUGHT HOW TO NEGATE SIDE EFFECTS OF PLANT-BASED DIET FOR SEA BREAM



Knowledge Need

Fish meal and fish oil are often used as ingredients in feed for fish that are produced through aquaculture. Increasing aquaculture production in response to global demand, as well as the rising cost of these marine ingredients, has stimulated the industry to explore alternative feed ingredients that are more sustainable. For example, this has resulted in Mediterranean farmers using plant ingredients to replace marine-sourced ingredients in feed for many farmed fish. However, this shift to plant-based diets has resulted in another challenge: it has led to chronic enteritis problems (i.e. inflammation of the small intestine) in the farmed fish, especially sea bream, and has increased the negative effects of parasitic diseases.

Consequently, there is demand for new cost-effective feed formulated from sustainable ingredients that does not result in any negative side effects.

Knowledge Output

Three different projects (**ARRAINA**, **ParaFishControl** and **AQUAEXCEL**) assessed whether negative side effects, for example affecting the gut, intestine and disease susceptibility of fish, due to changing to plant-based diets could be reversed. All three projects found that the addition of a fatty acid (sodium butyrate) to the diets can prevent enteritis in sea bream, allowing the fish to better utilise nutrients and achieve improved growth.

STEP 1

Collection
Jun 2017

STEP 3

Analysis - Profiling
Target User
Oct 2017

Knowledge Transfer Activity and Target Users

Initial contact was made with fish feed companies and sea bream fish farm managers in September 2017 to inform them of the Knowledge Output and of the **COLUMBUS** project. They were invited to learn more of the benefits of sodium butyrate at the **COLUMBUS** Brokerage Event in "Aquaculture Europe 2017" in Dubrovnik. The event was entitled "Aquaculture Knowledge Transfer - Facilitating the pathway from research outputs to industry products". The half-day

workshop attracted around 60 participants from ten countries and represented the general stakeholder participation of the full event. A relevant brief on the technology by the intellectual property holders was circulated to all interested parties.

STEP 4

Transfer -
Developing a KTP
Nov 2017

Knowledge Output Pathway

This Knowledge Output is ready to be used, however it is currently unknown on an industrial level. The pathway to impact highlights the need to raise awareness of sea bream farmers that there is an easy, cost-effective method to reduce the adverse effects of changing to more sustainable (plant-based) ingredients in feed. The first step taken by **COLUMBUS** was to sign a non-disclosure agreement with the intellectual property owners, before identifying and informing relevant industry stakeholders.

The intended eventual impact of this Knowledge Output Pathway is: to support the integration of plant-based ingredients in sea bream feed formulations

by demonstrating to sea bream farmers the clear benefit of including sodium butyrate to alleviate the risk of enteritis.

The pathway to achieving this eventual impact would require:

1. Present the Knowledge Output and demonstrate its benefit to sea bream farmers and feed companies.
2. Carry out training for sea bream farmers and feed companies on the utilisation of the Knowledge Output.
3. Application by fish farmers and feed companies of the knowledge.

STEP 2
Analysis –
Developing a KOP
Sep 2017



STEP 5
KT activity
(Dubrovnik) and
measure impact
Jan 2018

Measured Impact

A Skype presentation was arranged to provide industry training on 16 January 2018, attracting over 20 fish farmers following its announcement at Aquaculture Europe 2017. The intellectual property holder will present the Knowledge Output to the Greek fish farmers and fish feed companies, and explain to those in attendance how they can adopt the knowledge.

Next Steps

The uptake and application by the webinar attendees will be collected in due course.

PROJECT

ARRAINA | Advanced Research Initiative for Nutrition and Aquaculture | www.arriana.eu
FP7 – KBBE | Project ID: 288925

Value: €8.1 million (European Commission contribution: €6.0 million)

Timeline: Jan 2012 – Dec 2016

ParaFishControl | Advanced Tools and Research Strategies for Parasite Control in European farmed fish | www.parafishcontrol.eu | H2020-SFS | Project ID: 634429

Value: €8.1 million (European Commission contribution: €7.8 million)

Timeline: Apr 2015 – Mar 2020

AQUAEXCEL2020 | Aquaculture infrastructures for excellence in European fish research towards 2020 | www.aquaexcel2020.eu | H2020-INFRAIA | Project ID: 652831

Value: €9.7 million (European Commission contribution: €9.7 million)

Timeline: Oct 2015 – Sep 2020

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

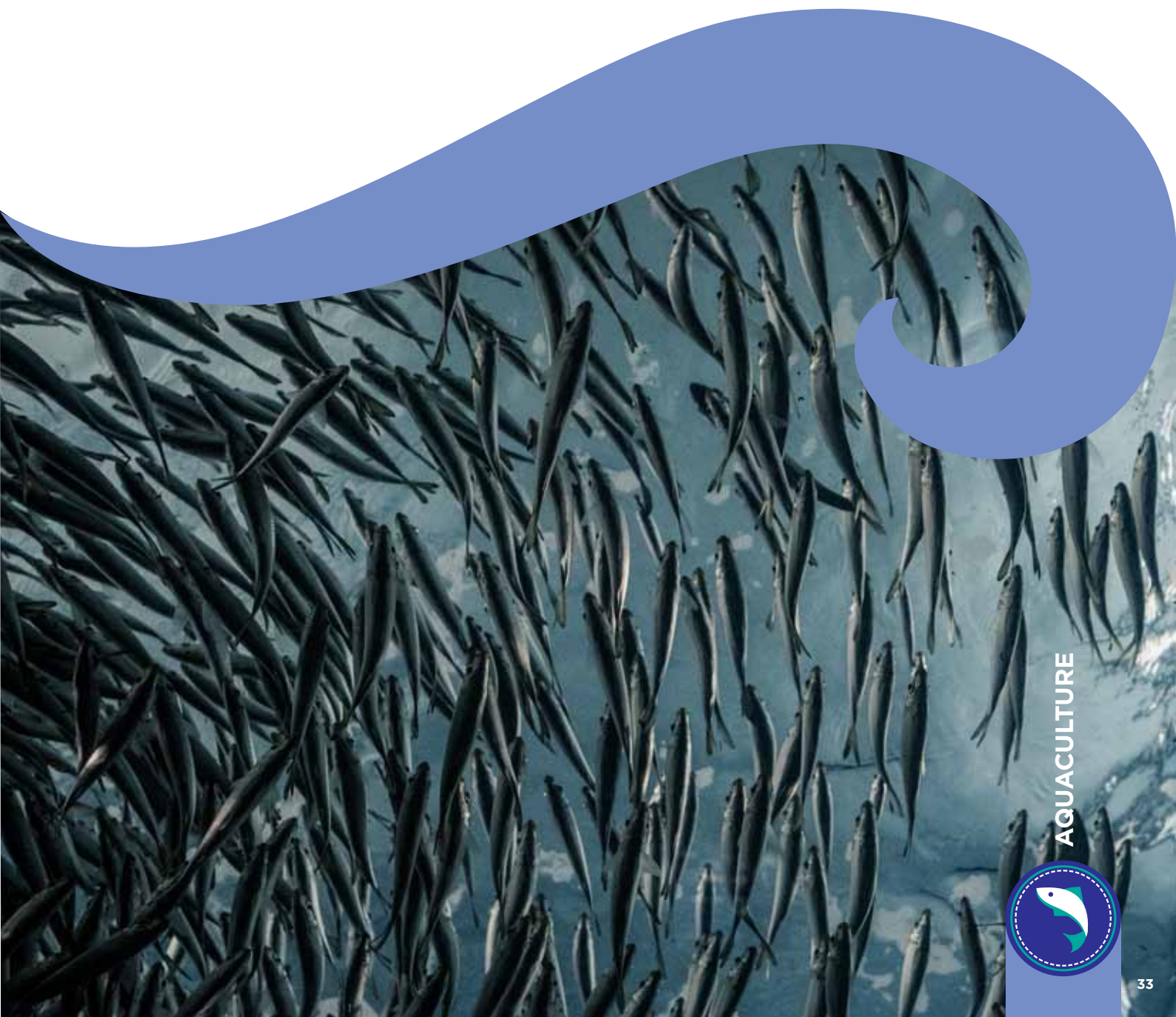
Dr Panos Christofilogiannis (**AQUARK**), Dr Ariadna Sitja-Bobadilla (**CSIC**),
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CONVENIENT VACCINATION OF SMALL FISH AGAINST HARMFUL DISEASES

THIS CASE STUDY SAW A KNOWLEDGE OUTPUT FOR CONVENIENT, EFFECTIVE VACCINATION OF SMALL FISH AGAINST HARMFUL DISEASES TRANSFERRED TO INDUSTRY STAKEHOLDERS AND FISH FARMING COMPANIES.

The **TARGETFISH** project, coordinated by Wageningen University (Netherlands), aimed to develop vaccines to help fight the outbreak of disease in farmed fish species. This required creating a new prototype vaccine aimed at combating viral or bacterial pathogens of fish based on improving existing vaccines (which are currently insufficient).

OVERALL IMPACT OF COLUMBUS: TRAINING ORGANISED WITH FISH FEED COMPANIES AND VACCINE SUPPLIERS



AQUACULTURE



Knowledge Need

The production of sea bass in the Mediterranean was estimated at 177,000 tonnes in 2016, according to the 2017 Annual Report from the Federation of Greek Mariculture. As sea bass are susceptible to several pathogens, fish farmers in the Mediterranean must vaccinate sea bass against illnesses such as vibriosis, pasteurellosis, and more recently against viral encephalopathy and retinopathy (VER) – also known as viral nervous necrosis (VNN).

This vaccination process, however, is laborious, time consuming and expensive; requiring very detailed planning to ensure that vaccination takes place before the onset of each disease. Given this, there is a need for an easier and faster method of vaccination against these diseases.

Knowledge Output

The Knowledge Output is a vaccination machine (produced by Rossi Denmark) called the “EasyVac 12.000SB”. It is designed to administer automatic vaccination by injection. The machine is available in three models: containing two, four or six stations for vaccination. It has numerous advantages, such as:

- It can vaccinate fish that weigh 8-200g.
- It can vaccinate 6,000-18,000 fish per hour.
- The injection is adjustable in its angle and depth.
- The machine removes air bubbles in the vaccine.
- It is possible to change vaccines and needles during operation.

This machine saves time and labour for fish farmers administering vaccination. It offers a new, flexible alternative for vaccinating small fish over 8g, ensuring protection from various pathogens.

STEP 1

Collection
Jun 2017

STEP 3

Analysis – Profiling
Target User
Oct 2017

Knowledge Transfer Activity and Target Users

Aqualife Services, the world's largest fish vaccine delivery company and a pioneer in farmed fish health and welfare, were contacted by phone in June 2017. They have bases in Scotland and Norway and work with aquaculture clients across the world. The capacity

of the vaccination machine was described – both in terms of its mechanics and its advantages. The Selonda Group, the world's largest producer and supplier of sea bream and sea bass, were also contacted in the same period. Both target users were provided with a brief on the technology by the intellectual property holders.

STEP 4

Transfer –
Developing a KTP
Nov 2017

Knowledge Output Pathway

This Knowledge Output is available to use, but is not widely known in Mediterranean aquaculture industry. The benefits of using a machine instead of manually vaccinating sea bass needs to be demonstrated, and a vaccine company enlisted to enable the commercialisation of the prototype.

The intended eventual impact of this Knowledge Output Pathway is: to provide a cost effective, fast and reliable method of vaccination for sea bass farmers to reduce costs and labour requirements.

STEP 2

Analysis –
Developing a KOP
Sep 2017

The pathway to achieving this eventual impact would require:

1. Raise awareness of the benefits and features of the knowledge to sea bass farmers.
2. Identify a professional vaccination services company to collaborate with on commercialising the knowledge.
3. Demonstrate the benefits of machine versus manual vaccination to fish farmers and provide training on how to use the prototype to sea bass farmers.
4. Commercialise the prototype and make widely available.



STEP 5

KT activity
(Dubrovnik/Athens)
and measure
impact
Jan 2018

Measured Impact

As a result of the knowledge transfer activities, interest was registered for more information and training to be provided on the prototype. Arrangements were also made for field testing to take place during the period of 15 – 20 January 2018.

Next Steps

Whilst the Knowledge Output is readily available to be applied by fish pathologists and fish vaccine companies, a training event has been organised on machine vaccination on Porto Buffalo farm in Evia Island, Greece, on 18 January 2018, so that these stakeholders can take full advantage of this technology. Following training and field testing, the impact of these activities will need to be measured and the product commercialised and made widely-available.

PROJECT

TARGETFISH | Targeted disease prophylaxis in European fish farming | www.targetfish.eu | FP7 – KBBE | Project ID: 311993 |

Value: €8.7 million (European Commission contribution: €6.0 million)

Timeline: Oct 2012 – Nov 2017

COMPETENCE NODE LEADER

Aquaculture | **AQUARK** | Athens, Greece | www.aquark.gr

CREDITS

Dr Panos Christofilogiannis (**AQUARK**), Torben Rød (**ROSSI AS**)

INFLUENCING DANISH LAW TO ACCEPT INTEGRATED MULTI-TROPHIC AQUACULTURE SCHEMES

THIS CASE STUDY OUTLINES HOW KNOWLEDGE OUTPUTS COULD BE USED TO INFLUENCE POLICY RELATING TO AQUACULTURE, ATTEMPTING TO MITIGATE THE NEGATIVE EFFECTS OF CURRENT LEGISLATION ON THE GROWTH OF SUSTAINABLE BLUE MUSSEL SEED PRODUCTION, BY PROMOTING THE USE OF INTEGRATED MULTI-TROPHIC AQUACULTURE.

The Integrated Blue Mussel and Aquaculture Production (**IBMAP**) project was coordinated by GEMBA Seafood Consulting, the Danish Aquaculture Association and Musholm (an aquaculture company based in Denmark). It was set up to explore “Applied opportunities in Integrated Blue Mussel and Aquaculture Production”.

IBMAP is supported by the European Maritime Fisheries Funds and the Ministry of Environment and Food of Denmark.

OVERALL IMPACT OF COLUMBUS: DANISH ENVIRONMENTAL PROTECTION ACT AMENDED BY PARLIAMENT

“I liked this initiative by **COLUMBUS** to get a practical view on the Musholm integrated blue mussel and aquaculture production and to assess the market potential of mussel seed export to the Netherlands.”

Alf Skovgaard, Environmental Protection Agency

Knowledge Need

Mussel production is the largest shellfish industry in Europe, and in recent years hatchery technology and production methods have developed to increase the sector's economic viability. One of these innovations is the concept of integrated multi-trophic aquaculture (IMTA) – combined aquatic systems in which nutrients released from one species can be used by another. This method combines production extractive aquaculture, such as blue mussels, with traditional aquaculture, such as finfish, which are fed formulated feeds. This not only provides economic benefits, but also a mutually benefitting ecosystem for the species included in the IMTA system. Legislation, however, can limit the productivity levels of aquaculture. Although the production of blue mussels would result in nutrients being removed, the laws do not yet acknowledge extractive aquaculture as a viable means of nutrient counterbalancing. Adapting legislation to recognise this type of counterbalancing would encourage growth in IMTA; benefitting both traditional aquaculture and blue mussel industries.

Knowledge Outputs

Whilst developing the concept of integrated blue mussel and aquaculture platforms, the **IBMAP** project identified the following Knowledge Outputs:

- Economically sound mussel seed production is of limited feasibility if legislation does not allow for the nutrient uptake by mussels. This legislative change is necessary to facilitate the counterbalancing of nutrient discharge from aquaculture.
- Of the range of products from integrated production, the sale of mussel seeds for mussel production in other aquaculture farms was found to have the highest economic potential.
- Identification of IMTA as the optimum farming system best suited for local conditions and identification of predator management approaches for blue mussel seed production in the Great Belt in Denmark.

STEP 1

Collection
Apr 2016

STEP 3

Analysis – Profiling
Target User
Apr – Aug 2016

Knowledge Transfer Activity and Target Users

Working with **GEMBA** Seafood Consulting, the project coordinator, **COLUMBUS** set up a meeting with Target Users at the Seafood Expo in Brussels in April 2016, including Musholm (the leading Danish mussel seed producer) and Theun de Ronde (a mussel farmer and mussel seed buyer). These stakeholders discussed the possibilities of laying out mussel seeds from the Great Belt in east Denmark to the Wadden Sea in southwest Denmark.

Since environmental regulation is an economic barrier for extensive mussel farming, **COLUMBUS** decided to bring Alf Skovgaard and Janni Rose Christensen, two employees of the Danish Environment Protection Agency, into the conversation. Subsequently, it was agreed that Theun de Ronde would visit the Musholm rainbow trout and mussel farm facilities in Gørlev, Denmark, in summer 2016. This tour would be hosted by Niels Dalsgaard (Director), Anders Lejbach (Head of Production) and Torben Wallach (Environmental Consultant).

STEP 4

Transfer –
Developing a KTP
Aug – Sep 2016

Knowledge Output Pathway

IBMAP found that there is huge economic potential in the sale of mussel seeds for mussel production. IMTA has been identified as the most efficient and effective farming system of blue seed mussel production in Denmark. Steps are required to incorporate this approach by overcoming legislative barriers to enable the advancement of IMTA aquaculture in Denmark.

The intended eventual impact of this Knowledge Output Pathway is: to support the sustainable growth of blue mussel seed production.

STEP 2

Analysis –
Developing a KOP
Apr 2016

The pathway to achieving this eventual impact would require:

1. Gaining endorsements from fisheries and aquaculture stakeholders supporting an approach to inform policy makers about the stifling effects of legislation on mussel production.
2. Actively carrying out this approach and thus inform policy makers on the limitations of current legislation.
3. Informing mussel farmers/dredgers of any subsequent changes in law, to stimulate new markets.



STEP 5

KT activity and
measure impact
Sep 2016 to
Nov 2017

Measured Impact

The half-day visit took place on 1 September 2016 and over this time, the attendees exchanged many ideas about aquaculture and mussel seed production techniques, sales potential and environmental law. After the meeting, it was agreed that the next successful harvest of mussel seeds (approximately 100 tonnes) would be sold to Theun de Ronde.

Since COLUMBUS' engagement with the Environment Protection Agency in Denmark, a law proposal (L111) was heard in the Danish Parliament on 16 January 2017. A working group was formed, based on this debate, to refine the law proposal. After a third reading, the law (Law number 680 of 08/06/2017 on Compensating marine measures by installation or expansion of sea farming) was accepted and an amendment in the Danish Environmental Protection Act is due late 2017-early 2018.

Next Steps

Nils Dalsgaard estimates that it will take years for effective implementation of the new Act and integrated blue mussel-aquaculture farming concept. The Danish Environmental Agency is in the process of promoting the new legislation to aquaculture farm operators in locations geographically suitable for IBMAP implementation. COLUMBUS KT efforts cannot be credited with change in legislation, but undoubtedly informed authorities of the economic and ecological benefits for aquaculture operators.

PROJECT

Applied opportunities for Integrated Blue Mussel and Aquaculture Production (**IBMAP**) | www.danskakvakultur.dk | Supported by European Maritime and Fisheries Board (**EMFF**) and Ministry of Environment and Food of Denmark

Value: €80 million (EC contribution: €40 million)

Timeline: Oct 2012 – Sept 2013

COMPETENCE NODE LEADER

Fisheries | **DTU Aqua** | Copenhagen, Denmark | www.aqua.dtu.dk

CREDITS

Thomas Thøgersen, Ivo Grigorov, Andre Visser (**DTU Aqua**)

IMPROVING INSPECTIONS OF UNDERWATER STRUCTURES USING LASER IMAGING SYSTEMS

THIS CASE STUDY OUTLINES HOW A COST-EFFECTIVE LASER CAMERA CAN BOOST VISIBILITY IN TURBID UNDERWATER ENVIRONMENTS, IMPROVING NECESSARY OFFSHORE INSPECTIONS OF UNDERWATER STRUCTURES.

The **UTOFIA** project (Underwater Time of Flight Image Acquisition), funded through Horizon 2020 and coordinated by SINTEF in Norway, was set up to establish “a compact and cost-effective underwater imaging system for turbid environments to fill the current gap between short-range, high-resolution conventional video and long-range, low-resolution sonar systems.

OVERALL IMPACT OF COLUMBUS: CONFIRMED LONG-TERM INDUSTRY INTEREST IN UPTAKE

“COLUMBUS brought our attention to an interesting project (UTOFIA) and it falls well in line with our interest in carrying out underwater surveys in a more efficient way.”

Mads Andersen, Maersk Drilling

Knowledge Need

Given the EU's growing energy demands, oil and gas production plays a part in providing a secure supply of energy to the continent. It is therefore vital that oil and gas installations are properly maintained and assessed for safety. Under the EU's "Safety of Offshore Oil and Gas Operations Directive", this responsibility lies with national authorities and oil and gas companies. One aspect of maintaining the safety of these installations is subsea visual monitoring of jack-ups (offshore rigs with legs lowered to the sea bed). These structures must be inspected regularly by law. To reduce costs, some companies are moving towards the utilisation of underwater remotely operated vehicles (ROVs) to perform inspections rather than using divers, which can be dangerous and costly. This activity has led to the development of a newly competitive sector.

Knowledge Output

The prototype devised by **UTOFIA** is a compact, cost-effective underwater imaging system for turbid environments. This system extends the imaging range by a factor of two to three over conventional video systems, whilst also providing video-rate 3D information. This system can easily be mounted on small ROVs to provide short-range, high-resolution conventional video and long-range, low-resolution sonar systems. Time-of-flight technology (used for measuring distances) is also integrated into the camera, allowing for increased visibility range in turbid environments.

STEP 1

Collection
Sep 2015

STEP 3

Analysis - Profiling
Target User
Nov 2015 -
Mar 2016

Knowledge Transfer Activity and Target Users

To highlight the potential of the Knowledge Output, **COLUMBUS** successfully contacted two of the world's largest oil and gas companies, Maersk Oil and **DONG** Energy (now Orsted Energy), to identify if there was a market need for the product.

Maersk invited the knowledge owner, Prof Andre Visser, to present the Knowledge Output and its potential applications to two members of staff from Maersk Drilling: Mads Andersen and Shayantharan Sivarajalingam.

In addition, the Technical University of Denmark (DTU), a **COLUMBUS** partner, showcased the

potential of the **UTOFIA** camera to two members of **DONG** Energy's Research and Development team: Jens Gengenbach and Jørn Scharling Holm.

Moreover, the camera was also showcased to GCE Subsea (Norway) - a company set up by the subsea industry to strengthen the energy business - and the public-private partnership **SERPENT** (UK).

STEP 4

Transfer -
Developing a KTP
Nov 2015 -
Mar 2017

Knowledge Output Pathway

The camera would allow offshore operators to monitor the state of underwater structures with greater safety, efficiency, and at less cost. They could also build customised software using the laser data stream, allowing them to predict invisible fractures and risks due to normal wear.

The intended eventual impact of this Knowledge Output Pathway is: to incorporate the **UTOFIA** camera into inspections of underwater structures by offshore operators.

STEP 2

Analysis –
Developing a KOP
Oct 2015

The pathway to achieving this eventual impact would require:

1. Participation from the offshore industry to confirm a market need for the technology and propose adjustments to the design.
2. Validation from experts that the Knowledge Output could be used for subsea visual monitoring of offshore oil, gas and wind settings – and that this is an investible opportunity.
3. Establishing field tests and further development of the product.
4. Commercialisation, including production lines, intellectual property rights and marketing.



STEP 5

KT activity and
measure impact
Nov 2015 –
Mar 2018

Measured Impact

Whilst correspondence ended with **DONG** Energy, Maersk were interested in the technology and its potential to assist the inspections of jack-ups with ROVs. However, it was recognised that more research is required before being able to proceed. Since then, a letter of interest was received by **COLUMBUS** from Maersk agreeing to:

- Support UTOFIA's follow-up Danske Maritime Fond project, "**SENTINEL**", to develop a machine-learning algorithm for automatic identification of marine features.
- Commit to participate in UTOFIA's Industry Advisory Board.
- Provide contacts for key ROV companies with whom they collaborate.
- Explore testing opportunities of **SENTINEL** on a jack-up system in Denmark.

Next Steps

The intended eventual impact of implementing the **UTOFIA** camera in offshore inspections was not achieved due to necessary development of the prototype. (The final prototype delivery is expected in March 2018.) However, **GCE Subsea** and **SERPENT** have expressed great interest in the results of the initial camera trials. Based on the results from the **SENTINEL** project, further development can help reach out to other offshore operators.

PROJECT

UTOFIA | www.utofia.eu | H2020 – Blue Growth | Project ID: 633098

Value: €5.7 million (EC contribution: €5.7 million)

Timeline: Feb 2015 – Apr 2018

COMPETENCE NODE LEADER

Fisheries | **DTU Aqua** | Copenhagen, Denmark | www.aqua.dtu.dk

CREDITS

Thomas Thøgersen, Ivo Grigorov, Andre Visser (**DTU Aqua**)

STATE-OF-THE-ART INNOVATIONS IN ENERGY FOR OFFSHORE AQUACULTURE

THIS CASE STUDY HAS SEEN THE CREATION OF A NEW SCIENCE-INDUSTRY CONSORTIUM THROUGH KNOWLEDGE TRANSFER ACTIVITIES. THIS CONSORTIUM WAS CREATED TO EXPLORE OPPORTUNITIES IN OFFSHORE AQUACULTURE FACILITIES.

The **DeepWind** project, coordinated by DTU-Wind Energy in Denmark, focused on designing a new vertical axis wind turbine (VAWT) concept specifically for offshore application. This new concept has the potential for better cost efficiency than already-existing offshore technology.

OVERALL IMPACT OF COLUMBUS: COLLABORATION FOR APPLICATIONS IN MULTI-USE AQUACULTURE PLATFORMS

“The COLUMBUS project has been instrumental in the transfer of knowledge from the DeepWind project to the newly formed consortium of experts in offshore energy and aquaculture. This consortium is actively pursuing a funding opportunity to bring the DeepWind VAWT Prototype to the next TRL so that it can be incorporated into the offshore aquaculture industry.”

Uwe Schmidt Paulsen, Senior Scientist, DTU Wind Energy
and Coordinator of the DeepWind Project

Knowledge Need

According to the Food and Agriculture Organisation, in 2013 fish accounted for 17% of all animal protein consumed by the global population – 49% provided by aquaculture. As the global population continues to grow, the market for aquaculture continues to increase too. However, the current scale of operations is not keeping up with this trend.

Knowledge management is a challenge for the industry – lots of research is being conducted in the field; however, there are difficulties in transferring the knowledge obtained to the relevant stakeholders. Due to the constraints of near-shore aquaculture, offshore facilities are a viable solution to the increasing demand for fish produced through aquaculture.

Offshore aquaculture using renewable energy is being considered as a potential solution. This concept is currently being researched but requires further progress before it can become a commercial option. This means, however, that offshore aquaculture has the potential to strengthen the growth and sustainability of the marine and maritime sectors in Europe – which is the core of a long term European Commission strategy known as Blue Growth.

Knowledge Output

The **DeepWind** project developed a proof-of-principle high-energy 1kW vertical axis wind turbine (VAWT). Its design is simple and is easy to construct and maintain, therefore making it cost-efficient. It is also unaffected by wind direction changes, turbulence, and other physical limitations of horizontal-axis wind turbines, thus making it a much more productive product.

STEP 1

Collection
Oct 2015

STEP 3

Analysis – Profiling
Target User
Dec 2016

Knowledge Transfer Activity and Target Users

The first step in the KOP was to bring together relevant experts to review the potential application of the VAWT prototype with a specific focus on aquaculture through the utilisation of multi-use platforms. A number of Target Users were identified and invited to an exploratory workshop at the University of Stavanger, Norway. The Target Users included:

- Several experts in offshore wind and aquaculture technology from the University of Stavanger.
- The CEO of GWind, a Norwegian company which develops innovative designs and applications for wind energy, including a floating VAWT.

- An engineer and expert in land-based VAWTs based at Uppsala University, Sweden.
- An electrical machine design expert from Aalborg University, Denmark.

The experts considered public funding as the most efficient method to advance the technology, and initially identified a specific funding call under Horizon 2020 (a European Commission research and innovation programme) to support the technology's development for aquaculture application, therefore reducing the need for external investment.

STEP 4

Transfer –
Developing a KTP
Dec 2016

Knowledge Output Pathway

Substantial investment is being provided to explore ideas for multi-use platforms that combine marine activities, such as offshore energy and aquaculture. The cost-efficient and flexible VAWT design could be used to power such multi-use platforms for either remote or near shore aquaculture.

COLUMBUS Knowledge Fellows from Marine Physical Resources and Marine Fisheries recognised that their networks could mutually benefit from the advancement of the VAWT technology in an aquaculture setting and determined a Knowledge Output Pathway to this end.

The intended eventual impact of this Knowledge Output Pathway is: to increase the **Technology-Readiness Levels (TRL)** of the **DeepWind**

prototype and eventually use the new VAWT technology in aquaculture offshore production.

The pathway to achieving this eventual impact would require:

1. Validation that the knowledge could be applied in an aquaculture setting by experts and that this is an investible opportunity.
2. Participation from the aquaculture industry to confirm a need for this technology and propose adjustments to the design.
3. Establishment of field-tests and subsequent development of product.
4. Commercialisation (including production lines, intellectual property rights and marketing).
5. Uptake of the commercialised VAWT technology in an offshore aquaculture production.

STEP 2

Analysis –
Developing a KOP
Oct 2016



STEP 5

KT activity and
measure impact
Dec 2016 –
Feb 2018

Measured Impact

During this meeting in Norway, all Target Users agreed that this Knowledge Output had high potential in an aquaculture setting and that they were interested in collaborating to further develop the knowledge. A consortium was then formed to explore funding opportunities within an aquaculture setting, with participants from aquaculture (DTU Aqua). Following the meeting, it was agreed that a submission for the identified funding call was impractical due to tight deadlines. However, the consortium has identified a Pilot Demonstrator funding call in the Horizon 2018-2020 Work Programme. They are now working towards applying to that source of funding to progress the development of the prototype. The Knowledge Output was also presented to GCE Subsea Cluster of Offshore Operators (Norway) in Aug-Nov 2017 who intend to promote the VAWT system to their offshore operators for further R&D under public/private funding calls in 2018-2019.

Next Steps

Upon the public release of the 2018-2020 Horizon 2020 Work Programme, COLUMBUS analysed the available funding and communicated the relevant opportunities to the DeepWind consortium. The consortium is actively working toward a project proposal submission in 2018.

PROJECT

DeepWind | Future DEEP-sea WIND turbine technologies | www.DeepWind.eu | FP7 – ENERGY
Project ID: 256769

Value: €4.2 million (European Commission contribution: €3.0 million)

Timeline: Oct 2010 – Sep 2014

COMPETENCE NODE LEADERS

Marine Physical Resources | **Aquatera** | Stromness, UK | www.aquatera.co.uk

Fisheries | **DTU Aqua** | Copenhagen, Denmark | www.dtu.dk

CREDITS

Thomas Thøgersen (**DTU-Aqua**), Jennifer Fox (**Aquatera**), Ivo Grigorov (**DTU-Aqua**),
Uwe Schmidt Paulsen (**DTU Wind**)

OPTIMISATION OF FISHING GEAR SELECTIVITY USING UNDERWATER IMAGING

THIS CASE STUDY OUTLINES AN UNDERWATER IMAGING SYSTEM FOR TURBID ENVIRONMENTS TRANSFERRED TO RESEARCH AND POLICY TARGET USERS, TO STIMULATE FURTHER RESEARCH & DEVELOPMENT (R&D) AND ADVANCE THE TECHNOLOGY READINESS LEVEL OF THE SYSTEM TO ENHANCE SPECIES AND SIZE SELECTIVITY OF FISHING GEAR DESIGN.

The **UTOFIA** project (Underwater Time of Flight Image Acquisition) was funded by Horizon2020 (an EU research and innovation programme) and coordinated by SINTEF in Norway. The aim of the project was to develop “a compact and cost-effective underwater imaging system for turbid environments”.

OVERALL IMPACT OF COLUMBUS: FUNDING SECURED FOR NEW APPLICATION OF TECHNOLOGY

“COLUMBUS made me recognise the potential for optimising gear selectivity, and develop real-time codend-closure. This could be massive. In the Landing Obligation regime, these are essential. Finally, the use of the camera in the evaluation of the physical impact and behaviour of the gear, is vast.”

Anonello Sala, EC Scientific, Technical and Economic Committee for Fisheries (STECF) Panel Expert, CNR, Italy

FISHERIES



Knowledge Need

Adopted in 2014, the European Commission's reformed Common Fisheries Policy banned discards (undersized portion of a catch of fish that is returned, often dead or undying, to the sea) in all European Union waters for many different fisheries. However, in the case of multi-species fisheries, once the fishing quota for one species has been met (known as the "choke" species), catches and landings of other species are limited. One way to maximise catches before reaching this quota is through innovative selective fishing gear. The European Commission is supporting many projects looking for solutions, such as this, to tackle the problems associated with discards.

The issue of discards can also be highly political, and requires innovation in technological solutions as well as accompanying advances in legislation to allow ready solutions to be implemented by fishers and regulation agencies.

Knowledge Output

UTOFIA has developed a compact, cost-effective underwater imaging system for turbid environments. This system extends the imaging range by a factor of 2 to 3 over conventional video systems whilst also providing video-rate 3D information. The system provides short-range, high-resolution conventional video and long-range, low-resolution sonar systems. Time-of-flight technology (used for measuring distances) is integrated into the camera, allowing for fish size – and potentially species – to be identified and providing increased visibility range in turbid environments.

STEP 1

Collection
Sep 2015

STEP 3

Analysis – Profiling
Target User
Oct 2015 –
Mar 2016

Knowledge Transfer Activity and Target Users

Four experts in the field of selective gear development were identified as Target Users: Antonello Sala (EC STECF Expert, Italy), Bob van Marlen (retired fisheries gear expert, Wageningen Inst., Netherlands), Ludvig Ahm Krag, DTU Aqua; Jordan Feekings, DTU Aqua; Niels Maden, Aalborg University (Denmark); and Daniel Stepputtis, the Head of the Fishery and Survey Group at the Thuenen-Institute of Baltic Sea Fisheries, Rostock (Germany).

In August 2016, **COLUMBUS** communicated to the Target Users the benefits of using the UTOFIA camera for testing and developing selective fishing gear in a face-to-face meeting with Ludvig Ahm Krag and held telephone conversations with both Jordan Feekings and Niels Maden.

STEP 4

Transfer –
Developing a KTP
Oct 2015 –
Mar 2016

Knowledge Output Pathway

The performance of types of fishing gear, in terms of selectivity, can be measured using catch comparisons. Video monitoring can determine the primary aspects of gear performances, thus reducing the choke species problem in fisheries. The **UTOFIA** camera can perform this task in turbid environments better than any other.

The intended eventual impact of this Knowledge Output Pathway is: to improve the selectivity of fishing gear types, using the UTOFIA camera to inform performance studies.

STEP 2

Analysis –
Developing a KOP
Oct 2015

The pathway to achieving this eventual impact would require:

1. Carrying out further research and development to address engineering and technological requirements for the application of the camera in fishing gear selectivity.
2. Integrating camera field-testing with gear testing. This would require engaging with research organisations that are developing new fishing gear.
3. Measuring the performance of fishing gear types based on the camera's findings.
4. Optimisation of the selective fishing gear.
5. Commercialisation of new fishing gear, including production lines, intellectual property rights and marketing.



STEP 5

KT activity and
measure impact
Oct 2015 –
Dec 2017

Measured Impact

Following COLUMBUS's transfer of knowledge to the Target Users, Ludvig Ahm Krag and Jordan Feekings decided to include the UTOFIA camera in two project proposals: "FLEXSELECT" submitted to the Danish Nature Agency and subsidised by the European Fisheries Fund Programme (EMFF) and "SMARTFISH" submitted to the Horizon 2020 SFS-22-2017 call.

COLUMBUS contributed to advancing the **Societal Readiness Level (SRL)** from SRL 1 (identifying a problem) to SRL 4 (problem validated through pilot testing within the environment). Two R&D applications were successfully funded to advance the **Technology Readiness Level (TRL)** of the knowledge from TRL 5 to TRL 7 beyond the lifetime of the **COLUMBUS** Project.

Next Steps

The funded projects will (1) solve engineering challenges with mounting the UTOFIA Camera at the fishing gear mouth with its independent power supply (Knowledge Output Pathway – Step 2); and, (2) allow direct observation to monitor size distribution and species escape behaviour at the fishing gear mouth. As well as allowing the measurement of fishing gear performance (Knowledge Output Pathway – Step 3), this advancement could allow fishing gear to be selectively opened and closed to target only mature individuals. Both projects aim to progress the **UTOFIA** camera's Technology Readiness Level for highly selective fishing gear from 5 to 7.

PROJECT

UTOFIA | www.utofia.eu | H2020 – Blue Growth | Project ID: 633098

Value: €5.7 million (EC contribution: €5.7 million)

Timeline: Feb 2015 – Apr 2018

COMPETENCE NODE LEADER

Fisheries | **DTU Aqua** | Copenhagen, Denmark | www.aqua.dtu.dk

CREDITS

Thomas Thøgersen, Jordan Feekings, Ludwig Ahm Krag (**DTU Aqua**)

UNDERWATER CAMERA FOR IMPROVING THE ASSESSMENT OF THE SMALL LOBSTER NEPHROPS

THIS CASE STUDY OUTLINES HOW THE KNOWLEDGE OUTPUT OF A COST-EFFECTIVE IMAGING SYSTEM CAN BE USED TO ASSESS THE STATUS OF FISHERIES, WITH A PARTICULAR FOCUS ON SURVEYING NEPHROPS (A TYPE OF SMALL LOBSTER).

The **UTOFIA** project (Underwater Time of Flight Image Acquisition) was coordinated by SINTEF, based in Norway. It was established to develop “a compact and cost-effective underwater imaging system for turbid environments to fill the current gap between short-range, high-resolution conventional video and long-range, low-resolution sonar systems.

OVERALL IMPACT OF COLUMBUS: FUNDING SECURED FOR NEW APPLICATION OF TECHNOLOGY

“I can guarantee the ICES Working Group of Nephrops Surveys will be very excited to hear the outcomes of the UTOFIA application to Nephrops Stock Assessment in the COLUMBUS project.”

Ana Leocadio (CEFAS, UK), Chair of ICES Working Group of Nephrops Surveys (WGNEPS)

Knowledge Need

In order for managers of fisheries to regulate fish stock, they must develop “stock assessments”. These assessments can be made by analysing data on the fishery and the stock’s biology. According to the European Environment Agency, approximately 45% of assessed European commercial stocks fail to stay within the level of maximum sustainable biological productivity. This means achieving accurate stock assessments is essential.

In the case of the bottom-dwelling lobster, *Nephrops norvegicus* (commonly known as the Norwegian Lobster, Dublin Bay prawn or langoustine), surveys using underwater video are performed annually. This information is then used to provide catch advice on stocks. However, the process is a laborious one. It involves using a video camera to count the number of burrow complexes (i.e. the places where *Nephrops* live). This camera is mounted on a sled and towed along the seabed. In Ireland alone, this survey typically involves around 4,000 minutes of video footage annually. However, the process is not only time consuming. It can be subjective as well – objects can sometimes be counted but not recorded and turbid waters can distort visibility.

Knowledge Output

UTOFIA has developed a compact, cost-effective underwater imaging system for turbid environments. This system extends the imaging range by a factor of two to three times that of conventional video systems, whilst also providing video-rate 3D information. The system provides short-range, high-resolution conventional video and long-range, low-resolution sonar systems. Time-of-flight technology is integrated into the camera, allowing for increased visibility range in turbid environments. This technology can therefore greatly improve the precision of *Nephrops* surveys.

STEP 1

Collection
Sep 2015

STEP 3

Analysis – Profiling
Target User
Feb 2016 –
May 2016

Knowledge Transfer Activity and Target Users

COLUMBUS presented the Knowledge Output to BIORAS A/S, a small/medium-sized enterprise (SME), based in Denmark that develops rapid analysis systems for biology and life sciences. However, for the technology to be improved, more funding was required for research and development.

To tackle this problem, **COLUMBUS** assisted the Target User (BIORAS A/S) in identifying and responding to calls for funding. For each of the proposals, BIORAS

aspired to develop the **UTOFIA** camera’s automated video analysis of marine life. The calls for funding were:

- The Irish Marine Institute tender call for “Under Water Mosaicking Software Library”
- ORIENTS Fund and International Maritime Fund

COLUMBUS also secured commitment from experts at the **ICES Working Group of Nephrops Surveys (WGNEPS)** to define the technological demand for this sector.

STEP 4

Transfer –
Developing a KTP
Feb 2016 –
May 2016

Knowledge Output Pathway

The **UTOFIA** camera has already proved to be capable of operating in a turbid environment by DTU Aqua in Denmark. With a few modifications, the camera will allow for more precise assessments of *Nephrops* stocks through automated counting mechanisms. This will reduce the time consumed and potential accuracy of current mechanisms. As with most technology, field testing and validation will be required to commercialise this product and make it available.

The intended eventual impact of this Knowledge Output Pathway is: to enable more efficient stock assessment of *Nephrops* to respond to European regulations on assessing fisheries' stocks.

STEP 2

Analysis –
Developing a KOP
Feb 2016 –
Mar 2016

The pathway to achieving this eventual impact would require:

1. Integrating the camera with software for automatic detection of marine life.
2. Establishing in-field testing of the camera by engaging with a competent authority responsible for delivering *Nephrops* stock assessments.
3. Comparing the performance of *Nephrops* stock assessments with and without the integrated camera-software system.
4. Validating that the new prototype provides an accurate assessment of stock.
5. Promoting the new prototype to other competent authorities of EU Member States who are responsible for delivering *Nephrops* stock assessments.



STEP 5

KT activity and
measure impact
May 2016 –
Mar 2018

Measured Impact

Submission for The Irish Marine Institute tender funding call was successfully submitted and evaluated, but was retracted by the funder for unspecified reasons. Funding for the **SENTINEL** project was granted under the ORIENTS call.

Next Steps

In order to optimise fundraising for the automated video assessment software, **BIORAS** A/S and **COLUMBUS** will publish a document outlining the opportunities for investing in further research and development of adapting the **UTOFIA** camera to *Nephrops* surveys. The document will be disseminated to organisations within the video analysis sector to increase potential for research and development funding.

Furthermore, **ICES WGNES** will act as a credible communication channel to advise all competent authorities responsible for performing *Nephrops* stock assessments on the use of the product once it has been validated.

PROJECT

UTOFIA | www.utofia.eu | H2020 – Blue Growth | Project ID: 633098

Value: €5.7 million (EC contribution: €5.7 million)

Timeline: Feb 2015 – Apr 2018

COMPETENCE NODE LEADER

Fisheries | **DTU Aqua** | Copenhagen, Denmark | www.aqua.dtu.dk

CREDITS

Thomas Thøgersen, Jordan Feekings, Ludwig Ahm Krag (**DTU Aqua**)

HIGHLIGHTING THE IMPORTANCE OF ACCESS AND BENEFIT-SHARING OF MARINE BIOLOGICAL RESOURCES

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT FOR RESEARCHERS APPLIED TO IMPROVING 'ACCESS AND BENEFIT-SHARING COMPLIANCE'. THIS WAS ACHIEVED BY TARGETING AGENCIES WITH CRITICAL ROLES IN MARINE GENETIC RESOURCE STORAGE AND SUPPLY CHAINS.

The **MicroB3** project, coordinated by Jacobs University Bremen (Germany), aimed to make large-scale data on marine microbial genomes and metagenomes accessible for marine ecosystems biology and to define new targets for biotechnological applications.

**OVERALL IMPACT OF COLUMBUS:
PROVISION OF TRAINING ON
COMPLIANCE FOR MARINE CULTURE
COLLECTORS AND
DISTRIBUTORS**

"I think that ABS regulations remain a confusing and often-misunderstood concept among not just researchers, but also culture collections and biotech industries. Hopefully together with COLUMBUS we can put together a workshop that will address this issue."

Thibaud Mascart, Scientific Project Manager, Ghent University

MARINE BIOLOGICAL
RESOURCES



Knowledge Need

The oceans are a repository of countless organisms whose genetic makeup may contain the key to critical biotechnological and pharmaceutical breakthroughs. As such, European researchers and entrepreneurs are actively searching for and evaluating marine genetic resources from around the world. In order to protect the local environments and communities that may rely on these resources, the United Nations and European Union Member States have agreed to abide by the Nagoya Protocol on Access and Benefit Sharing (ABS) – an international agreement which aims at sharing the benefits arising from the utilisation of genetic resources in a fair and equitable manner, specifically where the benefit could be realised in a different location from where the sample was sourced.

Knowledge Output

The ABS model agreement is a trialled contract that was designed and used by the MicroB3 partners to standardise their acquisition of marine genetic resources in compliance with the Nagoya Protocol. The goal of this agreement was to ensure that researchers were aware of, and that they comply with, the relevant policies of the Nagoya Protocol and their impact on acquiring and using biological samples from other countries. It was also designed to be used to check to see if a project adheres to Nagoya ABS standards. The agreement outlines the reason for the protocol, the consequences of not adhering to it, and the steps that must be taken to be compliant.

STEP 1

Collection
Mar 2017

STEP 3

Analysis – Profiling
Target User
Jun 2017

Knowledge Transfer Activity and Target Users

COLUMBUS identified two target users: the European Marine Biological Resource Cluster (EMBRC) and EuroMarine, both European marine science networks, who could become potential partners in the provision of ABS training. **COLUMBUS** provided them with

an infographical brochure on ABS providing key information on ABS compliance, and detailing where researchers could get more information. Furthermore, **COLUMBUS** highlighted the potential of using the model agreement as a tool for training collection agencies in ABS compliance.

STEP 4

Transfer –
Developing a KTP
Jul 2017

Knowledge Output Pathway

COLUMBUS recognised that rather than attempting to train every researcher in the details of ABS, it might be more efficient to institute a change at the culture collection stage, and its associated stakeholders.

The intended eventual impact of this Knowledge Output Pathway is: to facilitate the adoption of good ABS practices in the handling of marine biological resources.

STEP 2
Analysis –
Developing a KOP
Apr – May 2017

The pathway to achieving this eventual impact would require:

1. Raising awareness of the need for ABS compliance, including information such as how to find out more about compliance measures and how to participate in potential training opportunities.
2. Developing an ABS training session targeted at industrial actors, collection curators and project coordinators.
3. Make available updated ABS model agreement forms which can be incorporated into collection agencies or research projects to ensure ABS compliance.



STEP 5
KT activity and
measure impact
Nov 2017 –
Feb 2018

Measured Impact

EMBRC recognised the value of providing training to stakeholders within the marine biological resource supply chain and together with **COLUMBUS** developed a list of potential candidates to be invited to the training, e.g. stakeholders from large marine culture collections, distribution companies, and bioprospecting agencies. The agenda for a training workshop was developed in tandem with **EMBRC**. This event will take place in September 2018, with the goal of fostering real and immediate ABS-compliant procedures within these networks. Over one hundred participants will be invited, from culture collection organisations (such as the 61 members of the European Culture Collections' Organisation), delivery companies (such as DHL), and network and clusters (such as **EMBRC**).

Next Steps

The training seminar and workshop will take place in September 2018. **EMBRC** will host the event, and funding is being sought through cooperation with EuroMarine and the Royal Flemish Institute.

EXPLORING THE USE OF SEAWEED-DERIVED BIOPOLYMERS IN BIOMEDICAL TECHNOLOGY

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT WHEREBY BIODEGRADABLE PLASTICS WERE DEVELOPED FROM SUSTAINABLE BIOLOGICAL SOURCES AND TRANSFERRED TO A CONSORTIUM TO INVESTIGATE ITS USE IN DEVELOPING NOVEL WOUND DRESSINGS AND OTHER BIOMEDICAL ADVANCES.

The **SEABIOPLAS** project was coordinated by the Bantry Marine Research Station (Ireland) and sought to develop an alternative and more sustainable feedstock for the European Union's biodegradable polymer manufacturing industry.

OVERALL IMPACT OF COLUMBUS: MEMORANDUM OF AGREEMENT SIGNED WITH NEW SECTOR TO EXPLORE APPLICATION IN BIOMEDICAL RESEARCH

"I think the real benefit of projects like COLUMBUS is exchanges like this; meeting with people you probably would not have known of otherwise, and getting new ideas from different fields."

Dr Julie Maguire, Research Director and Manager, Bantry Marine Research Station

MARINE BIOLOGICAL
RESOURCES



Knowledge Need

The term 'bioprospecting' describes the search for plant and animal species from which medicinal drugs and other commercially-valuable compounds can be obtained. Recently, focus of many bioprospecting efforts has expanded to include marine organisms. Properties such as high salt and pressure tolerance, temperature adaptivity, and unusual physical and chemical structuring have led to a surge in marine biotechnological research.

More recently, the medical and pharmaceutical industries have become some of the heaviest investors in marine biological resources. While many of the biomedical investigations have been driven by the search for bioactive compounds, a subset has focused on marine biopolymers. These biopolymers boast a myriad of potential important applications, such as wound dressings, bone and dental biomaterials and adhesives, and tissue scaffolds.

Knowledge Output

The Knowledge Output consists of an innovative method of seaweed cultivation and processing that allows researchers to alter various compositional ratios (such as sugar levels) to produce a variety of tailored seaweed-derived biopolymers. This novel process of cultivation, pre-treatment and processing presents the potential for developing biopolymers from seaweed, with unique properties and potential applications across an array of biotechnology fields. During the lifetime of **SEABIOPLAS**, the focus was on developing these biopolymers into biodegradable plastics. After the project's end, some small to medium-sized enterprise partners began looking at applications in biofuel and feed, while others sought uses for some of the process's byproducts, such as calcium lactate.

STEP 1

Collection
May 2017

STEP 3

Analysis - Profiling
Target User
Jul 2017

Knowledge Transfer Activity and Target Users

COLUMBUS facilitated collaboration between the Knowledge Owner and the Target User (the **DERMA** project) by first conducting individual meetings. This was to clarify and ease concerns over intellectual property rights (IPR). Once both parties were satisfied in this regard, **COLUMBUS** hosted a meeting between the Knowledge Owner and Target User in December 2017.

During the meeting, the Knowledge Owner agreed to send the Target User a sample selection of biopolymers to explore their potential applications in existing areas of interest by the **DERMA** research teams. A meeting will be held in early 2018 to review the results and discuss next steps, such as options for full collaboration.

STEP 4

Transfer -
Developing a KTP
Aug 2017

Knowledge Output Pathway

COLUMBUS recognised a valuable opportunity in transferring the Knowledge Output to Interreg-2-Seas 'DERMA' project that was actively seeking marine biopolymers to evaluate for potential application in the development of biomedical prototypes using biopolymers, such as wound dressings and materials for medical implants.

STEP 2
Analysis –
Developing a KOP
Jun 2017

The intended eventual impact of this Knowledge Output Pathway is: to successfully develop a variety of biomedical tools from seaweed-based polymers.

The pathway to achieving this eventual impact would require:

1. Investigating potential applications of polymers produced by the innovative method of seaweed cultivation and processing.
2. Determining options for collaboration for larger scale provision of seaweed by-products.
3. Considering options for commercialisation of products to reach a wider market.



STEP 5

KT activity and
measure impact
Oct 2017
– Feb 2018

Measured Impact

The Knowledge Owner and Target User made an agreement to collaborate on any of the Knowledge Owner's biopolymers that the Target User finds applicable to their research. The Knowledge Owner released information to the Target User which would ordinarily be withheld due to IPR, and sent a collection of biopolymer samples for screening. The **SEABIOPLAS** consortium expressed willingness to work with **DERMA** on any research project that uses a **SEABIOPLAS** biopolymer or the overall cultivation and processing methodology.

Next Steps

Once the samples have been screened, the two parties will reconvene to discuss the next steps in their collaboration. This will involve the Target User describing which samples showed the most potential and to which **DERMA** research area they can be applied. From there, the Knowledge Owner and Target User will agree on options and conditions for further provision of biopolymers (for either full-scale research application, further initial screening, or both).

PROJECT

SEABIOPLAS | Seaweeds from Sustainable Aquaculture as Feedstock for Biodegradable Bioplastics | www.cordis.europa.eu/project/rcn/110672_en.html | FP7-SME-2013 | Project ID: 606032

Value: €2.0 million (European Commission contribution: €1.5 million)

Timeline: Oct 2013 – Sep 2015

COMPETENCE NODE LEADER

Marine Biological Resources | **AquaTT** | Dublin, Ireland | www.aquatt.ie

CREDITS

Keegan Porter, Georgia Bayliss-Brown (**AquaTT**), Dr Julie Maguire (**Bantry Marine Research Station, Ireland**), Dr Arn Mignon (**Ghent University**)

LOW-COST MARINE MICROBIAL SAMPLING KIT FOR THE NEXT GENERATION

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT FOR LARGE-SCALE MARINE MICROBIAL SAMPLING APPLIED TO IMPROVING EDUCATIONAL ACCESS TO MARINE BIOLOGICAL SCIENCES IN A NON-EUROPEAN DEVELOPING COUNTRY.

The **Micro B3** project, coordinated by Jacobs University Bremen (Germany), aimed to make large-scale data on marine microbes accessible for marine ecosystems biology and to define new targets for biotechnological applications. The project was funded by “The Ocean of Tomorrow” call under the European Commission’s Large Scale Integrating Projects Framework Programme.

OVERALL IMPACT OF COLUMBUS: POPULARISING BIOPROSPECTING CAREERS USING SAMPLING KITS



“I think it is possible to use the kits for bioprospecting and much interest was generated by the students as to the continuation of the programme next year. Our plan is to assemble more kits and also intend to incorporate the kits into our curriculum for yearly monitoring.”

Francis Asuquo, Dean of Faculty of Oceanography, University of Calabar

Knowledge Need

Microbes constitute the majority of life in the oceans. The remarkable diversity of these organisms and their chemical properties hints at a wealth of possible biotechnological applications, such as pharmaceutical usage. However, more than 90% of marine species remain undescribed by science, as outlined by 2011's Mora et al.'s "How many species are there on Earth and in the Ocean?". With the demand for new biotechnological applications outpacing resource availability of traditional resources, scientists are in a race to find these potentially invaluable applications of unexamined marine species.

The ratio of raw genetic material that is evaluated to those that reach market as a product is very small. This means that if biotechnological demands are to achieve any possibility of being met, an increase in the number of sample collections and researchers active within the field of marine biotechnology and bioprospecting (the search for new species from which commercially valuable products can be obtained) is necessary.

Knowledge Output

The Knowledge Output – the 'Ocean Sampling Day Kit' developed by Micro B3 – is an inexpensive, easy-to-use assortment of tools with an accompanying guide on how to properly collect samples of marine microbes. In the context of Micro B3's Ocean Sampling Day, the Knowledge Output led to researchers garnering samples from around 300 citizen scientists. The application of the Knowledge Output demonstrated that valuable biological resource samples can be reliably found without excessive costs of time and money. It also showed how the Knowledge Output can be used to expose non-experts to the needs and goals of bioprospecting and marine biotechnology.

STEP 1

Collection
Mar 2017

STEP 3

Analysis – Profiling
Target User
Jun 2017

Knowledge Transfer Activity and Target Users

COLUMBUS recognised the potential for expanding the use of the kit beyond Ocean Sampling Day. It therefore targeted a representative university to trial its use as an educational tool.

COLUMBUS met with the Knowledge Owner to discuss how the tool could be best employed in an alternative context. From this, the Dean of the Faculty of Oceanography at the University of Calabar, Prof. Francis Asuquo, was identified as an ideal Target User. As a partner in the AtlantOS project, and actively engaged in their integrated observing systems activities, Prof. Asuquo's curriculum aligned with **COLUMBUS**'s timeline. This was due to an educational research cruise he was delivering in December 2017 and was open to adopting the kit into this course.

Discussions with Prof. Asuquo were initiated at the event, "A New Era of Blue Enlightenment", launching the South Atlantic Flagship Initiative between the European Union, Brazil and South Africa.

COLUMBUS then organised the delivery of two pre-made kits from the Knowledge Owner to the Target User and facilitated a meeting between them to discuss effective techniques for their use. Subsequently, the Target User integrated the concepts behind the kits into a semester-long course which culminated in the kits being utilised during a one-week sample collection field exercise.

STEP 4

Transfer –
Developing a KTP
Jul 2017

Knowledge Output Pathway

COLUMBUS recognised that while the marine biotechnology profile is growing, there is an urgent need for improved student awareness, interest and access to learn about the concepts of marine bio-prospecting – particularly at the university and postgraduate level. Furthermore, in countries with fewer lab resources, the field of marine bioprospecting is difficult to access.

STEP 2
Analysis –
Developing a KOP
Apr – May 2017

The intended eventual impact of this Knowledge Output Pathway is: to stimulate interest in bioprospecting research using the Ocean Sampling Day Kit.

The pathway to achieving this eventual impact would require:

1. Conducting a pilot test to determine the kit's effectiveness in an educational setting.
2. Expanding the number of participating institutions and integrating the kits into their science curriculum.
3. Exploring the commercial and scientific opportunity for bioprospecting research institutions or companies to fund the programme in exchange for access to samples.
4. Creating an established and supported school-to-field pipeline aimed at growing the number of trained marine biotechnologists.



STEP 5
KT activity and
measure impact
Aug – Dec 2017

Measured Impact

- The Target User delivered a seminar to both students and staff of the University of Calabar explaining Ocean Sampling Day, the previous application of the kits, and the proposed integration of the kits into their 'Marine Environmental Chemistry' course curriculum.
- 18 Oceanography Masters students conducted a one-week sampling expedition along the Atlantic coast near Ibeno, Nigeria, using the kits. Tracking the research interests of these students would be a valuable measure of the long-term impact of this Knowledge Transfer activity.
- The Target User developed plans to build more kits to be incorporated into a yearly course with an aim of contributing samples to future Ocean Sampling Days.
- The Target User expressed interest in collaborating with a research institution or company to provide samples for bioprospecting purposes.

Next Steps

The success of the first Knowledge Transfer activity has encouraged the pursuit of two subsequent steps, which can occur simultaneously. The first is to transfer this Knowledge Output to further Target Users in the educational pipeline. The second would be to contact relevant research institutions or companies to purchase the kits and process the samples, ostensibly in exchange for permission to use the samples.

NOVEL LOW-COST RESPIROMETER FOR MEASURING CORAL HEALTH

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT FOR THE IN-SITU MEASUREMENT OF CORAL HEALTH, APPLIED TO IMPROVING THE EFFICIENCY OF CORAL CULTIVATION WHILE ALSO RAISING THE PROFILE OF THE KNOWLEDGE OUTPUT WITHIN THE MARINE CORAL RESEARCH COMMUNITY.

The **SYMBIOCORE** project was coordinated by the University of Aveiro (Portugal) and funded by the Marie Curie **International Research Staff Exchange Scheme (IRSES)**. The project sought to examine the effects of climate change on coral reef primary production, respiration and coral photo-physiology. It also aimed to determine whether there is more to coral bleaching than the physiological breakdown of symbioses, and to determine the ecological and biogeochemical consequences of phase shifts in coral reefs.

OVERALL IMPACT OF COLUMBUS: TRIAL ARRANGED FOR KNOWLEDGE OUTPUT IN A CORAL CULTIVATION CAPACITY

“I like the project and knowledge (COLUMBUS transferred to us) very much, and we shall be pleased and very interested in testing it in our facilities, on several species of corals.”

Stéphane Hénard, Director and Head of Aquariology, Nausicaá

Knowledge Need

Corals are important species in both the biotechnology and climate research fields. This is due to their physiological and chemical characteristics as well as the way in which they react to changes in their environment. Additionally, they form the foundation of many marine ecosystems and, as such, are critical elements in sustainable and ethical aquaria. One of the primary means of studying the factors affecting coral health and growth is the measurement of the metabolic rate of a coral's respiration. Currently, for both scientists and marine monitoring organisations, in-situ respirometry measurements are able to deliver general findings about the health of sections of coral reefs. However, they are often either too large or unwieldy for differentiating between individual corals, or are expensive and require an external power supply. This is because respirometers require powered machinery to mix the water, and are largely made of glass and metal. These attributes of respirometers also make them impractical for use by most aquaria and cultivators, who instead are more likely to measure the respirometry levels of all the coral in a tank. Such an arrangement makes it difficult for these users to accurately measure how cohabitating species in a tank affect specific coral types. It also makes the process of comparing growth rates awkward and risky due to the need to move the coral.

Knowledge Output

The Knowledge Output, the 'Flexi-Chamber,' was designed by Dr Emma Camp (University of Technology Sydney) to be a cost-effective method for measuring the metabolic rates of individual corals. The device uses an inexpensive, transparent and gas-impermeable bag, a three-valve contaminant-proof water extraction system, and a flexible design. This provides the user with the ability to conduct targeted and high-throughput (allowing for many different tests to occur quickly) in-situ metabolic measurements at minimal risk of coral damage and without requiring external power supplies.

STEP 1

Collection
Mar 2017

STEP 3

Analysis - Profiling
Target User
Jun 2017

Knowledge Transfer Activity and Target Users

COLUMBUS recognised that an institution involved in both cultivation and research would be ideal to pilot the Flexi-Chamber and have the most impact on subsequent uptake by secondary users.

The **COLUMBUS** Marine Biological Resources (MBR) Node identified a director of the Nausicaá Aquarium (France), Dr Stéphane Henard, as an ideal Target User. Dr Henard, among his many roles at Nausicaá, oversees the Coral Research Team. As a public aquarium, Nausicaá frequently makes changes to its displays. **COLUMBUS** recognised this as an advantage, as the

opportunity to discover how changes in environment affect each coral type would be valuable to the cultivation industry.

Members of Nausicaá are the leaders of communication for **COLUMBUS**. Through them the MBR Node was able to arrange a meeting with the Target User and the Knowledge Owner. Additionally, **COLUMBUS** arranged a meeting between the Knowledge Owner and Dr Andi Haas, a coral expert who has experimented with novel respirometers himself.

STEP 4

Transfer -
Developing a KTP
Jul 2017

Knowledge Output Pathway

COLUMBUS recognised that the relatively small size and user-friendly design of the Flexi-Chamber made it particularly well-suited for field research and organisations involved in the cultivation of coral for aesthetic, educational, and biotechnological reasons. Those most likely to benefit from the eventual impact of this Knowledge Output are aquaria, biotechnology researchers, and climate and marine environmental monitors. Trialling the Flexi-chamber in one organisation would showcase the advantages of using this method over traditional methods, and would also inform further adaptations which may be required to make it more effective.

The intended eventual impact of this Knowledge Output Pathway is: provide an affordable tool for measuring the health of coral and maximising their growth conditions.

The pathway to achieving this eventual impact would require:

1. Validating the Flexi-Chamber in a research aquarium on multiple species.
2. Considering adaptations for the Flexi-Chamber to make it more effective for aquarium use.
3. Raising awareness of the prototype's availability and benefits to aquaria, biotechnology researchers, and climate and marine environmental monitors.

STEP 2

Analysis –
Developing a KOP
Apr – May 2017



STEP 5

KT activity and
measure impact
Nov 2017 –
Jan 2018

Measured Impact

At this **COLUMBUS**-organised meeting the technical parameters of the device were explained by the knowledge owner to the target user. Nausicaá agreed to pilot the Flexi-Chamber and **COLUMBUS** facilitated the arrangement for the transfer of the prototype from Sydney to Boulogne-sur-Mer (France). The Flexi-Chamber will be used to monitor the growth and health of 112 species of coral in 20 exhibition tanks and a further 40 backstage research tanks. Additionally, it is expected that about one million annual visitors will have the opportunity to learn about the Flexi-Chamber through Nausicaá's display on the **COLUMBUS** project. Dr. Haas has expressed interest in examining the Flexi-Chamber once it has been implemented at Nausicaá, and he and the Knowledge Owner have agreed to meet later this year to discuss potential design improvements.

Next Steps

The progression of the Knowledge Output down the Knowledge Output Pathway towards wider use of the Flexi-Chamber will be influenced by the degree of success of the implementation at Nausicaá, particularly if it is shown to provide a cost-benefit advantage over existing methods. Although such progression will be beyond the timespan and control of **COLUMBUS**, the MBR node has worked with the Nausicaá communications team to maximise the exposure of the Flexi-Chamber to other potential users through the **COLUMBUS** display.

MITIGATING MICROPLASTIC POLLUTION WITH WASTE WATER TREATMENT TECHNOLOGY

THIS CASE STUDY HAS SEEN TWO RESEARCH ORGANISATIONS COLLABORATE TO DEVELOP A KNOWLEDGE OUTPUT FOR NOVEL PRE-TREATMENT TECHNIQUES OF PLASTICS, SO THAT IT CAN BE APPLIED IN AN INDUSTRIAL SETTING TO REDUCE MICROPLASTICS IN THE WATER COLUMN.

The **BIOCLEAN** project was coordinated by the University of Bologna (Italy) and funded under the European Commission's FP7 Programme. It sought to find smart and robust biotechnological solutions for the degradation and detoxification of plastic waste. Ultimately, the project aimed to mitigate the current impact of plastics in marine ecosystems.

**OVERALL IMPACT OF COLUMBUS:
COLLABORATION TO DEVELOP A NOVEL
PLASTIC TREATMENT TO PREVENT
MICROPLASTICS ENTERING THE
MARINE SYSTEM FROM INDUSTRIAL
SOURCES**

**"COLUMBUS has helped me pursue
a potential (microplastics) research
collaboration with GMIT on freshwater
environments and waste management."**

Dr Vincent Verney, French National Centre for Scientific Research



Knowledge Need

A persistent problem in current efforts to reduce plastic and microplastic waste in the marine environment is the fact that most sources of these pollutants are terrestrial. As a result, cleaning efforts that only target the oceans fail to tackle the root of the problem. Intercepting plastics along pathways, such as rivers, is a critical component of the overall battle against such pollution. However, options for what to do with the plastic that has been collected remain limited and challenging. Many plastics (particularly microplastics) cannot be effectively recycled. Without a process to break this waste down, the plastic will continue to pose a risk to the environment.

The Irish Environmental Protection Agency identified microplastic “hot-spots” where either the quantity of microplastics being produced is relatively high (such as plastics recycling plants) or where there is a high likelihood of microplastics accumulating (such as urban wastewater treatment plants). These locations would, therefore, make ideal starting points for the implementation of technology or processes that can help capture or degrade microplastics.

Knowledge Output

The Knowledge Output is a biodegradation pre-treatment chamber that breaks down plastics. The technology is based on the **Advanced Oxidation Process (AOP)** that is used to treat wastewater. During the BIOCLEAN project, the device was adapted to be able to handle 1kg of plastic at a time. The device couples ultraviolet and ozone treatments in a chamber (called a fluid bed reactor), which can operate in both gas and liquid phases. This allows the reactor to use a cycle of physical and chemical processes to make the properties of the plastic’s substrate more susceptible to bioremediation (the process of using microorganisms to consume and break down environmental pollutants). Therefore, the potential for ingestion and accumulation in the bodies and tissues of many organisms would be reduced, which is a key threat of microplastics in the marine environment.

STEP 1

Collection
Mar 2017

STEP 3

Analysis – Profiling
Target User
Jun 2017

Knowledge Transfer Activity and Target Users

COLUMBUS identified a Galway Institute of Technology (GIT) researcher as a Target User – an expert in microplastics and the pathway of microplastic pollution from source to impact area. **COLUMBUS** initiated the Knowledge Transfer activity by facilitating the exchange of knowledge between the Knowledge Owner and the Target User. Initial interactions focused on determining how the Knowledge Output could be adapted to be incorporated into industries, such as plastic recycling and waste water treatment plants. This was followed by a Skype meeting hosted by **COLUMBUS** in December 2017. The meeting covered the following:

- Technical details of the Knowledge Output.

- How the Knowledge Output could be applied to the Target User’s research.
- Opportunities for collaboration between the Knowledge Owner and Target User.
- Pathways for finding assistance with funding and a potential project proposal.

Following the meeting, **COLUMBUS** arranged for a member of the Knowledge Owner’s research team to accompany the Target User on a water sampling trip to exchange methodologies and observe GIT’s lab analysis for microplastics in freshwater.

STEP 4

Transfer –
Developing a KTP
Jul 2017

Knowledge Output Pathway

COLUMBUS recognised the potential for this biodegradation pre-treatment chamber to help specific industries reduce or eliminate their microplastic by-product pollution. To achieve this, further validation of the prototype in an industrial setting is required, as well as scaling up the prototype to be able to handle industrial volumes of waste.

The intended eventual impact of this Knowledge Output Pathway is: to integrate a biodegradation pre-treatment chamber into industries, such as plastic recycling and waste water treatment plants, for use in eliminating microplastic by-products.

The pathway to achieving this eventual impact would require:

1. Testing of the prototype in an industrial setting.
2. If relevant and desired, pursuing a patent or other intellectual property protection.
3. Scaling up the prototype.
4. Transferring the knowledge to further companies and industries.
5. Commercialising the prototype and making widely available.

STEP 2

Analysis –
Developing a KOP
Apr – May 2017



STEP 5

KT activity and
measure impact
Ongoing

Measured Impact

Due to the **COLUMBUS** Knowledge Transfer, the Target User is now exploring options for the development of a project proposal in collaboration with the Knowledge Owner that will trial the use of the AOP in plastic processing or waste industries as a means of reducing microplastic emissions.

Next Steps

The Target User plans to contact a multinational industry stakeholder, who previously expressed interest in testing new plastic reduction technologies, providing details of the Knowledge Output.

The Target User will be working with AquaTT, the **COLUMBUS** Marine Biological Resources Node leader, to progress further down the Knowledge Output Pathway via an Irish Environmental Protection Agency funded project. Prior to testing the AOP in an industrial setting and scaling the product to a commercial scale, AquaTT will ensure that intellectual property is protected.

HARMFUL ALGAL BLOOM (HAB) FORECAST AND WARNING SYSTEM

THIS CASE STUDY HAS LAID THE GROUNDWORK FOR AN IMPACTFUL KNOWLEDGE OUTPUT – DEVELOPED TO FORECAST HARMFUL ALGAL BLOOMS (HABS) IN WESTERN EUROPEAN WATERS – TO BE EXPANDED TO THE ADJACENT REGIONS OF MACARONESIA AND NORTH AFRICA.

The **ASIMUTH** project, coordinated by the Bantry Marine Research Station Ltd, used a combination of modelling and satellite imagery to develop short-term forecasts of harmful algal blooms (HABs) along the European Atlantic coasts that could be delivered to users via mobile phones and the internet. The project was a collaborative project funded by the European Commission's "Space Call 3" call.

OVERALL IMPACT OF COLUMBUS: SHORT-TERM HAB FORECASTING APPROACH TRANSFERRED TO FURTHER REGIONS



MARINE BIOLOGICAL
RESOURCES



Knowledge Need

An algal bloom is a rapid increase or accumulation in the population of algae in freshwater or marine water systems. Harmful Algal Blooms (HABs) are characterised by their capacity to cause large-scale mortality events in a variety of ways, such as the production of toxins, physical damage and hypoxia. Beyond the direct threat to the environment and human health posed by such events, there is also a significant socio-economic cost: HABs can force the closure of shellfish and fish farms, desolate fishing areas, and close valuable recreational areas. This has led many HAB monitoring agencies to begin investigating ways to predict such occurrences, so at-risk industries might have time to take mitigating actions.

HABs are likely to become increasingly common with climate change; therefore, posing an even greater threat to aquaculture, fisheries, environmental management, and tourism. Furthermore, HABs originating from the middle latitudes of the globe have begun affecting marine and maritime activities further North in ways previously unseen. HAB monitoring efforts need to be in place to be prepared for these events originating from both local and warmer waters.

Knowledge Output

The ASIMUTH HAB forecast is a model which uses satellite imagery, in-situ networks, and biological and chemical data collected on-site to predict where HABs are likely to form in local waters. Each forecast is based on the expert opinion of the biologists who assess the available information at the time of publication. This forecast is then distributed to provide warnings or guidance for concerned parties, such as shellfish farmers.

The HAB forecast system allows biologists to focus their efforts on high-risk areas, where they perform multiple daily checks. This gives shellfish farmers advanced warnings of possible HABs. This is critical for the shellfish industry because HABs can cause closures and loss of stock.

Using the ASIMUTH HAB forecast, the Marine Institute, in Ireland, issues a weekly HAB forecast bulletin that provides a weekly risk assessment as well as long-term assessments and information. This has helped Irish shellfish farmers adjust their seeding and harvesting seasons to minimise HAB disruption.

STEP 1

Collection
Mar 2017

STEP 3

Analysis – Profiling
Target User
Jun – Jul 2017

Knowledge Transfer Activity and Target Users

Three activities pursued over the course of COLUMBUS's involvement. For the first activity, **COLUMBUS** arranged a meeting between the Knowledge Owner and Target Users from a Galicia/Portugal INTERREG project called MARRISK. The purpose of this meeting was to discuss how the MARRISK researchers could integrate lessons learned from ASIMUTH and the subsequent Irish monitoring programme into their work. Yet it emerged, that MARRISK had already planned for collaboration with PRIMROSE, an Irish follow-up project to ASIMUTH.

With this new information, **COLUMBUS** reviewed the Knowledge Output Pathway and decided to pursue parallel new Target Users: one within the Macaronesia region and the other within the North African region. For the Macaronesia effort, **COLUMBUS** met with a representative from the Oceanic Platform of the Canary Islands (PLOCAN) to explain how the Knowledge Output had been implemented in Ireland; describe

some of the goals of PRIMROSE and MARRISK; and, present how PLOCAN could incorporate the Knowledge Output into their own HAB monitoring and research programmes.

For the North African region, **COLUMBUS** identified the Intergovernmental Oceanographic Commission (IOC) network on Harmful Algae in North Africa (HANA) group as the ideal Target User; however, the Knowledge Fellow struggled to make direct contact. This branch of the Knowledge Transfer activity was routed to Beatriz Reguera, who had worked on ASIMUTH, was a member of PRIMROSE, and the editor of IOC-HAB's Harmful Algae News. **COLUMBUS** worked with Beatriz to outline ideas for how the Knowledge Output might be used by HANA to bypass some of their resource and funding difficulties.

STEP 4

Transfer –
Developing a KTP
Jul – Aug 2017

Knowledge Output Pathway

COLUMBUS recognised that the success of the monitoring structure provided by ASIMUTH might be replicable in other regions. Furthermore, it was reasoned that if the system was spread to other regions it would provide an improved capability to forecast HABs, particularly those from warmer waters.

The intended eventual impact of this Knowledge Output Pathway is: to develop an improved, more active, user-focused network of HAB monitoring and forecasting – one that covers Europe and its adjoining regions.

STEP 2
Analysis –
Developing a KOP
Apr – May 2017

The pathway to achieving this eventual impact would require:

1. Expanding application beyond Ireland through new, industry-focused projects, targeting first those European Atlantic waters with similar profiles and where the modelling will be the most similar.
2. Expanding application to adjacent regions, particularly those that are most at risk to HABs or countries where native HABs may pose a future threat to European Union waters, such as Macaronesia and North Africa, through either the establishment of ASIMUTH-like projects, or else by incorporating the outputs from ASIMUTH and similar projects into current operating procedures.



STEP 5
KT activity and
measure impact
Sep 2017 –
Feb 2018

Measured Impact

Much of the impact of this Knowledge Transfer remains to be seen. However, the activity is continuing and there have been positive results which suggest the Knowledge Output is continuing to progress towards the Eventual Impact:

- In Macaronesia, PLOCAN has plans to develop their HAB programme and researchers there have expressed their interest in incorporating aspects of ASIMUTH into those efforts once funding and resources are available. The Target User has also raised the matter to senior decision makers.
- The **COLUMBUS** plan for HANA was brought up to the Chair of IOC-HAB who agreed that the Knowledge Output could find application in HANA. COLUMBUS is currently working with the Knowledge Owner and a Target User from IOC-HAB to develop a plan for adapting aspects of the Knowledge Output to HANA's scientific and resource requirements.
- **COLUMBUS** met with representatives from the newly-started projects PRIMROSE and MARRISK who agreed that as these projects moved forward they would evaluate any potential aspects that could be useful to PLOCAN or HANA.

Next Steps

COLUMBUS will hold a final meeting with PRIMROSE, MARRISK, and the IOC-HAB to outline the Knowledge Output Pathway we believe to be most likely to generate impact: the drafting of a project proposal; development of a policy brief aimed at securing funding or resources for the Target User; incorporation of aspects of the Knowledge Output into current monitoring efforts in either HANA or PLOCAN; and, an agreement between the Target User and PRIMROSE or MARRISK to include the Target User as an observer in project activities.

USING HUMAN DIAGNOSTICS TECHNOLOGY TO SCREEN FOR CHEMICALS IN THE ENVIRONMENT

**THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT
- A DEVICE DESIGNED TO BE USED IN HUMAN
DIAGNOSTICS - BE REFOCUSED THROUGH A PLANNED
PROJECT AIMED AT APPROPRIATING THE DEVICE FOR
SCREENING AQUATIC ENVIRONMENTS AND SEAFOOD
FOR HARMFUL CHEMICALS.**

The Assessment and Potential Human Impact of Exposure to Environmental Contaminants on Marine and Freshwater Bivalves was a five-year project funded by the Irish Government's National Development Plan 2007-2013 under their Science, Technology, Research and Innovation for the Environment (STRIVE) Developing Environmental Research Potential (DERP) scheme. It sought to "report on the spatial occurrence and relative distribution of pharmaceutical residues in the Irish marine environment and their bioaccumulation potential."

**OVERALL IMPACT OF COLUMBUS: FACILITATED
AN AGREEMENT TO CONSIDER OPTIONS
FOR FURTHERING THE ENVIRONMENTAL
MONITORING POTENTIAL OF THE
KNOWLEDGE OUTPUT**

"I want to thank COLUMBUS for arranging this meeting and helping me find others who are willing to work on these topics. Often the alternative seems to be cold-calling, which is tough to do and much less effective."

Dr Brian Quinn, Reader in Ecotoxicology,
University of the West of Scotland

MARINE BIOLOGICAL
RESOURCES



Knowledge Need

Pharmaceutical waste from both manufacturing plants and human effluent has increasingly been identified as a source for “contaminants of emerging concern” in freshwater and marine environments within the European Union. As such, there is a growing need for tools which can effectively screen for these (and other) chemicals; particularly in fishery and aquaculture environments where they pose a threat to human health through contaminated seafood. However, detection and identification of chemicals either in the environment or in organic matter often requires equipment that is highly advanced, expensive and difficult to access. This means that current screening techniques employed by many environmental monitors rely on collecting samples which get sent back to a central laboratory where processing can be delayed by competing demands, transportation time, and resources. This process limits the ability and responsiveness of environmental monitors to both identify and find solutions to chemical contamination. This means a more convenient method to evaluate contamination would be highly sought after.

Knowledge Output

The Knowledge Output is a lightweight, portable device that allows for on-the-spot diagnostics of biomarkers to evaluate chemical contamination levels. To date this screening has focused on chemicals known to be associated with pharmaceutical waste, particularly anti-biotics. This technique is based on the adaptation of human diagnostic techniques for environmental monitoring. It conducts an analysis of tissue and hemolymph (a fluid equivalent to blood in most invertebrates) extracted from the marine blue mussel (*Mytilus* spp.) to identify chemicals in the marine environment. The device is high-throughput and relatively easy to train someone on, all of which make it ideal for monitoring agencies.

STEP 1

Collection
Mar 2017

STEP 3

Analysis – Profiling
Target User
Jul – Aug 2017

Knowledge Transfer Activity and Target Users

Target Users of this Knowledge Output were identified as Ioanna Katsiadaki and Ben Maskrey – the lead investigators of physiology, endocrinology and toxicology at the **Centre for Environment, Fisheries and Aquaculture Science (CEFAS)**. Although the Knowledge Output had been tested in field experiments, **COLUMBUS** recognised that for the device to be effective in a regulatory monitoring context – and for an expanded list of chemicals – further research might be required before continuing field trials. During the first phase of the Knowledge Transfer Activity, the

Target User confirmed that from their own experience in the subject area it would indeed be better in the long term if prior to field trials they collaborated with the Knowledge Owner on a research project focused specifically on the device and its applications. This will enable the researchers to calibrate the device to the chemicals of most concern to monitoring agencies and will also establish a more thorough scientific base on which to build the industrial application. In terms of the Knowledge Output Pathway, this meant that step two was deemed necessary.

STEP 4

Transfer –
Developing a KTP
Sep 2017

Knowledge Output Pathway

Whilst originally intended for monitoring purposes, the technology is currently being used to monitor fish health. **COLUMBUS** recognised there were mainly broader applications for the Knowledge Output within marine monitoring.

The intended eventual impact of this Knowledge Output Pathway is: to enable faster, cheaper and easier monitoring of pharmaceutical contaminants in freshwater and marine environments.

STEP 2
Analysis –
Developing a KOP
Apr – Jun 2017

The pathway to achieving this eventual impact would require:

1. Stimulating collaboration with marine and seafood monitoring and research agencies to assess requirements to enable the device to be fit-for-purpose for marine monitoring purposes.
2. If necessary, carry out further research and testing to further develop the Knowledge Output's potential application to marine and seafood monitoring.
3. Trialling the Knowledge Output in a marine and seafood monitoring capacity.
4. Distributing of the device and training its future users within marine and seafood monitoring.



STEP 5
KT activity and
measure impact
Nov 2017 –
Feb 2018

Measured Impact

- It was agreed that the Knowledge Owner would supply the Target User with relevant data from his monitoring research, so the Target User could compare this with their own work in the field.
- Both Target User and Knowledge Owner are investigating funding mechanisms for establishing a new joint research project based on their collective findings.
- The Knowledge Owner and Target User have arranged to meet to decide the details of this new project. Details that need to be discussed include thoughts on ultimate application of the Knowledge Output, potential industry/government/academic partners, and near and long-term goals.

Next Steps


COLUMBUS will remain involved with the knowledge owner until the end of February 2018 (project end) and will be assisting in the evaluation of potential funding mechanisms and partners. Once funding has been procured, the device will be tested and evolved. This will support an industrial application and commercialisation.

ENGAGING REGIONAL POLICY MAKERS IN MARINE LITTER PREVENTION

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT OF PRACTICAL SOLUTIONS TO PREVENT MARINE LITTER INSPIRE A LOCAL ENVIRONMENTAL CAMPAIGN. THIS CAMPAIGN AIMED TO STIMULATE AWARENESS AND SHARED RESPONSIBILITY OF OUR OCEANS AND COASTLINES.

The project **CleanSea**, coordinated by Stichting VU (Netherlands), aimed to generate new information on the impacts (biological, social and economic) of marine litter and used this information to develop novel tools for collecting and monitoring litter, as well as protocols for monitoring data.

OVERALL IMPACT OF COLUMBUS: ESTABLISHING A REGIONAL MARINE ANTI-LITTER CAMPAIGN BASED ON SCIENCE-DRIVEN BEST PRACTICES



“Through COLUMBUS we received information about ready-to-use results from CleanSea. The information has helped us to shape a new local campaign on ghost gear on the Dorset and East Devon Coast.”

Matilda Manley, Litter Free Coast and Sea
and Litter Free Dorset Project Co-ordinator

Knowledge Need

Marine litter is a huge societal challenge, and one that continues to grow in scale. Environmentalists, non-governmental organisations (NGO) and governmental bodies have spent increasing effort and funds over the past few years to raise awareness of and respond to a growing body of scientific literature that highlights the damage caused by marine litter around the world. To ensure that these efforts are effective, the continued assessment of existing and potential techniques for combatting marine litter is essential. Only through the continued improvement on current best practices will policies at the local, regional and national level be able to effectively tackle the currently-untenable marine litter problem.

Knowledge Output

The **CleanSea** brochure, "Policy options for litter-free seas", contains a set of practical and effective regulatory and economic instruments as well as co-management initiatives for addressing marine litter. It aims to provide interest groups with practical policy options and measures to support progress towards marine litter reduction, that can be tailored to regional specificities and priorities. The options presented emerged from a coordinated assessment of the most promising policy options, measures and best practices implemented in Europe or being considered at national and regional levels. It also includes proposals for actions based on social, technological or institutional innovations obtained from **CleanSea** hosted consultations with stakeholders.

STEP 1

Collection
Feb 2016

STEP 3

Analysis - Profiling
Target User
May 2017

Knowledge Transfer Activity and Target Users

The first target user of the project was identified as Litter Free Coast and Sea (LFCS) – an organisation set up to clean the seas and coasts of Dorset and East Devon. The second target user was identified as the Fisheries Local Action Group (FLAG).

COLUMBUS organised a meeting in Devon where both target users were in attendance. During this meeting, the target users were introduced to the Knowledge Output and the potential of incorporating its findings on a local level.

STEP 4

Transfer –
Developing a KTP
Aug 2017

Knowledge Output Pathway

COLUMBUS determined the best approach would be to pilot the initiative on a small scale to highlight the effectiveness and appropriateness of using the recommendations found in the **CleanSea** brochure.

The intended eventual impact of this Knowledge Output Pathway is: to involve political stakeholders in marine litter prevention campaigns.

STEP 2
Analysis –
Developing a KOP
May 2017

The pathway to achieving this eventual impact would require:

1. Identifying local campaigners in the Dorset coastal area with an interest in reducing marine litter.
2. Developing the concept of a local campaign – i.e. deciding on the content, who to involve and an appropriate timeframe.
3. Instigating a local campaign by involving political stakeholders in marine litter prevention.
4. Showcasing the case study to other Member States to stimulate further marine litter prevention programs at a local, regional, national and international level.



STEP 5
KT activity and
measure impact
Aug 2017

Measured Impact

The managers of the LFCS campaign were very happy to receive ready-to-use results from **CleanSea** since they do not have the facilities to start their own research projects or to collect data. They rely on the collaboration with partners from local universities and partners from local/regional authorities to get new campaigns started, as well as the support of volunteers. Following **COLUMBUS**' interaction, LFCS began planning a new local campaign on ghost fishing gear (fishing gear that has been lost, dumped or abandoned) on the Dorset and East Devon Coast. FLAG agreed to use regional resources to fund the campaign.

Next Steps

LFCS are developing applications to receive further funding for additional Knowledge Transfer activities. If successful, secondary projects will be delivered by the end of 2018.

PROJECTS

CleanSea | Towards a Clean, Litter-Free European Marine Environment through Scientific Evidence, Innovative Tools and Good Governance | www.cordis.europa.eu/project/rcn/106632_en.html | FP7-ENV-2012-two-stage | Project ID: 308370

Value: €3.8 million (European Commission contribution: €3.0 million)

Timeline: Jan 2013 – Dec 2015

COMPETENCE NODE LEADER

Environment & Futures | **Project Management Jülich** | Rostock, Germany | www.ptj.de

CREDITS

Caren Krüger (**Project Management Jülich**)

EDUCATIONAL MATERIAL ON THE IMPACT OF PLASTIC LITTERING IN MARINE ENVIRONMENTS

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT OF EDUCATIONAL MATERIAL TRANSFERRED TO GERMAN SCHOOL CHILDREN. THE GOAL WAS TO RAISE PUBLIC AWARENESS AND ENCOURAGE RESPONSIBILITY REGARDING THE IMPACTS OF MARINE LITTER.

The **MARLISCO** project (Marine Litter in European Seas – Social Awareness and Co-Responsibility) was coordinated by Provincia di Teramo (Italy). It was established to promote public awareness and a sense of shared responsibility for the management of marine litter.

OVERALL IMPACT OF COLUMBUS: MARINE LITTER EDUCATIONAL MATERIALS ADOPTED BY GERMAN SCHOOL SYSTEM

“COLUMBUS helped us to prove that our educational material provides a solid basis for teacher training seminars.”

Anke Vorlauf, Coastal Union Germany (EUCC-D)

Knowledge Need

Marine litter is a serious and well-recognised issue. The public has become aware of its impact on the marine ecosystem through recent media reports. However, relevant stakeholders on all levels lack knowledge on potential solutions and proper action. **MARLISCO** recognised that marine topics and the impacts of pollution are especially under-represented in schools' curricula. **MARLISCO** aimed to engage citizens – with a focus on producing Education material for 10 to 15-year olds – in these vital topics and help demonstrate the enormous societal benefit of looking after our oceans.

Knowledge Output

To increase the literacy of 10- to 15-year olds on the dangers of marine litter, a **MARLISCO** educational pack ("Know Feel Act! To Stop Marine Litter") was developed. This pack was designed to engage students and create a better understanding of the importance of cleaner, healthier marine ecosystems. It has been made available in 14 languages and enables teachers and students to discuss the impact of marine littering in a stimulating manner. The pack can be adopted in schools – especially for general subjects like Geography – and professional training seminars for teachers. It can also be used by educators outside the formal schooling system and directed towards those that lie outside the 10- to 15-year old age bracket if necessary.

STEP 1

Collection
Jun 2016

STEP 3

Analysis – Profiling
Target User
Nov 2016

Knowledge Transfer Activity and Target Users

COLUMBUS determined the best approach was to pilot the initiative in one European Member State, then use this as a best practice example and enable its replication across Europe. Scientists, teachers and representatives from German regional ministries of education took part in a workshop organised by **COLUMBUS** in Rostock, Germany on 17 November

2016. In this workshop, the educational pack was presented. Those present discussed methods of implementing the educational material into German schools. The first teacher training was conducted in February 2017 in Rostock where over 20 teachers attended. Further projects and seminars took place in Kiel during 2017, with more planned to commence in 2018.

STEP 4

Transfer –
Developing a KTP
Mar 2017

Knowledge Output Pathway

COLUMBUS believed that as the **MARLISCO** educational pack is very comprehensive, after attending a brief seminar on the material, teachers will be able to start the educational process with their students right away.

The intended eventual impact of this Knowledge Output Pathway is: to use the **MARLISCO** educational pack to raise awareness and knowledge of the problem of marine litter.

The pathway to achieving this eventual impact would require:

1. Bringing together stakeholders from ministries, teachers and further education experts to determine how to include the **MARLISCO** educational pack into current curricula.
2. Adapting the Educational material depending on the kind of school or age of the school children.
3. Organising teaching seminars to introduce the educational pack to teachers.

STEP 2

Analysis –
Developing a KOP
Sep 2016



STEP 5

KT activity and
measure impact
Nov 2017

Measured Impact

A wide range of teachers in Northern Germany are now aware of the existence of the **MARLISCO** educational material. The material itself and teacher seminars are part of follow-up projects funded by national programmes. Teachers have been making use of the educational packs directly, thus helping achieve the goal of sparking awareness and creating a sense of co-responsibility with regards to marine litter.

Next Steps

The **MARLISCO** educational packs will be adapted to Target Users and used during several teacher training seminars, especially in German coastal states.

PROJECTS

MARLISCO | Marine Litter in European Seas - Social Awareness and Co-Responsibility
www.marlisco.eu | FP7-SCIENCE-IN-SOCIETY | Project ID: 289042

Value: €4.5 million (European Commission contribution: €4.1 million)

Timeline: Jun 2012 – May 2015

COMPETENCE NODE LEADER

Environment & Futures | **Project Management Jülich** | Rostock, Germany | www.ptj.de

CREDITS

Careen Krüger, Lydia Gustavs (**Project Management Jülich**)

NEW EXHIBITION ON THE ENVIRONMENTAL IMPACTS OF PLASTIC WASTE

THIS CASE STUDY HAS FOSTERED THE UPTAKE OF UP-TO-DATE RESEARCH RESULTS ON MARINE LITTER TO FULFIL A COMMITMENT PROPOSED AT THE G7 SUMMIT.

This case study concerns the accumulation of Knowledge Outputs produced by four European Union-funded projects focused on combatting marine litter: **COMMON SENSE**, **CleanSea**, **MARLISCO** and **Sea Change**.

OVERALL IMPACT OF COLUMBUS: CONTRIBUTED TO THE CREATION OF A TRAVELLING INTERACTIVE EXHIBIT TO EDUCATE PEOPLE ON MARINE PLASTIC WASTE

“Thanks to COLUMBUS the compilation of suitable exhibition material was enlarged by drawing knowledge from EU-funded research projects.”

Dr. Julia Schnetzer, Campaign Manager, Ocean Plastics Lab

**MARINE ENVIRONMENT
AND FUTURES**



Knowledge Need

Marine litter is a global challenge and was specifically addressed as such in 2015 at the G7 summit in Germany. As an Annex to the Leaders' Declaration of G7 2015, a "G7 Action Plan to Combat Marine Litter" was set up, with Germany and the Federal Ministry of Education and Research as primary instigators from the very beginning. One of the areas highlighted in this action plan is public engagement, both through a reduction of plastics use and discard in daily life as well as by making scientific endeavours to reduce plastic waste more accessible.

Knowledge Output

COLUMBUS recognised that four Knowledge Outputs from the European Commission's 7th Framework Programme for Research and Technical Development (FP7) projects dealing with marine litter would be valuable when combined as a cluster:

- **COMMON SENSE**'s "Microplastic Analyser" is a new, state-of-the-art analytical method with the possibility to standardising real-time measurements of microplastics
- **CleanSea**'s documentary film, available on YouTube, entitled "CleanSea, a scientific voyage into the problem of marine litter and what we can do about it".
- **MARLISCO**'s guide for reducing marine litter, "Stopping Marine Litter Together!"
- **Sea Change**'s infographic on plastic in the marine environment'

STEP 1

Collection
Nov 2015 –
Jun 2016

STEP 3

Analysis – Profiling
Target User
May 2017

Knowledge Transfer Activity and Target Users

The Target Users were the Ocean Plastics Lab as well as its funders, the Germany and the Federal Ministry of Education and Research and the German Marine Research Consortium (KDM) – a partner for the identification of new research fields and for the development of international research strategies. As a G7 follow-up activity, German funding agencies,

BMBF and KDM, initiated the Ocean Plastics Lab project. Hundreds of results from research institutions, non-governmental organisations and current recently finished projects were screened, assessed and made ready for being presented at the exhibition.

COLUMBUS provided collected Knowledge Outputs from marine litter projects for display in the exhibit.

STEP 4

Transfer –
Developing a KTP
Oct 2017

Knowledge Output Pathway

COLUMBUS team recognised an opportunity to showcase these remarkable results in the travelling exhibition, Ocean Plastics Lab, which is a national project funded by the Federal Ministry of Education and Research in Germany (BMBF). This exhibition intends to raise awareness among visitors and political stakeholders of the Knowledge.

The intended eventual impact of this Knowledge Output Pathway is: to raise awareness of marine litter research and get political stakeholders to enhance the impact of marine litter related research.

The pathway to achieving this eventual impact would require:

1. Transferring the related research to the campaign manager of the Ocean Plastics Lab.
2. Expanding the travelling exhibition with the Knowledge Outputs.

STEP 2

Analysis –
Developing a KOP
May –
July 2017



STEP 5

KT activity and
measure impact
Dec 2017

Measured Impact

The Ocean Plastics Lab opened its doors to the public for the first time in Turin, Italy, during the meeting of the G7 science ministers. It was inaugurated on the 27th September by Johanna Wanka (German Federal Minister of Education and Research), Carlos Moedas (EU Commissioner for Research, Science and Innovation), and Mauro Laus (President of the Regional Council of Piedmont). The exhibition spans four 20-foot containers with exhibits and contributions from more than 50 projects and institutions from five continents. After Turin, the exhibition tour stopped in Paris from 4th-17th November 2017.

The selected Knowledge Outputs from **MARLISCO**, **COMMON SENSE** and **CleanSea** were incorporated in the exhibition Ocean Plastics Lab. The number of visitors (high-level politicians and the public) to the exhibition exceeded expectations – more than 5,000 each in Turin and Paris.

Next Steps

For 2018 and beyond, further stops are planned in Brussels, Washington D.C. and Berlin. If further material suitable for exhibition is fostered it can be included into the digital archive of the Ocean Plastics Lab. As a national funded project, the Ocean Plastics Lab will be supported until 2020.

PROJECTS

COMMON SENSE | Cost-effective sensors, interoperable with international existing ocean observing systems, to meet eu policies requirements | www.commonsenseproject.eu

FP7-OCEAN-2013 | Project ID: 614155

Value: €6.1 million (European Commission contribution: €4.7 million)

Timeline: November 2013 – February 2017

MARLISCO | MARine Litter in Europe Seas: Social Awareness and CO-Responsability

www.marlisco.eu | FP7-SCIENCE-IN-SOCIETY-2011-1 | Project ID: 289042

Value: €4.5 million (European Commission contribution: €4.1 million)

Timeline: June 2012 – May 2015

CleanSea | Towards a Clean, Litter-Free European Marine Environment through Scientific Evidence, Innovative Tools and Good Governance | www.cordis.europa.eu/project/rcn/106632_en.html

| FP7-ENV-2012-two-stage | Project ID: 308370

Value: €3.8 million (European Commission contribution: €3.0 million)

Timeline: January 2013 – December 2015

Sea Change | www.seachangeproject.eu | H2020-BG-2014-1 | Project ID: 652644

Value: €3.5 million (European Commission contribution: €3.5 million)

Timeline: March 2015 – February 2018

COMPETENCE NODES

Environment & Futures | **Project Management Jülich** | Rostock, Germany |

www.ptj.de/en/start

CREDITS

Careen Krüger, Lydia Gustavs (**Project Management Jülich**)


INNOVATIVE SOLUTIONS FOR THE PACKAGING INDUSTRY USING MATERIAL MADE FROM CRUSTACEANS

THIS CASE STUDY HAS ANALYSED ALTERNATIVE PACKAGING DERIVED FROM CHITOSAN-BASED MATERIAL (A SUBSTANCE MADE BY TREATING THE CHITIN SHELLS OF CRUSTACEANS WITH AN ALKALINE), IDENTIFIED TARGET GROUPS AND FOSTERED THE KNOWLEDGE TRANSFER PROCESS.

The **N-CHITOPACK** project was coordinated by MAVI SUD S.R.L in Italy. This EU-funded project aimed to use chitin nanofibrils (miniature biopolymers) to produce antibacterial and biodegradable bioplastics for food packaging.

The **CHIBIO** project was coordinated by The Fraunhofer Society in Germany. This EU-funded initiative tackled shell waste and aimed to determine a use for every component of shell waste and to process chitin in more sustainable ways.

OVERALL IMPACT OF COLUMBUS: RECOGNISED NEED FOR FURTHER RESEARCH TO BRING SUSTAINABLE PACKAGING TO MARKET



“While aiming for a circular economy it is absolutely necessary to explore alternative materials for the packaging industry. Chitosan derived packaging products from crustacea waste could be one opportunity. But as long as the production costs are not economically compatible political regulations might be indispensable.”

Prof. Leif Alexander Garbe, Chemistry Professor at the University of Applied Science Neubrandenburg

Knowledge Need

Plastic food packaging poses a great hazard to the environment. Plastic is traditionally made from unsustainable petrochemicals, making it non-biodegradable and contributing to the global waste problem. The food sector (including beverage industry) accounts for approximately two thirds of global packaging and about 50% of these packages are made of plastics. The seafood industry is an immense sector; and so is its associated waste. Much of this waste is related to chitin: a fibrous substance and a major constituent in the exoskeleton of arthropods and the cell walls of fungi. The **N-CHITOPACK** project reported that chitin waste exceeds 250 billion tonnes per year and is considered hazardous due to its high perishability and polluting effect, both on land and sea.

Knowledge Output

Chitin from seafood waste is used to make chitin nanofibrils, a bio-based polymer, to produce new, completely biodegradable films. Both flexible and rigid food packaging were realised proving the concept of industrially produce durable, environmentally-friendly packaging.

STEP 1

Collection
Apr 2016 –
May 2017

STEP 3

Analysis – Profiling
Target User
Mar 2017

Knowledge Transfer Activity and Target Users

The **N-CHITOPACK** results were transferred, via email and teleconferencing, to a Target User, Prof. Garbe from the University of Applied Science Neubrandenburg. Prof. Garbe is also the director of ZELT (Centre of Nutrition and Food Technology) and of the company Food Production NB GmbH.

STEP 4

Transfer –
Developing a KTP
May – Dec 2017

Knowledge Output Pathway

COLUMBUS worked with the project coordinators and partners and determined that further research would be required for the alternative packaging material to be ready to use by the packaging industry.

The intended eventual impact of this Knowledge Output Pathway is: to provide alternative material for the packaging industry that is environmentally and utilising waste materials

The pathway to achieving this eventual impact would require:

1. Carrying out further research to optimise the material for the packaging industry
2. Compiling information on development costs, competitors, and provision of raw material
3. Bringing the alternative packaging material to market and highlighting its benefits to industry

STEP 2

Analysis –
Developing a KOP
May 2017



STEP 5

KT activity and
measure impact
Mar – Sep 2017

Measured Impact

Further applications of the raw material were discussed with the Target User, and potential project ideas were developed. However, due to intellectual property rights protection, and the identified need for further research on processing, the End User (the packaging industry) was difficult to reach during the lifetime of **COLUMBUS**.

Next Steps

No further steps are planned within **COLUMBUS**.

The results of **CHIBIO** were incorporated into a follow-up project (ChitoTex) on textile products from insects, while **N-CHITOPACK** is the partner of a new Horizon 2020 project called **POLYBIOSKIN** which started in 2017.

PROJECTS

N-CHITOPACK | Sustainable technologies for the production of biodegradable materials based on natural chitin-nanofibrils derived by waste of fish industry, to produce food grade packaging www.cordis.europa.eu/project/rcn/105848_en.html | FP7-SME-2012 | Project ID: 315233

Value: €1.2 million (European Commission contribution: €0.9 million)

Timeline: November 2012 – October 2014

CHIBIO | Development of an integrated biorefinery for processing chitin rich biowaste to specialty and fine chemicals | www.chibiofp7.fraunhofer.de | FP7-KBBE-2011-5 | Project ID: 289284

Value: €4.0 million (European Commission contribution: €2.9 million)

Timeline: November 2011 – October 2014

COMPETENCE NODES

Environment & Futures | **Project Management Jülich** | Rostock, Germany | www.ptj.de/en/start

CREDITS


Careen Krüger, (**Project Management Jülich**)

INNOVATIVE TOOLS COMBINED TO SUPPORT QUALITY ENVIRONMENTAL IMPACT ASSESSMENTS IN MARINE ENVIRONMENTS

THIS CASE STUDY HIGHLIGHTS TWO KNOWLEDGE OUTPUTS THAT HAVE BEEN TESTED FOR APPLICATION BEYOND THEIR ORIGINAL INTENDED USE WITHIN THE SCOPE OF THE MARINE STRATEGY FRAMEWORK DIRECTIVE (MSFD).

The **DEVOTES** project (DEvelopment Of innovative Tools for understanding marine biodiversity and assessing good Environmental Status) was funded by the European Commission 7th Framework Programme from 2012-16. Coordinated by AZTI (Spain), an overarching objective of **DEVOTES** was to support the implementation of the Marine Strategy Framework Directive (MSFD), which aims to protect the marine environment.

OVERALL IMPACT OF COLUMBUS: CONFIRMED APPLICABILITY OF THE TOOL FOR IMPACT ASSESSMENTS



“Although DEVOTES has made a great effort to transfer the knowledge to the end users, COLUMBUS has enhanced this task by identifying new end users and by collaborating in a coordinated action between projects to enable the transfer of the knowledge in a more effective way.”

Dr Ángel Borja, DEVOTES Project Coordinator and Researcher at AZTI-Tecnalia, Spain

MARINE GOVERNANCE
AND MANAGEMENT



Knowledge Need

Environmental Impact Assessments (EIAs) ensure that the implications of any environmental decision are thoroughly considered before any such decision is made. EIAs can be undertaken for individual projects, such as development of a dam, motorway, airport or factory. Strategic Environmental Assessment (SEAs) are similar to EIAs except they pertain to plans or programmes for the public. The purpose of both assessments is to ensure that plans, programmes and projects that are likely to significantly affect the environment are subject to environmental assessment prior to their approval. Both EIAs and SEAs require an environmental report to be prepared. Carrying out both EIAs and SEAs require significant effort and cost. Not conducting EIAs and SEAs on a project is a breach of EU Directives. If this happens, activity on the project is forbidden to continue.

Knowledge Outputs

The Nested Environmental status Assessment Tool (NEAT) is a software created by **DEVOTES** to assess the environmental status of European seas, developed mainly by Aarhus University, Niva Denmark and Mari Lin. It functions by providing a value that represents the combined status of a range of environmental data (including indicators of “Good Environmental Status” that align specific ecosystem and habitat descriptors). The software was designed to support the implementation of the MSFD by environmental authorities of the European Union and the equivalent environmental programmes by the Regional Sea Conventions. To achieve greater efficiency, NEAT integrates a second Knowledge Output: the DEVOTool catalogue of Marine Biodiversity Indicators. This catalogue includes more than 500 indicators for assessing marine biodiversity and other relevant descriptors.

STEP 1

Collection
Nov 2015

STEP 3

Analysis - Profiling
Target User
Mar - Apr 2016

Knowledge Transfer Activity and Target Users

As both tools (NEAT and DEVOTool) were available and ready-to-use, a workshop was organised in which the knowledge owners and potential target users explored the suitability and benefits of using the tools for EIAs and SEAs in a marine context. Any improvements that could be made to the tool to support the new application were also discussed.

The event was organised to confirm the full relevance of NEAT in a complementary niche market and to promote the tool's usage by those in attendance. The **COLUMBUS** team in CETMAR (Vigo, Spain) was

responsible for organising the event. They identified and invited target users to a workshop held on 29 July 2016.

24 potential target users attended the workshop, including researchers, non-governmental organisations, environmental consultants, a representative from the Galicia Regional Government, and staff from two Galician Fishing Associations. Among the speakers at the event were **DEVOTES** partners, Dr Ángel Borja and Dr María Uyarra, and the technical advisor to the Spanish Ministry of Agriculture, Food and Environment.

STEP 4

Transfer -
Developing a KTP
Apr 2016

Knowledge Output Pathway

COLUMBUS investigated the value in combining NEAT and DEVOTool for planners obliged to carry out EIAs and SEAs using the best available scientific knowledge.

The intended eventual impact of this Knowledge Output Pathway is: to improve the efficiency and reliability of carrying out EIAs and SEAs using a tool that aids interpretation of the data provided by users.

The pathway to achieving this eventual impact would require:

1. Confirming that it fulfils a need for identified end users (marine project planners).
2. Piloting the combined tools and validating whether they are applicable for completing impact assessments, rather than assessing the status of the marine environment.
3. Facilitating and promoting access to the tool in other EU Member States.
4. Developing training materials and provision of training to ensure end users understand how to appropriately use the tools.

STEP 2

Analysis –
Developing a KOP
Jan – Feb 2016



STEP 5

KT activity and
measure impact
Jun 2016

Measured Impact

Three months after the event, attendees were surveyed to measure any uptake of the tools, as well as feedback on the effectiveness of the knowledge transfer workshop in terms of focus, relevance and suitability. All 24 attendees saying they would use the tool in the field, four of which intending to use the tool in the immediate future.

The training materials have been made available on the **DEVOTES** website to allow future target users to access the information.

Initial piloting of the tools has been completed by the Galicia Regional Ministry of the Sea to assess the abundance of marine resources along the Galician coast. It has been proposed that Galicia's Regional Government will also use the tool to understand the status of areas that require assessment by the Galician Fishing Guilds.

Next Steps

The combined efforts of **DEVOTES** partnership to disseminate NEAT and the efforts by **COLUMBUS** to transfer the tool to different user profiles, demonstrate the versatility of the tool. The dissemination of knowledge transfer experiences is expected to inspire further knowledge uptake.

PROJECT

DEVOTES | DEvelopment Of innovative Tools for understanding marine biodiversity and assessing good Environmental Status | www.devotes-project.eu | FP7 – ENVIRONMENT
Project ID: 308392

Value: €12.1 million (European Commission contribution: €9.0 million)

Timeline: Nov 2012 – Oct 2016

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | www.cetmar.org

CREDITS

Mónica Incera, Rosa Fernandez, Marisa Fernandez (**CETMAR**), María Uyarra, Ángel Borja (**AZTI**)

ACHIEVING GOOD ENVIRONMENTAL STATUS IN MARITIME PORTS

THIS CASE STUDY COMBINES TWO KNOWLEDGE OUTPUTS, TEAP AND TEIP, FROM THE PERSEUS AND PORTOPIA PROJECTS RESPECTFULLY, TO IMPROVE OR MAINTAIN GOOD ENVIRONMENTAL STATUS IN EUROPEAN MARITIME PORTS.

The **PERSEUS** project, coordinated by HCMR (Greece), was funded to identify the interacting patterns of natural and human-derived pressures on the Mediterranean and Black Seas and assess their impact on marine ecosystems.

The **PORTOPIA** project, coordinated by Vrije Universiteit Brussels (Belgium), aimed to create an integrated knowledge base and management system of port performance in maritime settings.

OVERALL IMPACT OF COLUMBUS: NEW APPLICATION OF TOOLS TO SUPPORT IMPACT ASSESSMENT IN PORTS

“The COLUMBUS project has been beneficial to TEAP and TEIP, as not only have the tools been upgraded as a result of the seminar, but COLUMBUS has enhanced TEAP and TEIP’s recognition as a useful tool, and is now known by many more stakeholders.”

Rosa Mari Darbra, Associate Professor, Chemical Engineering Department, Polytechnic University of Catalonia



Knowledge Need

Adopted in 2008, the MSFD aims to protect Europe's marine waters by applying an ecosystem-based approach to the management of human activities and achieving Good Environmental Status (GES) of the EU's waters by 2020. GES is defined by 11 descriptors. Member States are obliged to assess the environmental status of ports, identify any pressures ports are having on GES descriptors and their subsequent impacts, define environmental targets and monitoring programmes, and develop management measures towards achieving these goals.

Port activities have the potential to put multiple environmental pressures on GES descriptors. They may include the introduction of invasive species, contaminants, marine litter and underwater noise, and increase in eutrophication.

Knowledge Outputs

Two complementary computer-based tools can be used to identify the pressures that ports are having on GES descriptors and, consequently, can help port environmental managers design management plans to respond to identified pressures:

- **PERSEUS'** tool for the identification and assessment of Environmental Aspects in Ports (TEAP)
- **PORTOPIA's** tool for the identification and implementation of Environmental Indicators in Ports (TEIP)

Used together, significant environmental aspects of an individual port can be identified, supported by an exhaustive list of indicators for each environmental aspect. These indicators can be used to develop monitoring and management plans to improve or maintain the environmental status of the ports. The use of these tools can also help the official accreditation of the environmental standards of ports.

STEP 1

Collection
Dec 2015

STEP 3

Analysis - Profiling
Target User
Sep - Oct 2016

Knowledge Transfer Activity and Target Users

Since the combined tool required the validation of specialists, a web seminar was organised to present its dual application to targeted, knowledgeable influencers. The seminar not only functioned to inform attendees of the tool's existence, but also facilitated discussion on its applicability and usability for performing impact assessments. **COLUMBUS** identified and invited 17 key Target Users to a web seminar hosted in November 2016. Participants

included representatives from various Spanish port authorities, public bodies managing ports at regional level, environmental managers and consultants, researchers, and a port operating company.

The Knowledge Output developers, Rosa Mari Darbra and Martí Puig (Polytechnic University of Catalonia), presented the tools and examples of prior applications. Once familiarised with the tools, participants were invited to suggest improvements for consideration by the Knowledge Owners.

STEP 4

Transfer -
Developing a KTP
Oct 2016

Knowledge Output Pathway

COLUMBUS recognised the potential of combining these tools to be utilised by port managers and consultants in Europe. It was determined that their combined application needed to be validated with the potential end users before further development was carried out.

The intended eventual impact of this Knowledge Output Pathway is: to maintain or improve the environmental status of marine ports in line with mandatory regulations

STEP 2

Analysis –
Developing a KOP
Jun – Aug 2015

The pathway to achieving this eventual impact would require:

1. Confirming a need by port environmental managers and consultants (end users) for better identification of the pressures that ports are having on GES descriptors.
2. Confirming that the combined tool is a potential solution to this need (from the perspective of the end user).
3. Combining the tools to validate application and usability.
4. Implementing improvements based on end user feedback.
5. Generating online tutorials to a targeted audience.



STEP 5

KT activity and
measure impact
Nov 2016

Measured Impact

A post-Knowledge Transfer activity evaluation found that more than 40% of attendees confirmed an interest in using the tools in their operational context. They were:

- Three public bodies managing ports at a regional scale, one of which has already started using the tools in their operations.
- Three environmental consultancies and one researcher committed to using TEAP and TEIP in their future assessments.

100% of the attendants gave very positive comments on the content and development of the webinar and the applicability of the tools. They all found the experience extremely useful. In addition, six improvements were suggested by the participants and the tool has been updated accordingly. The webinar was also recorded and given to the Knowledge Output developers.

Next Steps

The development of massive online courses has been suggested to the Knowledge Output developers as a means of increasing the impact beyond the lifetime of **COLUMBUS**.

PROJECTS

PERSEUS | Policy-oriented marine Environmental Research for the Southern European Seas
www.perseus-net.eu | FP7 - ENVIRONMENT | Project ID: 287600

Value: €17.0 million (European Commission contribution: €13.0 million)

Timeline: Jan 2012 - Dec 2015

PORTOPIA | Ports Observatory for Performance Indicator Analysis | www.portopia.eu
FP7 - TRANSPORT | Project ID: 605176

Value: €4.3 million (European Commission contribution: €3.0 million)

Timeline: Sep 2013 - Aug 2017

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | www.cetmar.org

CREDITS

Mónica Incera, Rosa Fernandez, Marisa Fernandez (**CETMAR**), Rosa Mari Darbra and Martí Puig
(**Polytechnic University of Catalonia**)

EUROPEAN RESEARCH'S CONTRIBUTION TO THE ACHIEVEMENT OF GOOD ENVIRONMENTAL STATUS AND A STRONGER BLUE ECONOMY IN EUROPE

**THIS CASE STUDY COMBINES KNOWLEDGE
OUTPUTS TO INFORM THE EUROPEAN
COMMISSION (EC) ON THE CONTRIBUTION OF
RESEARCH TO MARINE AND MARITIME POLICY.**

The **STAGES** project (Science and Technology Advancing Governance on Good Environmental Status) is part of the European Commission's **7th Framework Programme for Research and Technological Development (FP7)**. It was coordinated by **CETMAR** (Spain) and funded to synthesise research relevant to the **Marine Strategy Framework Directive (MSFD)** – a European legislation adopted in 2008 to protect marine environments. The aim of the project was not only to make that research widely accessible, but also to identify a need for further research that could be used to help implement the MSFD.

OVERALL IMPACT OF COLUMBUS: ASSESSMENT OF POLICY-SUPPORTING EVIDENCE FROM FUNDED RESEARCH

“COLUMBUS contributed to increasing the impact of the STAGES project by upgrading some of its Knowledge Outputs according to the needs of the European Commission services.”

Marisa Fernandez, STAGES Project Coordinator and Head of the Control and Management of Marine Resources Area at CETMAR, Spain

MARINE GOVERNANCE
AND MANAGEMENT



Knowledge Need

The MSFD is a major part of the European Union's Integrated Maritime Policy. It aims to protect European marine waters by applying an ecosystem-based approach to the management of human activities, enabling sustainable use of our marine environments. The MSFD establishes a framework within which EU Member States must take the necessary steps towards achieving or maintaining Good Environmental Status (GES) in marine environments by 2020. For the MSFD to be successful, scientific research and subsequent knowledge uptake is vital. This is to ensure relevant decision makers are well versed on the matter, enabling positive environmental change to take place.

Europe has also developed the Blue Growth Strategy – a strategy to achieve smart, sustainable growth in Europe's marine and maritime sectors. The EC have highlighted five aspects of these sectors that promise high potential for sustainable jobs and growth: aquaculture, coastal tourism, marine biotechnology, ocean energy, seabed mining and maritime transport. These sectors (and some other relevant ones such as maritime transport, and fisheries) represent a large part of the “Blue Economy” – the marine and maritime economy that represents millions of jobs and generates billions of euros annually.

Knowledge Outputs

The prioritised Knowledge Outputs from **STAGES** were:

1. The **MSFD** component of the marine repository developed by EurOcean, the Marine Knowledge Gate (www.kg.eurocean.org) – an innovative tool which provides an inventory of **MSFD**-relevant marine science and technology projects and their Knowledge Outputs.
2. An overview of the **MSFD**-related research identified during STAGES's lifetime.
3. The **STAGES** “clustering tool” – a tool that groups research by relevant GES descriptors.

STEP 1

Collection
Oct 2015

STEP 3

Analysis – Profiling
Target User
n/a

Knowledge Transfer Activity and Target Users

Expanding on the efforts of **STAGES**, **COLUMBUS** performed an analysis of FP7's contribution to achieving GES and Blue Growth. A total of 1,242 FP7 funded projects were scrutinised. 993 of these projects were assigned to the Blue Economy activities (aquaculture, coastal tourism, marine biotechnology, ocean energy etc.) and marine regulations. The remainder were considered too generic in terms of the research activities they covered. From this, a synthesis report was then compiled documenting major findings and example reference projects to illustrate the conclusions reached. Within four months

all analysis was performed, and a synthesis report was produced: “Overview of FP7 projects relevant to major Marine and Maritime Regulations: **MSFD**, **MSPD** and **CFP** and Blue Growth Sectors”. A list of projects contributing to the Blue Economy sectors (aquaculture, coastal tourism, marine biotechnology, ocean energy, sea bed mining and maritime transport) and a list of projects contributing to marine policies (including the MSFD) were also provided to the EC by COLUMBUS's Desk Officer, Marco Weydert.

STEP 4

Transfer –
Developing a KTP
n/a

Knowledge Output Pathway

Together, these Knowledge Outputs can provide a combined understanding of the status of the science relevant to **MSFD**. They also represent a system that is able to organise, filter and synthesise large amounts of FP7 projects. Combined with Knowledge Outputs that were collated and processed by **COLUMBUS** (from 914 projects), they could be assessed to provide a 'review of the current understanding' for the Marine Resources Unit of the EC's **Directorate-General for Research and Innovation (DG Research and Innovation)**.

STEP 2

Analysis –
Developing a KOP
n/a

The intended eventual impact of this Knowledge Output Pathway is: to provide the Marine Research Unit at DG Research and Innovation with structured and synthesised information on how FP7 projects have contributed to Blue Economy activities.

The pathway to achieving this eventual impact would require:

1. Defining a project classification structure consisting of research areas and sub-areas.
2. Filtering keywords and classifications of all marine FP7 projects.
3. Compiling a synthesis report of major findings and example reference projects to illustrate conclusions to the EC.



STEP 5

KT activity and
measure impact
Mar 2017

Measured Impact

The report and the list of projects were delivered to the EC in March 2017. Through its Marine Resource Unit, DG Research and Innovation has been making use of the report and lists of relevant projects. Moreover, the clustering exercise – the combining of research produced by separate projects – has allowed CETMAR to identify interesting sub-clusters, feeding additional knowledge transfer efforts.

Next Steps

The final step in the KOP, the development of a synthesis report, was finalised and delivered to the end user, the European Commission. No further steps are proposed.

PROJECTS

STAGES | Science and Technology Advancing Governance on Good Environmental Status

www.stagesproject.eu | FP7 - ENVIRONMENT | Project ID: 308473

Value: €1.1 million (European Commission contribution: €1.0 million)

Timeline: Sep 2012 - Aug 2014

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | **www.cetmar.org**

CREDITS

Mónica Incera, Rosa Fernández, Marisa Fernández, Raquel Díez, Jose Luis Gómez, Pablo Fernández (**CETMAR**) and Cristina Costa (**EurOcean**).

SPECIALISED DATABASE TO ASSESS THE STATUS OF NON-INDIGENOUS SPECIES IN EUROPEAN SEAS

THIS CASE STUDY SHOWCASES HOW A KNOWLEDGE OUTPUT COULD ASSIST EUROPEAN UNION MEMBER STATES IN ASSESSING THE STATUS OF NON-INDIGENOUS SPECIES IN EUROPEAN WATERS.

The **VECTORS** project is part of the European Commission's 7th Framework Programme for Research and Technical Development (FP7). It was coordinated by Plymouth Marine Laboratory (United Kingdom) and funded to synthesise research relevant to the Marine Strategy Framework Directive (MSFD) – a European legislation adopted in 2008 established to protect marine environments. The project aimed to provide new knowledge to help govern and manage our seas in a holistic and considered way.

OVERALL IMPACT OF COLUMBUS: NATIONAL NIS DATABASES STRUCTURE ADOPTED BY SPAIN

“COLUMBUS contributes to the knowledge flows between developers of AquaNIS (a database developed within the EU FP7 project VECTORS) and end users, once the VECTORS project has ended, increasing its legacy.”

Sergej Olenin, AquaNIS developer and Professor at Coastal Research and Planning Institute, Klaipeda University (Lithuania)

**MARINE GOVERNANCE
AND MANAGEMENT**



Knowledge Need

The MSFD is a major part of the European Union's Integrated Maritime Policy. It aims to protect European waters by applying an ecosystem-based approach to the management of human activities, enabling the sustainable use of our marine environments. The MSFD establishes a framework within which EU Member States must take the necessary steps towards achieving or maintaining Good Environmental Status (GES) in marine environments by 2020. To help Member States interpret what GES means in practice, the Directive sets out eleven qualitative descriptors describing what the environment will look like when GES has been achieved. The second of these descriptors, the **MSFD Descriptor 2 (MSFD-D2)**, focuses on assessing the scale of the pressure and impacts of marine **non-indigenous species (NIS)**.

One of the crucial issues for dealing with the MSFD-D2, as well as global management of marine NIS, is ensuring the accuracy, veracity and quality of national and European NIS databases and information systems. These systems play a pivotal role in informing regional policy and management decisions as well as helping to identify resource priorities.

Knowledge Outputs

The **VECTORS** project has provided tools to support the development of strategies to mitigate and respond to changes in the marine environment. Among these tools is AquaNIS, a searchable database of aquatic non-indigenous and cryptogenic (of unknown origin) species and their distribution in European waters and neighbouring regions. Currently, the tool contains data on 1,455 marine, brackish and freshwater alien species involved in 4,502 introduction events in 19 large marine ecosystems of Europe and neighbouring regions.

An important feature of AquaNIS is that it can easily be extended with new modules, when necessary. The information system is equipped with a structured-search function for retrieval and organisation of using multiple and complex criteria. Yearly updates are made possible via data reported by the members of the International Council for the Exploration of the Sea (ICES) Working Group on Introductions and Transfers of Marine Organisms. This ensures that the data is quality-assured and that all relevant new observations are included. Taxonomy is based on the updated accounts in the World Register of Marine Species.

The structure of AquaNIS has been specifically built to assist Member States in MSFD-D2 assessments. However, it has also been demonstrated as useful for other purposes, such as the compliance with IMO Ballast Water Convention and other NIS-related regulations.

STEP 1

Collection
Nov 2015

STEP 3

Analysis - Profiling
Target User
June 2017 -
July 2017

Knowledge Transfer Activity and Target Users

COLUMBUS decided the best approach was to pilot the use of AquaNIS in one member state as a pilot for others to follow. The **COLUMBUS** team at **CETMAR** (Spain) organised a meeting with the involvement of the knowledge developer, University of Klaipeda (Lithuania), and three Target Users from Spain. These three Target Users were: the Spanish Ministry of Agriculture, Fisheries, Food and Environment; the Spanish Oceanographic Institute; and the Marine and Environment Science Centre of the University of Lisbon (Portugal). The meeting was held on the 6th September 2017 at the Headquarters of the Spanish Oceanographic Institute in Madrid, Spain.

In addition, another seven international experts attended and contributed to the discussions and conclusions. These experts included:

- Representatives of international scientific bodies (such as ICES)
- Representatives of the Regional Sea Conventions
- The European Commission's Joint Research Centre
- Representatives from the following relevant European NIS databases: The World Register of Introduced Marine Species (WoRMS); The European Alien Species Information Network (EASIN); and The Marine Mediterranean Invasive Alien Species (MAMIAS)

STEP 4

Transfer -
Developing a KTP
July 2017

Knowledge Output Pathway

COLUMBUS, with the support of international NIS experts, identified a new data structure that could potentially speed up the development of compatible, national information systems on marine NIS. Subsequently, AquaNIS can be expected to become a useful tool for supporting regional and cross-border cooperation and coordination in the context of MSFD-D2.

The intended eventual impact of this Knowledge Output Pathway is: to support Member States with assessment and reporting requirements for the MSFD-D2.

The pathway to achieving this eventual impact would require:

1. Confirmation that AquaNIS could be used to support reporting on MSFD-D2.
2. Transferring AquaNIS to organisations willing to exchange significant data on Marine NIS – in particular, organisations in charge of MSFD-D2.
3. Member States developing national NIS databases that are compatible with AquaNIS.
4. Utilisation of these national NIS databases to support reporting requirements for the MSFD-D2.

STEP 2

Analysis –
Developing a KOP
May 2017



STEP 5

KT activity and
measure impact
Sep 2017

Measured Impact

The Knowledge Transfer activity stimulated a constructive discussion on the major challenges regarding data and data management. Experts shared valuable insights on AquaNIS, as well as currently available databases - **EASIN**, **MAMIAS** and **WoRMS**. AquaNIS' Knowledge Owners agreed to promote the database features to Competent Authorities and operational performers implementing the MSFD-D2 in Spain.

Next Steps

The Marine Governance and Management Competence Node will support the Knowledge Owners correspondence with these Competent Authorities and operational performers until the end of the **COLUMBUS** project.

PROJECTS

VECTORS | Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors
www.marine-vectors.eu | FP7- Large-Scale Integrating Project | Project ID: 266445

Value: € 16.6 million (European Commission contribution: €12.5 million)

Timeline: Feb 2011 – Jan 2015

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | www.cetmar.org

CREDITS

Mónica Incera, Rosa Fernández, Marisa Fernández, (**CETMAR**), Sergej Olenin (**Klaipeda University**) and Francisco Alemany (**Spanish Oceanographic Institute**)

FURTHERING THE INTEGRATION AND HARMONISATION OF EXISTING INFORMATION SYSTEMS ON MARINE NON-INDIGENOUS SPECIES

**THIS CASE STUDY SHOWS HOW A KNOWLEDGE
OUTPUT HAS HELPED INTEGRATE AND HARMONISE
ALREADY-EXISTING DISTRIBUTED INFORMATION
SYSTEMS ON MARINE NON-INDIGENOUS SPECIES (NIS).**

The **VECTORS** project is part of the European Commission's **7th Framework Programme for Research and Technical Development (FP7)**. It was coordinated by Plymouth Marine Laboratory (United Kingdom) and funded to synthesise research relevant to the **Marine Strategy Framework Directive (MSFD)** – a European legislation adopted in 2008 established to protect marine environments. The project aimed to provide new knowledge to help govern and manage our seas in a holistic and considered way, putting the impacts the oceans have on humans at the centre of decision making.

OVERALL IMPACT OF COLUMBUS: PROGRESS ON HARMONISATION, INTEGRATION AND INTEROPERABILITY OF EUROPEAN NIS

“COLUMBUS contributes to the knowledge flows between developers of AquaNIS (a database developed within the EU FP7 project VECTORS) and end users, once the VECTORS project has ended, increasing its legacy.”

Sergej Olenin, AquaNIS developer and Professor at Coastal Research and Planning Institute, Klaipeda University (Lithuania)

**MARINE GOVERNANCE
AND MANAGEMENT**



Knowledge Need

The MSFD is a major part of the European Union's Integrated Maritime Policy. It aims to protect European waters by applying an ecosystem-based approach to the management of human activities, enabling the sustainable use of our marine environments. The MSFD establishes a framework within which EU Member States must take the necessary steps towards achieving or maintaining **Good Environmental Status (GES)** in marine environments by 2020. To help Member States interpret what GES means in practice, the Directive sets out eleven qualitative descriptors describing what the environment will look like when GES has been achieved. The second of these descriptors, the **MSFD Descriptor 2 (MSFD-D2)**, focuses on assessing the scale of the pressure and impacts of marine **non-indigenous species (NIS)**.

To implement this policy, and other legal instruments developed to reduce the spread of NIS, many online databases have been created to provide information on biological invasions at different scales. However, various issues – such as lack of rigorous scientific validation procedures, inconsistencies among databases or lack of common and agreed definitions – in many cases hinder the effectiveness of assessing and managing biological invasions. As a result of this, there is a strong need for integration and harmonisation of existing distributed information on NIS.

Knowledge Output

The **VECTORS** project has provided tools to support the development of strategies to mitigate and respond to marine life changes. Among these tools is AquaNIS, a searchable database of aquatic non-indigenous and cryptogenic species and their distribution in European waters and neighboring regions. Currently the tool contains data on 1455 marine, brackish and freshwater alien species involved in 4502 introduction events in 19 Large Marine Ecosystems of Europe and neighboring regions.

An important feature of AquaNIS is its flexible, easily extendible structure, where new blocks and functional modules may be added as necessary. The information system is equipped with a structured-search function that allows for the retrieval and organisation of data by multiple and complex criteria. The yearly updates stem from data reported by the members of the **International Council for the Exploration of the Sea (ICES)** Working Group on Introductions and Transfers of Marine Organisms. This ensures that the data is quality-assured and that all relevant new observations are recorded. Taxonomy is based on the updated accounts in the World Register of Marine Species.

STEP 1

Collection
Nov 2015

STEP 3

Analysis - Profiling
Target User
June 2017 -
July 2017

Knowledge Transfer Activity and Target Users

COLUMBUS decided the best approach was to pilot the use of AquaNIS in one member state as a pilot for others. The **COLUMBUS** team at **CETMAR** (Spain) organised a meeting with the involvement of the knowledge developer, University of Klaipeda (Lithuania), and three target users from Spain. These three Target Users were: the Spanish Ministry of Agriculture, Fisheries, Food and Environment; the Spanish Oceanographic Institute; and the Marine and Environment Science Centre of the University of Lisbon (Portugal). The meeting was held on 6th September 2017 at the Headquarters of the Spanish Oceanographic Institute in Madrid, Spain.

In addition, another seven international experts attended and contributed to the discussions and conclusions. These experts included:

- Representatives of international scientific bodies, such as ICES.
- Representatives of the Regional Sea Conventions.
- The European Commission's Joint Research Centre.
- Representatives from the following relevant European NIS databases: The World Register of Introduced Marine Species (**WoRMS**); The European Alien Species Information Network (**EASIN**); The Marine Mediterranean Invasive Alien Species (**MAMIAS**).

In addition to **AquaNIS**, **NEAT** was presented at the meeting. This was intended to allow attendees to explore the possibility of **NEAT** complementing NIS databases when assessing **GES** in relation to the **MSFD-D2**.

Knowledge Output Pathway

COLUMBUS wanted to explore the link between AquaNIS and other relevant NIS databases at European and Regional levels to improve the interoperability and long-term sustainability of NIS data systems. This would also facilitate the comparability of data within regions towards implementing the MSFD and Regional Sea Conventions – an EU Marine Directive that ensures regional coordination among Member States.

The intended eventual impact of this Knowledge Output Pathway is: to enhance existing environmental data platforms with AquaNIS data.

The pathway to achieving this eventual impact would require:

1. Transferring AquaNIS to organisations willing to exchange significant data on marine NIS – in particular, organisations in charge of MSFD-D2
2. Identifying amendments that are required for existing platforms to implement AquaNIS data

STEP 2

Analysis –
Developing a KOP
May 2017



STEP 5

KT activity and
measure impact
Sep 2017

STEP 4

Transfer –
Developing a KTP
July 2017

Measured Impact

The Knowledge Transfer Activity stimulated a constructive discussion around the major challenges regarding data and data management. Experts shared valuable insights on **AquaNIS**, **EASIN**, **MAMIAS** and **WoRMS**. It was also discussed how **NEAT** could enhance existing platforms for marine NIS assessment. Follow-up actions have been agreed by workshop participants to support the continuity of integrating these platforms, at which point the full impact of knowledge transfer will be achieved. During the meeting, the interest and opportunity of **AquaNIS** becoming a data partner of **EASIN** was highlighted. This would facilitate data access for Member States to properly address **MSFD-D2**.

Moreover, ICES's representative proposed that **CIESM** involves all Mediterranean countries in a further meeting. This meeting would further discuss the harmonisation, integration and interoperability between AquaNIS and the other relevant **NIS** databases represented in the meeting (**EASIN**, **WRIMS** and **MAMIAS**).

Next Steps

The Marine Governance and Management Competence Node will facilitate and follow up the agreed actions for the remainder of the **COLUMBUS** project.

PROJECTS

VECTORS | Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors
www.marine-vectors.eu | FP7- Large-Scale Integrating Project | Project ID: 266445

Value: € 16.6 million (European Commission contribution: €12.5 million)

Timeline: Feb 2011 – Jan 2015

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | www.cetmar.org

CREDITS

Mónica Incera, Rosa Fernández, Marisa Fernández, (**CETMAR**), Sergej Olenin (**Klaipeda University**) and Francisco Alemany (**Spanish Oceanographic Institute**)

CLUSTERED KNOWLEDGE ON MARINE LITTER USED TO FULFIL EU POLICY NEEDS

THIS CASE STUDY SHOWS THE TRANSFERRING OF CLUSTERED KNOWLEDGE OUTPUTS ON MARINE LITTER SUPPORT EU MEMBER STATES IN THE IMPLEMENTATION OF THE MARINE STRATEGY FRAMEWORK DIRECTIVE (MSFD).

COLUMBUS has collated 103 marine litter-related Knowledge Outputs from 60 projects, generated mainly from the **7th Framework Programme for Research and Development (FP7)** and from other programmes funded by the European Commission, such as Horizon 2020, LIFE and INTERREG.

OVERALL IMPACT OF COLUMBUS: DOSSIER ON STATE-OF-THE-SCIENCE IN MARINE LITTER RESEARCH

“The MSFD-GES Technical subgroup on Marine Litter can profit from the dossier prepared by COLUMBUS.”

Dr Georg Hanke, EU-Joint Research Centre

MARINE GOVERNANCE
AND MANAGEMENT



Knowledge Need

The EU MSFD establishes a framework within which EU Member States must achieve or maintain **Good Environmental Status (GES)** of their waters by 2020. GES is based on eleven qualitative descriptors. **Descriptor 10 of the MSFD (MSFD-D10)** concerns marine litter and states that “properties and quantities of marine litter [must not] cause harm to the coastal and marine environment”.

Marine litter is a key marine environment and biodiversity challenge. Its generation and prevention are linked to a variety of human activities and policy areas, such as waste and wastewater management, product design, shipping, fisheries policies, consumption and behavioural patterns. Efforts to reduce and understand marine litter are supported by policy and legislative activities and by an increasing number of projects tackling aspects relevant to MSFD-D10. Current knowledge of specific aspects pertaining to this descriptor – such as quantities of litter in European seas, the degradation and fate of litter in marine environments, and its potentially harmful biological, physical and chemical impacts on marine life and habitats – however, is still insufficient.

Knowledge Output

COLUMBUS has collected many Knowledge Outputs over the course of the project, including 103 Knowledge Outputs relating to the topic of marine litter. The main information sources were:

- **COLUMBUS** Deliverable 4.1 “Inventory of relevant projects by priority focus area”
- **COLUMBUS** Deliverables 5.4 (“Overview of FP7 projects relevant to major Marine and Maritime Regulations: MSFD, MSPD [Maritime Spatial Planning Directive] and CFP [Common Fisheries Policy] and Blue Economy activities”) and 5.5. (“Listing of classified marine policy and blue economy relevant projects under FP7”).
- **STAGES** Project Deliverable “State of the Art Report – Theme 3 Disturbances”.
- Information platforms: The EurOcean Marine Knowledge Gate, **CORDIS**, **LIFE** Programme repository, and **JPI-OCEANS** project database.

STEP 1

Collection
Nov 2015 -
Sep 2017

STEP 3

Analysis – Profiling
Target User
Jun 2017

Knowledge Transfer Activity and Target Users

All marine-litter related Knowledge Outputs were combined into a single dossier and validated by marine litter specialists at Cefas. The dossier was developed and sent to the Target Users at the MSFD-MCC, whom support EU Member States in the harmonised implementation of the MSFD.

STEP 4

Transfer –
Developing a KTP
July 2017

Knowledge Output Pathway

MSFD Competence Centre (MSFD-MCC) was established by the European Commission's Joint Research Centre to share harmonised marine policy and scientific information, providing the MSFD Common Implementation Strategy with up-to-date scientific knowledge. During a remote meeting between **COLUMBUS** and representatives of the MSFD-MCC, marine litter was identified as an area of great interest in terms of capturing relevant and updated knowledge. **COLUMBUS** determined that a dossier of Knowledge Outputs could provide support to EU Member States in responding to the obligatory requirements of the MSFD-D10.

STEP 2

Analysis –
Developing a KOP
May - Jun 2017

The intended eventual impact of this Knowledge Output Pathway is: to support operational performers and Competent Authorities to facilitate access to knowledge deemed potentially relevant to implementing the MSFD-D10.

The pathway to achieving this eventual impact would require:

1. Exploration of the potential of the dossier to support MSFD implementation with the end users (the MSFD-MCC).
2. Elaboration of the clustered knowledge, enriched by further sources of knowledge on marine litter.
3. Validation of the clustered knowledge with marine litter experts from the Centre for Environment, Fisheries and Aquaculture Science.
4. Provision of the validated clustered knowledge with



STEP 5

KT activity and
measure impact
Sep - Dec 2017

Measured Impact

One of the Target Users, co-chairing the MSFD GES technical subgroup on Marine Litter, confirmed that the dossier will be useful for updating and enriching the list of marine litter projects that the task group has already developed. Moreover, the Target User identified a more strategic approach to developing with the European Commission's Directorate-General of Research and Innovation on a longer time scale; where the clustered knowledge would act as a baseline of information from which to develop a marine litter database.

Next Steps

The dossier developed by **COLUMBUS** will be shared with CETMAR-led "CleanAtlantic"; a project aimed at tackling marine litter in the Atlantic Area. This project was funded by the Atlantic Area Programme and includes within its working plan a compilation of relevant projects and associated results. The dossier will act as the starting point for this compilation. Further interaction with the MSFD-MCC is expected to coordinate actions and make the best use of this marine litter knowledge, such as developing a marine litter database to support the implementation of MSFD.

PROJECTS

Multiple

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | www.cetmar.org

CREDITS

Marisa Fernández, Rosa Fernández, Raquel Diez and Mónica Incera (**CETMAR**)

INCORPORATING KNOWLEDGE MANAGEMENT AND TRANSFER METHODOLOGIES IN A PUBLICLY FUNDED PROJECT TO MAXIMISE ITS UPTAKE AND IMPACT

THIS CASE STUDY SHOWS HOW THE LESSONS LEARNT FROM THE STAGES AND COLUMBUS PROJECTS HAVE FACILITATED THE MARINER PROJECT CONSORTIUM TO EFFECTIVELY TRANSFER KNOWLEDGE TO IMPROVE THE RESPONSE TO HAZARDOUS AND NOXIOUS SUBSTANCES (HNS) SPILLS.

The **STAGES** project (Science and Technology Advancing Governance on Good Environmental Status) was part of the EC's **7th Framework Programme for Research and Technical Development (FP7)**. It was coordinated by CETMAR (Spain) and funded to synthesise research relevant to the **Marine Strategy Framework Directive (MSFD)** – a European legislation, adopted in 2008, established to protect marine environments. The aim of the project was not only to make that research widely accessible, but also to identify a need for further research that could be used to help implement the MSFD.

The Horizon 2020 project **COLUMBUS**, coordinated by BIM (Ireland), focused on ensuring that applicable knowledge generated through European Commission-funded science and technology research could be transferred effectively to advance the governance of the marine and maritime sectors as well as improving the competitiveness of European companies and unlocking the potential of the oceans to create future jobs and economic growth in Europe – a long-term strategy known as “Blue Growth”.

**OVERALL IMPACT OF COLUMBUS:
KNOWLEDGE TRANSFER SUCCESSFULLY
IMPLEMENTED IN PROJECT DESIGN**

**“STAGES and COLUMBUS
have become a great source
of inspiration to maximize
the impact of the MARINER
research project.”**

Marisa Fernández, STAGES Project
Coordinator and Head of the Control
and Management of Marine Resources
Area at CETMAR, Spain

**MARINE GOVERNANCE
AND MANAGEMENT**



Knowledge Need

The Europe 2020 Flagship Initiative Innovation Union (2010) states: “We need to get more innovation out of our research”. The European Commission (EC) is demanding improved systems and methodologies for knowledge capture and transfer and a need to show demonstrable impact from EC-funded research.

The EC has funded many research projects to respond to these strategies yet need to know the combined outcome of this research to inform policies and funding calls.

Knowledge Output

The **COLUMBUS** and **STAGES** projects were both established to unlock the potential of knowledge gained from funded research projects. Through these projects, recommendations and a robust methodology to capture knowledge from research results were established, addressing the structural requirements of transferring knowledge from science to policy, industry, science and wider society.

The clustered Knowledge Outputs from **STAGES** and **COLUMBUS** comprise:

- Recommendations on how to capture and collate knowledge (i.e. the Knowledge Output from **STAGES**).
- A step-by-step guide to the **COLUMBUS** Knowledge Transfer Methodology.
- Insights on the knowledge analysis process to inform more successful transfer plans.

STEP 1

Collection
Oct 2015

STEP 3

Analysis - Profiling
Target User
Jul 2017

Knowledge Transfer Activity and Target Users

The Knowledge Transfer Activity consisted of the **COLUMBUS** team in **CETMAR** interacting with the Project Coordinator and consortia to integrate the Knowledge Outputs into the MARINER action plan, and subsequently adapt them to the new project objectives. The first step of **COLUMBUS** transfer was at proposal stage, when the Knowledge Outputs, namely the insights and experiences of the knowledge transfer strategies within **STAGES** and **COLUMBUS**,

were transferred to the **MARINER** consortia. The next step of the pathway to impact was to implement the Knowledge management strategies upon project commencement. The **COLUMBUS** team provided advice and direction on how the recommendations and methodologies could be incorporated and adapted to the projects requirements through ongoing correspondence.

STEP 4

Transfer -
Developing a KTP
Apr 2015 - Dec 17

Knowledge Output Pathway

To increase the impact potential of new projects, excellent guidance on the incorporation of tangible, user-friendly knowledge management strategies in publicly-funded projects is required. To prove this concept, it was decided to make an example of how this could be achieved by a new project. The **MARINER** project was identified for this purpose. The aim of the **MARINER** project is to improve planning, preparedness and response to **Hazardous and Noxious Substance (HNS)** spills in Europe.

STEP 2

Analysis –
Developing a KOP
Jan 2016 –
Jun 2016

The intended eventual impact of this Knowledge Output Pathway is: to facilitate the MARINER consortium of successfully harnessing and transferring relevant knowledge of HNS spill response to competent authorities and other relevant stakeholders.

The knowledge output pathway to achieving this eventual impact corresponds with the timeline of the **MARINER** project:

1. Incorporating Knowledge Management strategies into the design of the **MARINER** project proposal to increase the potential of successful funding.
2. Upon project implementation, developing a Knowledge Management methodology and distribute to partners to allocate roles and responsibilities.
3. Transfer of knowledge collected by **MARINER** using a Knowledge Management Strategy to the EC.



STEP 5

KT activity and
measure impact
Dec 2017

Measured Impact

Impact for the first step is clearly seen as it resulted in an enriched proposal which was successfully evaluated and funded. For the second step, within MARINER's working plan, one key action is fully designed to focus on collection, analysis and transfer of HNS knowledge. The recommendations developed in **STAGES** improved and facilitated the work that was done in the **MARINER** project for harnessing relevant research relevant within its "knowledge tool". The **COLUMBUS** Knowledge Transfer methodology developed by AquaTT, and insights from the knowledge analysis experiences reflected in two reports developed by **CETMAR**, were also used by **MARINER** as guidance for upgrading the Knowledge Transfer actions foreseen in this project.

Next Steps

The **STAGES**-inspired Knowledge Tool will be kept updated beyond the project's lifetime to facilitate access to the collated knowledge. **MARINER** partners are a core part of the ARCOPOL Platform network – a network designed to further improve maritime safety in the Atlantic area – and will be an ideal channel to widely disseminate the methodology, knowledge and tools implemented and developed in the framework of **MARINER** and inspired by **STAGES** and **COLUMBUS**.

PROJECTS

STAGES | Science and Technology Advancing Governance on Good Environmental Status

www.stagesproject.eu | FP7 - ENVIRONMENT | Project ID: 308473 |

Value: €4.0 million (European Commission contribution: €4.0 million)

Timeline: March 2015 - Feb 2018

COMPETENCE NODE LEADER

Marine Governance and Management | **CETMAR** | Vigo, Spain | **www.cetmar.org**

CREDITS

Rosa Fernández, Marisa Fernández, Raquel Diez and Mónica Incera (**CETMAR**)



DISCARDS DATA SHARING: AN OUTCOME FROM DIALOGUE BETWEEN DISCARDS-FOCUSED PROJECTS AND THE EUROPEAN FISHERIES CONTROL AGENCY

THIS CASE STUDY SHOWCASES A KNOWLEDGE OUTPUT CONTRIBUTING TO THE REDUCTION OF DISCARDING THROUGH THE IMPLEMENTATION OF THE “LANDING OBLIGATION”.

The **Life iSEAS** project was coordinated by the Marine Research Institute of the Spanish National Research Council (Spain) and funded by the European Commission LIFE program. The project aimed to promote more sustainable fishing practices through the improvement of expertise and developing new approaches to managing discarded biomass and avoiding unwanted catch.

The **MINOUW** project, coordinated by the Marine Science Institute of the Spanish National Research Council (Spain), aimed to minimise unwanted catches in European fisheries. It sought to do so by incentivising the adoption of fishing technologies and practices that reduce pre-harvest mortality and post-harvest discards, while avoiding damage to sensitive marine species and habitats.

OVERALL IMPACT OF COLUMBUS: FACILITATED DATA SHARING THAT WILL IMPROVE AUTHORITIES’ DISCARD MANAGEMENT EFFORTS IN EUROPEAN WATERS



“COLUMBUS helped EFCA to enhance dialogue with EU research projects in the area of discards and to exchange relevant information, improving both the reach of the projects and the work of EFCA on monitoring the implementation of the Landing Obligation.”

Miguel Nuevo, European Fisheries Control Agency

Knowledge Need

“Discarding” is the practice of returning unwanted fish catches to the sea – either dead or alive – often because they are undersized or due to market demands. Discards constitute a needless waste of valuable marine resources and play an important role in the depletion of marine populations.

The **Common Fisheries Policy (CFP)** is the European Union’s instrument for the management of fisheries, enhancing the sustainability of commercial fish stocks and the economic competitiveness of the fishing industry. The CFP is designed to sustainably manage fish stocks as a shared resource, giving all European fishing fleets equal access to EU waters and fishing grounds and allowing fishermen to compete fairly. The reform of the CFP of 2013 aims at gradually eliminating the wasteful practice of discarding through the introduction of the **Landing Obligation (LO)**. The LO requires all catches of regulated commercial species on-board to be landed and counted against quota.

Since the publication of the LO, however, getting good quality data for the estimation of reliable discard rates has become more difficult.

Knowledge Outputs

The clustered analysis of the outputs from three projects tackling the problem of fishing discards, namely, **Life-ISEAS** and **H2020 MINOUW** and DiscardLess, allowed the identification of some relevant data sets as transferrable knowledge outputs obtained by two of these projects. These data could supplement currently available data for European Fisheries Control Agency (EFCA), in particular, for the area of **Southern Western Waters (SWW)** in the Atlantic Ocean.

STEP 1

Collection
Nov 2016

STEP 3

Analysis - Profiling
Target User
Jan 2017

Knowledge Transfer Activity and Target Users

The **COLUMBUS** project set up a science-policy dialogue focused on fishing discards with the European Fisheries Control Agency (EFCA). The meeting was held at the EFCA’s Headquarters in Vigo (Spain) on the 2nd February 2017. EFCA experts showed interest in learning if and how additional

data on fisheries and discards, obtained from sources different to their regular surveys, could improve the outcomes of their risk assessments. Data on fishing discards (obtained by the **Life iSEAS** and **MINOUW** projects) on the area of SWW in the Atlantic was shared with the **EFCA**.

STEP 4

Transfer -
Developing a KTP
Jan 2017

Knowledge Output Pathway

Through analysis with experts, **COLUMBUS** agreed that raising awareness of the possible solutions to discards would be valuable to fisheries authorities. This could then facilitate the knowledge being presented to fishers through official means. Furthermore, fisheries and discards data could be useful for many applications, including helping fisheries authorities develop informed local discard strategies.

STEP 2

Analysis –
Developing a KOP
Nov – Dec 2017

The intended eventual impact of this Knowledge Output Pathway is: to improve the risk assessment process for determining the likelihood of non-compliance with LO in the SWW area.

The knowledge output pathway to achieving this eventual impact corresponds with the timeline of the **MARINER** project:

1. Presenting the comprehensive information about available discard data in the area of SWW to fisheries authorities.
2. Generating a science-policy dialogue around discard data involving the Knowledge Owners and fisheries authorities
3. Fostering interaction and collaboration to continue sharing discards data a Knowledge Management Strategy to the EC.



STEP 5

KT activity and
measure impact
Nov 2017

Measured Impact

Based on the EFCA's response, the **MINOUW** project was contacted again to facilitate the sharing of data that the project had gathered from fisheries in the Portuguese coasts. The exchange of data from the Life iSEAS project is under discussion.

This transfer of data is expected to improve the process for risk assessment and for determining the likelihood of non-compliance with the LO, specifically in the SWW area in the Atlantic. Currently (January 2018), the **EFCA** is outlining the requirements for data exchange.

Next Steps

Further interaction and collaboration is expected between **EFCA** and discard-related projects.

PROJECTS

Life iSEAS | Knowledge-Based Innovative Solutions to Enhance Adding-Value Mechanisms towards Healthy and Sustainable EU Fisheries | lifeiseas.eu/es/el-proyecto | LIFE | Project Number: LIFE13

Value: €3.8 million (European Commission contribution: €1.9 million)

Timeline: July 2014– June 2018

MINOUW | Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries | minouw.icm.csic.es | H2020- H2020 – Research and Innovation Action | Project ID: 634495

Value: €6.2 million (European Commission contribution: €5.9 million)

Timeline: March 2015 – Feb 2019

COMPETENCE NODE LEADERS

Marine Governance and Management | CETMAR | Vigo, Spain | www.cetmar.org
Fisheries | DTU Aqua | Kongens Lyngby, Denmark | www.aqua.dtu.dk

CREDITS


Mónica Incera, Rosa Fernández, Marisa Fernández, Jose Luis Gómez (**CETMAR**), Thomas Talund Thøgersen, Ivo Grigorov (**DTU Aqua**), Mario dos Santos, Miguel Nuevo (**EFCA**)

ENHANCING STAKEHOLDERS' PERCEPTION OF THE LANDING OBLIGATION IN EUROPEAN FISHERIES

THIS CASE STUDY ILLUSTRATES HOW FISHING AUTHORITIES IN THE EUROPEAN FISHERIES CONTROL AGENCY (EFCA) GATHERED INSIGHTS ABOUT THE STAKEHOLDERS' PERCEPTION OF THE "LANDING OBLIGATION".

The **Life iSEAS** project (Knowledge-Based Innovative Solutions to Enhance Adding-Value Mechanisms towards Healthy and Sustainable EU Fisheries) was coordinated by the Marine Research Institute of the Spanish National Research Council (Spain) and funded by the European Commission LIFE program. The project aimed to promote more sustainable fishing practices through the improvement of expertise and developing new approaches to managing discarded biomass and avoiding unwanted catch.

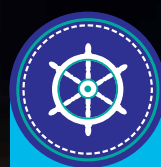
OVERALL IMPACT OF COLUMBUS: CRITICAL RESEARCH ON STAKEHOLDER VIEWS WAS UPDATED TO PROVIDE AUTHORITIES WITH MORE EFFECTIVE KNOWLEDGE FROM WHICH TO BASE THEIR LANDING OBLIGATION POLICIES



"COLUMBUS helped EFCA to enhance dialogue with EU research projects in the area of discards and to exchange relevant information, improving both the reach of the projects and the work of EFCA on monitoring the implementation of the Landing Obligation."

Miguel Nuevo, European Fisheries Control Agency

**MARINE GOVERNANCE
AND MANAGEMENT**



Knowledge Need

“Discarding” is the practice of returning unwanted fish catches to the sea – either dead or alive – often because they are undersized or due to market demands. Discards constitute a needless waste of valuable marine resources and contribute to the depletion of marine populations.

The **Common Fisheries Policy (CFP)** is the European Union’s instrument for the management of fisheries, enhancing the sustainability of commercial fish stocks and the economic competitiveness of the fishing industry. The CFP is designed to sustainably manage fish stocks as a shared resource, giving all European fishing fleets equal access to EU waters and fishing grounds and allowing fishermen to compete fairly. The reform of the CFP in 2013 included the goal of gradually eliminating the wasteful practice of discarding through the introduction of the **Landing Obligation (LO)**. The LO requires all catches of regulated commercial species on-board to be landed and counted against quota.

To implement this regulatory framework there needs to be interaction and involvement of all stakeholders. Stakeholders’ perception of the LO can be key to the efficient and effective implementation of the regulation.

Knowledge Output

This Knowledge Output is a detailed study (covering all stakeholders from the Galician fisheries sector) that clarifies the environmental and socio-economic impacts of proposed solutions for discard reduction. It comprises a compilation of meaningful information revealing stakeholders’ perception of LO through systematic interviews. This work was carried out in 2015, in the early stages of the project.

STEP 1

Collection
Nov 2016

STEP 3

Analysis - Profiling
Target User
Jan 2017

Knowledge Transfer Activity and Target Users

COLUMBUS first interviewed the fishers a second time to provide an update on their perceptions of the LO. **COLUMBUS** identified the European fisheries control agency (EFCA) as being the target user of this Knowledge Output. With the intended application by **EFCA** to integrate the Knowledge Output into its

ordinary activities to enable an effective and uniform application of Fisheries regulations. Following initial **COLUMBUS** interaction, a science-policy dialogue workshop was organised by **COLUMBUS** and **EFCA** focused on fishing discards, held at the EFCA’s Headquarters in Vigo (Spain) on the 2nd February 2017.

STEP 4

Transfer -
Developing a KTP
Jan 2017

Knowledge Output Pathway

COLUMBUS recognised that more effective engagement in the future could be assisted by providing insights on stakeholder's perceptions after two years of progressive implementation of the LO to the European Fisheries Control Agency (EFCA), and facilitating an open dialogue with fishers based on these results.

The intended eventual impact of this Knowledge Output Pathway is: to improve the effectiveness and efficiency of fisheries authorities' engagement with stakeholders to implement fisheries regulations appropriately.

The pathway to achieve this eventual impact would require:

1. Updating the information available from Life iSEAS (in relation to the stakeholders' perception) by interviewing the fishers for a second time
2. Presenting the comprehensive information about available knowledge to the Target User, the EFCA.
3. Organising a science-policy dialogue around the LO and the discard ban.
4. Enabling collaborative research between the knowledge holders of Life iSEAS's study on stakeholders' perception and the end user (the EFCA) to inform future engagement with fishers.

STEP 2

Analysis –
Developing a KOP
Nov – Dec 2016



STEP 5

KT activity and
measure impact
Feb – Mar 2017

Measured Impact

The **EFCA** hired the services of the knowledge holder at University of Santiago de Compostela (Galicia, Spain) to conduct a supplementary study following the same approach already applied in the context of Life iSEAS project. This information is key to understanding how fishers are responding to the regulation – and why. It can also be used to inform future stakeholder interaction efforts by the **EFCA**.

Next Steps

The repetition of the consultation processes provided some clues on how the stakeholders' perception is evolving and which factors are driving this evolution. This information is important to guide communication and stakeholder interaction strategies by a policy agent like the **EFCA**.

PROJECTS

Life iSEAS | Knowledge-Based Innovative Solutions to Enhance Adding-Value Mechanisms towards Healthy and Sustainable EU Fisheries | lifeiseas.eu/es/el-proyecto | LIFE | Project Number: LIFE13 ENV/ES/000131

Value: €3.8 million (European Commission contribution: €1.9 million)

Timeline: July 2014– June 2018

COMPETENCE NODE LEADERS

Marine Governance and Management | CETMAR | Vigo, Spain | www.cetmar.org
Fisheries| DTU Aqua|Kongens Lyngby, Denmark| www.aqua.dtu.dk

CREDITS

Mónica Incera, Marisa Fernández, Jose Luis Gómez, Rosa Fernández (**CETMAR**), Thomas Talund Thøgersen, Ivo Grigorov (**DTU Aqua**), Mario dos Santos and Miguel Nuevo (**EFCA**)

USING PERFORMANCE DATA OF SELECTIVE FISHING GEARS TO REDUCE FISHING DISCARDS

THIS CASE STUDY SHOWCASES A KNOWLEDGE TRANSFER ACTIVITY IN SUPPORT OF FISHERIES AUTHORITIES AND FISHERS IN THE BALTIC SEA. IT AIMS TO REDUCE FISHING DISCARDS IN EUROPEAN WATERS AND COMPLY WITH THE EUROPEAN UNION'S DISCARD BAN.

The Horizon 2020 **DiscardLess** project was coordinated by the **National Institute of Aquatic Resources at the Technical University of Denmark (DTU-Aqua)**. The project aimed to minimise unwanted catches by promoting fishing technologies and practices that reduce pre-harvest mortality and post-harvest discards – while also avoiding damage to sensitive marine species and habitats. The general approach is based on technical and socio-economic solutions on a case-by-case analysis of the main types of European fisheries.

OVERALL IMPACT OF COLUMBUS: THE TRANSFER OF KNOWLEDGE REGARDING SELECTIVE GEARS HAS RESULTED IN MORE SUSTAINABLE FISHING METHODS IN THE BALTIC SEA



“COLUMBUS helped EFCA to enhance dialogue with EU research projects in the area of discards and to exchange relevant information, improving both the reach of the projects and the work of EFCA on monitoring the implementation of the Landing Obligation”

Miguel Nuevo, European Fisheries Control Agency

Knowledge Need

“Discarding” is the practice of returning unwanted catches of fish to the sea – either dead or alive – often because they are undersized or due to market demands. Discards constitute a needless waste of valuable marine resources and contribute to the depletion of marine populations.

The **Common Fisheries Policy (CFP)** is the European Union’s instrument for the management of fisheries, enhancing the sustainability of commercial fish stocks and the economic competitiveness of the fishing industry. The CFP is designed to sustainably manage fish stocks as a shared resource, giving all European fishing fleets equal access to EU waters and fishing grounds and allowing fishermen to compete fairly. The reform of the CFP of 2013 aims at gradually eliminating the wasteful practice of discarding through the introduction of the **Landing Obligation (LO)**. The LO requires all catches of regulated commercial species on-board to be landed and counted against quota.

Enforcement of the LO regulations would be considerably easier if fishers were able to avoid the catch of unwanted fish by using more selective fishing gears. To this end, accessible comparative information about the practical performance of modified gears is crucial to stimulating uptake of the most efficient ones.

Knowledge Output

The **DiscardLess** project generated outcomes focused on technologies and strategies to reduce or avoid fishing discards. These Knowledge Outputs are:

- A manual describing the different stages of the fish capture process. This highlights how different parts of the fishing gear may influence selection and identified possible design changes to alter the selectivity of the gear.
- A catalogue of factsheets documenting selective fishing gear trials and the catch composition obtained with their use.

STEP 1

Collection
Nov 2016

STEP 3

Analysis - Profiling
Target User
Jan 2017

Knowledge Transfer Activity and Target Users

COLUMBUS identified the European fisheries control agency (**EFCA**) as being the target user of this Knowledge Output. With the intended application by EFCA to integrate the Knowledge Output into its ordinary activities to enable an effective and uniform application of the CFP, particularly in relation

to the problem of fishing discards. Following initial **COLUMBUS** interaction, a science-policy dialogue workshop was organised by **COLUMBUS** and **EFCA** focused on fishing discards with the European Fisheries Control Agency (EFCA). The meeting was held at the EFCA’s Headquarters in Vigo (Spain) on 2nd February 2017.

STEP 4

Transfer -
Developing a KTP
Jan 2017

Knowledge Output Pathway

COLUMBUS determined that discard-related knowledge would be better incorporated into the policy system if fisheries experts and fisheries policy makers could review **DiscardLess** Knowledge Outputs together.

The intended eventual impact of this Knowledge Output Pathway is: to improve the fishing practices to avoid unwanted catches (i.e. catches that are below minimum size) by using more selective fishing gears.

The pathway to achieve this eventual impact would require:

1. Presenting comprehensive information about available knowledge on technologies and strategies to reduce or avoid fishing discards in the Baltic Sea to fisheries authorities
2. Generating a science-policy dialogue around the LO and the discard ban in the Baltic Sea involving the knowledge owners and fisheries authorities
3. Raising awareness of potential solutions to reduce discards to fishers through a stakeholder event

STEP 2

Analysis –
Developing a KOP
Nov – Dec 2016



STEP 5

KT activity and
measure impact
Mar 2017

Measured Impact

As a result of the science-policy dialogue organised by **COLUMBUS** (in collaboration with the **EFCA**), technologies and strategies to reduce or avoid fishing discards were presented to stakeholders in the Baltic Sea during a meeting chaired by **EFCA**, offering conclusions from a comparative study of different fishing gear designs to increase selectivity. The stakeholder meeting took place in Hamburg in March 2017. This action fostered the uptake of some of the innovative and selective designs studied by DiscardLess by fishers in the Baltic Sea. Currently, one of the selective designs highlighted by the project is in the process of being adopted by regulators for full implementation.

Next Steps

No further steps are foreseen by **COLUMBUS** in relation to this case study. The **EFCA** is aware of this knowledge and can now use it in many other stakeholder events they plan in the future.

PROJECTS

DiscardLess | DiscardLess – Strategies for the gradual elimination of discards in European fisheries | www.discardless.eu | H2020 - Research and Innovation Action | Project ID:633680

Value: €3.8 million (European Commission contribution: €1.9 million)

Timeline: July 2014– June 2018

COMPETENCE NODE LEADERS

Marine Governance and Management | CETMAR | Vigo, Spain | www.cetmar.org
Fisheries | DTU Aqua | Kongens Lyngby, Denmark | www.aqua.dtu.dk

CREDITS

Mónica Incera, Rosa Fernández, Marisa Fernández, Jose Luis Gómez (**CETMAR**), Thomas Talund Thøgersen, Ivo Grigorov (**DTU Aqua**), Mario dos Santos and Miguel Bueno (**EFCA**)

BEST PRACTICE IN USE AND SHARING OF MARINE OBSERVATIONS AND DATA BY INDUSTRY

THIS CASE STUDY SAW KNOWLEDGE ANALYSED, INTERPRETED AND COMPILED INTO A DIGESTIBLE 'BEST PRACTICE GUIDE' TO ENABLE MORE EFFICIENT ENGAGEMENT WITH INDUSTRY AND LED TO CHANGES IN THE OPERATIONS OF KEY PUBLIC MARINE DATA-SHARING INITIATIVES.

The **COLUMBUS** Marine Observation and Monitoring node has considered Knowledge Transfer from 'clustered marine data' – namely the wealth of marine data that is available from numerous projects in public repositories.

OVERALL IMPACT OF COLUMBUS: COMPANIES SHARING AND CREATING NEW SERVICES BASED ON OTHERWISE INACCESSIBLE MARINE DATA

“When we consider industry marine data sharing and reuse, the guidelines produced by this project really hits the spot.”

David Mills, Director, Integrated Marine Data and Information System (IMarDIS) as stated at the Open Sea Lab hackathon

**MARINE MONITORING
& OBSERVATION**



Knowledge Need

In Europe, there are many local, national and regional marine data repositories. Marine data portals and repositories provide users with access to data, metadata and derived data-products. They play a crucial role in marine knowledge creation and application, contributing to open innovation and delivering growth in the Blue Economy – representing millions of marine jobs and generating billions of euros annually.

Despite this potential, a report produced by the COLUMBUS project 'Marine Data Portals and Repositories and their role in Knowledge Transfer to support Blue Growth' highlights that there is still limited uptake and application of these valuable resources by users in the value chain. There is a need for improved engagement between publicly funded marine data sharing initiatives and the private sector.

Knowledge Outputs

Open-access marine observation databases such as the European Marine Observation and Data Network (EMODnet), COPERNICUS Marine Environment and Monitoring Service (CMEMS), the pan-European infrastructure for ocean & marine data management (SeaDataNet), Data Publisher for Earth & Environmental Science (PANGAEA) and European Atlas of the Sea Data contain data generated by research projects.

The **COLUMBUS** Marine Observation and Monitoring Node has taken the approach to consider 'clustered marine data' as a Knowledge Output, i.e. the wealth of marine data that is available from numerous projects in public repositories. It is usually when combined with other data that data sets become more valuable and applicable by users.

STEP 1

Collection
May 2016

STEP 3

Analysis - Profiling
Target User
May 2017

Knowledge Transfer Activity and Target Users

To better understand industry's perspective on marine data use, individual meetings were arranged with industrial marine companies including DEME (Dredging, Environmental and Marine Engineering) as well as a Flemish maritime innovation incubator. **COLUMBUS** Competence Node representatives also attended Oceanology International (a leading ocean technology marine science exhibition and conference) where 17 companies were approached directly.

STEP 4

Transfer -
Developing a KTP
May 2017

COLUMBUS organised a brokerage event titled "Power of open marine data for the blue economy" at SeaTech Week in Brest, France, in October 2016 to foster dialogue between the participants on industry use of marine data. The audience comprised marine data specialists, observation technology specialists, maritime companies and maritime clusters from Europe, Canada, USA and Japan. **COLUMBUS** utilised the outcomes from this brokerage event and individual interviews with companies to develop a Best Practice Guide on the "Use and sharing of marine observations and data by industry". The guidelines produced were shared with marine observatories and data sharing initiatives, including the EMODnet Steering Committee and EuroGOOS members, as well as being widely disseminated.

Knowledge Output Pathway

It was apparent to **COLUMBUS** that there were many generic obstacles preventing greater reuse and sharing of marine data by industry in Europe. To overcome these challenges, it was decided to analyse these further and consider how the intermediary observatories and data-sharing initiatives could better engage with industry.

The intended eventual impact of this Knowledge Output Pathway is: to see greater use and sharing of marine data resources by the private sector.

STEP 2

Analysis –
Developing a KOP
May 2017

The pathway to achieving this eventual impact would require:

1. Researching industry's perception of marine data and the applicability of public marine data resources to better understand obstacles facing its use by industry.
2. Producing a best practice guide based on the collection, analysis and synthesis of new knowledge relevant to marine data resources.
3. Providing the guide to marine observatories and data sharing initiatives.
4. Synthesising the recommendations by actors in the marine observation and data-sharing community.



STEP 5

KT activity and
measure impact
Ongoing

Measured Impact

As a direct result of this work, EMODnet established its 'Associated Partnership Scheme'. DEME, one of the worlds' largest dredging companies, joined EMODnet as an associated partner.

The Best Practice Guide has been publicly endorsed and commended by key figures in the marine data for industry sectors; as well as being recognised as an example of global best practice, and uploaded to the global Ocean Best Practices Repository within the Ocean Data Interoperability Platform (ODIP).

Two companies have indicated that they are developing new services with marine data that they were previously unaware of before interaction with the **COLUMBUS** Monitoring and Observation Node. A multinational maritime company is also exploring how they can share data with EMODnet.

Next Steps

Marine data sharing initiatives continue to implement recommendations outlined in the guidelines resulting in greater reuse and sharing of marine data by industry.

PROJECTS

Multiple

COMPETENCE NODE LEADER

Marine Monitoring and Observation | Seascope Consultants | Romsey, UK
www.seascopeconsultants.co.uk

CREDITS

Seascope Consultants, **VLIZ**, **EuroGOOS**, Marine South East, **PLOCAN**, SmartBay Ireland

NEW INNOVATIVE MARINE DATA APPLICATIONS BY BUILDING ON EXISTING RESOURCES AND SERVICES

THIS CASE STUDY SHOWS HOW OPEN-ACCESS MARINE DATA REPOSITORIES CAN BE IMPROVED AND MADE MORE USER-FRIENDLY THROUGH THE COLLABORATION OF MARINE SCIENTISTS WITH EXPERTS FROM DIFFERENT SECTORS SUCH AS INFORMATION TECHNOLOGY, COMPUTER PROGRAMMING AND GRAPHIC DESIGN.

The **COLUMBUS** Marine Observation and Monitoring node has considered Knowledge Transfer from 'clustered marine data' – namely the wealth of marine data that is available from numerous projects in public repositories.

OVERALL IMPACT OF COLUMBUS: HACKATHON IDENTIFIES FIVE NEW MARINE DATA APPLICATIONS

**MARINE MONITORING
& OBSERVATION**



Knowledge Need

The Marine Knowledge 2020 Strategy is a European strategy that promotes bringing together marine data from different sources with the aim of improving the effectiveness of marine data for use by industry, public authorities and researchers. The strategy indicates that making marine data accessible via interoperable sharing platforms will increase opportunities for competition and innovation in the Blue Economy. In addition, the European Open Science Cloud offers a service that will provide European researchers with open access to research across borders and scientific disciplines.

A **COLUMBUS** report, 'Marine Data Portals and Repositories and their role in Knowledge Transfer to support Blue Growth', recognised that the visibility of marine data repositories and portals does not extend well beyond the marine research and wider earth observation community. To attract new users, and develop new applications from currently available (but under-utilised) marine data, new approaches must be explored.

Knowledge Outputs

Knowledge Outputs from projects such as MyOcean and SeaDataNet have been instrumental in the establishment of key European marine observation and data sharing initiatives, such as EMODnet and CMEMS. The combination of several sources of marine data is more valuable and applicable by users. Open-access marine data represent a vast and largely untapped resource within Europe, particularly by innovative start-up communities.

Knowledge Output Pathway

COLUMBUS identified open data competitions and hackathons as highly efficient ways to activate talented information technology, software and data specialists with the skills to harness marine data resources and translate these into proof-of-concept applications and tools. Developing an efficient hackathon requires digital research and start-up experts to explore how an open

STEP 1

Collection
Apr 2016

STEP 3

Analysis - Profiling
Target User
Aug 2017

Knowledge Transfer Activity and Target Users

During the early analysis stages of this case study, "imec.living-labs" - an organisation that conducts living-labs research for innovative digital solutions - was identified as an important intermediary in planning a marine data hackathon. They include users early on and all through the innovation process: this includes capturing, understanding and validating users' interactions with products and services, at an early stage.

After significant correspondance with imec (including four face-to-face meetings), a concept was designed for a marine data bootcamp and hackathon to incorporate teambuilding and training. This concept was presented to the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) as the owner of the European Marine Observation and Data Network (EMODnet).

STEP 4

Transfer -
Developing a KTP
Aug 2017

data competition could add value by assessing available European marine data, observation systems and tools.

COLUMBUS decided to organise a hackathon that brought together computer programmers, developers, graphic designers, interface designers, project managers and marine science experts to collaborate with the goal to create novel, usable applications.

The intended eventual impact of this Knowledge Output Pathway is: to develop new solutions and innovative applications for users of marine data based on open-access resources.

STEP 2
Analysis –
Developing a KOP
Jul 2017

The pathway to achieving this eventual impact would require:

1. Exploring mechanisms, tools and activities to engage actors from outside the traditional marine monitoring and observing community to act as catalysers to develop new innovative applications by building on existing resources and services.
2. Developing and organising a 'Marine Data Hackathon'.
3. Identifying and inviting suitable participants.
4. Creating a 'Marine Open Data Competition' to conceive and co-create innovative solutions.
5. Developing high potential applications for use by marine data users.



STEP 5
KT activity and
measure impact
Nov 2017

Measured Impact

The concept was agreed by DG MARE who allocated funding to realise the marine data bootcamp and Hackathon. The result was EMODnet's first Open Sea Lab (www.opensealab.eu) which took place in November 2017. A total of 69 people applied to participate in the Open Sea Lab, of whom 35 attended and formed the final seven teams. These were comprised of developers, open data experts, sectoral experts (e.g. fisheries) and ranged from companies, to entrepreneurs to students.

Five new proof-of-concept applications were developed based on marine data. The winning team are in discussions with a digital innovation incubator, as they are interested in further developing their proposed application, a tool to identify suitable sites to farm seaweed in Europe.

The Open Sea Lab dedicated Twitter account received 145 new followers from its inception.

Next Steps

The innovative proof-of-concept applications will be developed into functional tools and applications for end-users, through bringing them to the attention of a business or user group that could support their further development. Based on participant feedback, accessibility of the data services for future users will be improved.

PROJECTS

Multiple

COMPETENCE NODE LEADER

Marine Monitoring and Observation | Seascope Consultants | Romsey, UK
www.seascopeconsultants.co.uk

CREDITS


Seascope Consultants, **VLIZ**, **EuroGOOS**, Marine South East, **PLOCAN**, SmartBay Ireland

ADVANCING STATE-OF-THE-ART TECHNOLOGY IN SENSING MARINE POLLUTANTS

**THIS CASE STUDY HAS SEEN AN INNOVATIVE
SENSOR BROUGHT CLOSER TO MARKET THROUGH
ESTABLISHING CONTACTS WITH INFRASTRUCTURE
FACILITIES OFFERING TO TRIAL THE SENSOR AT SEA.**

The **SMS** project (**S**ensing toxicants in **M**arine waters makes **S**ense using biosensors), coordinated by Università degli Studi di Roma 'Tor Vergata' (Italy), focused on the development of an innovative sensor and monitoring device that quickly and effectively detects four categories of marine pollutants.

**OVERALL IMPACT OF COLUMBUS: SECURED SEA
TRIALS FOR SHELLFISH SENSOR MONITORING**



“The COLUMBUS project has been helpful in advancing this innovative new sensor along the value chain by making connections with potential test sites. This would result in the long-term deployment of the biosensor in a relevant environment to inform improvements to respond to the potential costumers’ needs.”

Carmem-Lara Manes, R & D Director for Environmental Microbiology (Knowledge Owner, SMS)

MARINE MONITORING
& OBSERVATION



Knowledge Need

Marine monitoring methods and technologies are used to alert public authorities and professionals about potential pollution risks for human health and the environment. However, current monitoring methods can be expensive and relatively slow. For some of them, it can take up to five days to supply information needed to act in the event of harmful levels of marine toxins, such as from harmful algal blooms. These slow monitoring processes have created a demand for faster and more effective methods. In relation to new sensor development, the European Marine Board's 'Navigating the Future IV' – a series which provides policy briefs on guiding research and science policy agendas at European and national levels – acknowledged this demand, stating “there is a need for improved cross-sector research in the development of sensors, platforms etc. to ensure marine science benefits from innovative technological developments in other areas.”

Knowledge Outputs

The **SMS** project has devised a rapid, sensitive, quantitative, molecular-based sensor system for the detection of toxic microalgae species in marine environments. Current monitoring devices take around three days to detect toxic microalgae, whereas a remote, autonomous analyser (within the SMS sensor) can detect three species of toxic microalgae *in situ* in just six hours. This device incorporates a proprietary technique – meaning that it detects only living cells – ensuring false positives do not arise from dead cells in the water. The device can be expanded and adapted for other species if the genetic sequence of the species is known. There is currently no other device on the market capable of doing this.

Knowledge Output Pathway

Shellfish farming requires constant monitoring to ensure shellfish containing biotoxins are not harvested, sold

STEP 1

Collection
Dec 2015

STEP 3

Analysis – Profiling
Target User
Jul – Nov 2017

Knowledge Transfer Activity and Target Users

In collaboration with the **COLUMBUS** partner **PLOCAN** (a multipurpose infrastructure that provides support for research and innovation in the marine and maritime sectors), it was agreed to invite the knowledge owner to a brokerage event focusing on new sensor technologies. This event was titled “Knowledge Transfer in Maritime Sensing Technologies” and was organised alongside the Horizon 2020 “AtlantOS” project’s General Assembly. The AtlantOS project represents 62 partners from 13 countries across the globe, including Germany, the UK, South Africa, Brazil, USA and Canada. These partners represent key figures in the global marine

monitoring and observation data landscape. Eight representatives from sensor development companies were also invited to the brokerage event. The knowledge owner pitched the innovative device to the participants and contributed to a panel discussion. During this discussion, they were invited to focus on the future steps to take and barriers to overcome in progressing their sensor towards commercialisation. Following the event, there was a networking lunch in which attendees were invited to approach the knowledge owner and find out more information about the product.

STEP 4

Transfer –
Developing a KTP
Nov 2017

and consumed. This Knowledge Output could improve the monitoring of harmful levels of marine toxins in shellfish production sites, and therefore reduce the risk of contamination and cases of food poisoning. To be utilised by shellfish farmers (and commercialised), the SMS sensor will require an additional six months of development and one year of sea trial testing to allow for seasonal variations.

The intended eventual impact of this Knowledge Output Pathway is: to enable public authorities and shellfish farmers to react rapidly and appropriately in

the event that harmful levels of a marine toxins are recorded, enabling them to quickly issue public alerts or harvest stocks.

The pathway to achieving this eventual impact would require:

1. Facilitating the further development of the SMS sensor for use as a shellfish monitoring tool
2. Carrying out sea trials of the adapted sensor
3. Raising awareness of the benefits of the adapted sensor among shellfish farmers to initiate demand
4. Engaging with sensor developers to commercialise the validated sensor and bring to market

STEP 2
Analysis –
Developing a KOP
Jul 2017



STEP 5
KT activity and
measure impact
Nov 2017 and
ongoing

Measured Impact

During the networking lunch, the knowledge owner was approached by four people, representing key figures in the global marine monitoring and observation data landscape, who were interested in finding out further details about the device. Two demonstration sites were offered for sea trialling: one in Italy and one in Spain. These discussions are ongoing.

The knowledge owner was also invited to contribute to a book chapter on marine monitoring and advance the knowledge base in relation to innovative sensors and their potential.

Next Steps

At the event, all participants were informed of the fact that the European Commission is building a project pipeline, which will include high-potential marine monitoring tools, to take to potential investors, including European Investment Bank. The knowledge owner has applied for funding to progress the sensor towards commercialisation.

PROJECTS

SMS | Sensing Marine Toxicants Make Sense Using Biosensors | www.project-sms.eu
FP7- KBBE | Project ID: 613844

Value: €625,470

Timeline: December 2013 – August 2017

COMPETENCE NODES

Monitoring and Observation Node
Aquaculture Node

CREDITS

Seascope, AQUARK, PLOCAN

USING MARINE TOURISM TO INCREASE ACCESS TO EUROPEAN MARINE BIODIVERSITY DATA

THIS CASE STUDY HAS FORGED CLOSER LINKS BETWEEN MARINE TOURISM CITIZEN SCIENCE ACTIVITIES AND THE EUROPEAN MARINE OBSERVATION AND DATA NETWORK (EMODNET) TO ENABLE WIDER ACCESS TO QUALITY CONTROLLED BIODIVERSITY DATA.

The **WILDSEA** Europe project created a transnational sustainable tourism route, connecting European coastal destinations recognised as having a rich marine biodiversity. The objective of **WILDSEA** was to build a strong business case for the sustainable development of Europe's coastal tourism destinations. It also aimed to showcase biodiversity as a valuable touristic asset and promote public-private cooperation in its sustainable use and conservation. Furthermore, it aimed to promote the development of new tourism experiences and packages designed to attract new visitors to coastal tourism destinations – this included stimulating public interest via citizen science activities.

OVERALL IMPACT OF COLUMBUS: REPOSITORY MADE AVAILABLE FOR DATA COLLECTED BY MARINE TOURISM CITIZEN SCIENCE INITIATIVES

“The tourism sector is seeking new ways to upscale its commitment to environmental conservation, and citizen science can be a powerful tool towards that end. COLUMBUS led us to EMODnet, which opens an exciting window of opportunity for WILDSEA member operators to contribute with valuable data to marine research and to more effective conservation policies.”

Julia Vera Prieto, Director of Travelecoology

MARINE MONITORING
& OBSERVATION



Knowledge Need

Citizen science activities are initiatives that allow non-scientists to meaningfully contribute to scientific research. They are increasingly recognised as an important source of information with the potential to contribute to marine environmental monitoring and environmental risk mitigation. Citizen science activities have the potential to fill data-gaps as they may focus on parts of the marine environment where traditional monitoring efforts are lacking. Increasing the access to data collected via citizen science activities contributes to our knowledge of the sea – as well as increasing participants' sense of responsibility and co-ownership of the marine environment.

Merging the marine tourism market with citizen science activities has yet to be fully exploited. Traditionally, there has been little support for marine tourism companies wanting to incorporate citizen science activities into packages and products offered to tourists. Consequently, there is a demand for aiding and facilitating marine tourism companies in introducing these activities to their customers.

One of the challenges of citizen science data is ensuring that the quality of the data collected is reliable. The logistics of how and where to store the data – and how to make it available for long-term open access – is also very important.

Knowledge Output

WILDSEA developed guidelines for marine tourism operators to encourage and support them in offering responsible and sustainable citizen science activities as part of their ecotourism activities. The guidelines included information on data collection and who might be interested in this data. This would allow tourists and visitors to make responsible contact with marine species in the wild, while learning about their ecology and participating in efforts to preserve them.

The **WILDSEA** Knowledge Owners were two Spanish marine environmental organisations: **Travelecoology** (a boutique consulting firm specialising in travel and tourism, nature and sustainability) and **SUBMON** (an organisation that provides services relating to the conservation, study and awareness of the marine environment).

STEP 1

Collection
May 2016

STEP 3

Analysis – Profiling
Target User
Jun 2016

Knowledge Transfer Activity and Target Users

The coordinator of EMODnet Biology was contacted by **COLUMBUS** and asked about the possibility of using EMODnet as a repository for data collected by marine tourism citizen science initiatives. They responded positively with detailed information on the criteria and procedure for submitting data to EMODnet and on the quality control and processing involved. These details were passed back to the Knowledge Owners who highlighted EMODnet as a repository for collected marine biodiversity data in their guidelines. These guidelines have been disseminated widely by the Knowledge Owners throughout the **WILDSEA** community and beyond.

STEP 4

Transfer –
Developing a KTP
Jun 2016

Knowledge Output Pathway

In discussions with **Travelecoology** and **SUBMON**, **COLUMBUS** decided to connect the project with EMODnet Biology – a resource that provides free access to data on the temporal and spatial distribution of marine species and their traits from all European regional seas. It was also decided to include information on how to share biodiversity data with EMODnet in the guidelines produced by **WILDSEA**.

The intended eventual impact of this Knowledge Output Pathway is: to increase the amount of quality-controlled, open-access European marine biodiversity data that has been collected via responsible and sustainable citizen science marine tourism activities.

The pathway to achieving this eventual impact would require:

1. Including details on how citizens can upload data to EMODnet Biology in **WILDSEA** citizen science guidelines for responsible marine tourism.
2. Promoting the **WILDSEA** guidelines and providing training to marine tourism companies.
3. Collecting and depositing data by citizen science activities into EMODnet Biology. This is to ensure quality control and further processing and registering of a digital object identifier (DOI) for the company providing the data.
4. Re-using the biodiversity data and recognition for tourism companies through acknowledgement of the DOI in a publication, report or other material.

STEP 2

Analysis –
Developing a KOP
Jun 2016



STEP 5

KT activity and
measure impact
Jan 2018

Measured Impact

As of yet, there have been no new submissions from tourism operators to EMODnet Biology. However, this is still a relatively new venture for tourism companies and only covered one season since the guidelines were produced. It is also possible that collected data has been submitted to local or regional repositories.

Next Steps

It is hoped that the excellent work of **WILDSEA** can be further promoted by other projects and initiatives and that these guidelines will be actively taken-up and used by tourism companies. It is expected that this will lead to more data submissions to open access repositories, such as EMODnet, and ultimately greater re-use of marine biodiversity data.

PROJECTS

WILDSEA Europe | Project **WILDSEA** Europe | www.wildsea.eu | Funding call COSME programme

Timeline: June 2015 – December 2016

COMPETENCE NODE LEADER

Marine Monitoring and Observation | **Seascape Consultants** | Romsey, UK

www.seascapeconsultants.co.uk

CREDITS


Seascape Consultants, Travelecoology, SUBMON

REFERENCE TURBINE OVERCOMES BOTTLENECK IN OFFSHORE WIND DEVELOPMENT

**THIS CASE STUDY SHOWCASES A KNOWLEDGE
OUTPUT BEING TRANSFERRED TO ALLOW TARGET
USERS TO SAVE TIME AND MONEY IN DESIGNING
TURBINES FOR OFFSHORE WIND.**

The **LEANWIND** project, coordinated by University College Cork in Ireland, planned to “provide cost reductions across the offshore wind farm lifecycle and supply chain through the application of lean principles and the development of state-of-the-art technologies and tools”.

**OVERALL IMPACT OF COLUMBUS:
IMPROVED COMMERCIAL DESIGNS
IN OFFSHORE WIND**



“The COLUMBUS project has given me the unique opportunity to speak in detail with six individual experts in my field specifically about the 8MW Reference Turbine Knowledge Output from the LEANWIND project. The discussion we had and the feedback received over the course of these meetings was invaluable to my continuing work with the LEANWIND project and beyond. It has been extremely useful to engage with these experts and to learn more about the knowledge gaps and requirements in this field.”

Dr Cian Desmond, University College Cork, LEANWIND Project

Knowledge Need

The EU's Renewable Energy Directive sets a binding target of fulfilling at least 20% of energy needs from renewable sources by 2020; extended to at least 27% by the 2030 Energy Strategy. Offshore wind technology is not as well developed as onshore wind technology, making it more costly and less likely to be considered as a viable energy provision option. For Europe to successfully meet its energy obligations, innovation in the design and manufacturing of wind power generation components is critical.

"Reference turbines" are developed for open-access by engineers. These are theoretical designs of turbines, for industry-use, that can be used to support concept studies assessing offshore wind technology and installations prior to development. Currently, only 5MW and 10MW reference turbines are available for industry-use, developed by the National Renewable Energy Laboratory (NREL) in the United States and Technical University of Denmark (DTU) in Denmark.

Knowledge Output

The Knowledge Output consists of an open-access description of an industry-validated 8MW theoretical reference turbine (<http://iopscience.iop.org/article/10.1088/1742-6596/753/9/092013/pdf>). The turbine is described in terms of mass distribution, dimensions, power curve, thrust curve, maximum design load and tower configuration. The design of this 8MW Reference Wind Turbine has been checked and validated by the design consultancy, DNV-GL. Through consultation with the **LEANWIND** Industry Advisory Group, the **LEANWIND** project partners recognised a gap in the market for an 8MW Reference Turbine. Given that 10MW can be expensive to install, and 5MW is suitable only for small scale operations, an 8MW Reference Turbine would be a valuable addition to the knowledge base and could be used for a variety of applications.

STEP 1

Collection
Oct 2015

STEP 3

Analysis - Profiling
Target User
Apr - Jun 2016

Knowledge Transfer Activity and Target Users

Initiated by telephone calls and followed up by face-to-face meetings, **COLUMBUS** brokered conversations between the Project Coordinators and four Target Users: two from industry (Floating Power Plant and DNV-GL), one from a publicly-funded research centre and one a university (Norwegian University of Science and Technology). During the Knowledge Transfer process, one of these Target Users suggested two additional Target Users who were subsequently added to the Knowledge Transfer Plan. Both additional Target Users were researching offshore wind energy in academia.

Individual meetings were set up between the **COLUMBUS** Knowledge Fellow, the Knowledge Output owner and the Target Users. The objective of the meetings was to fully explain the Knowledge Output to the Target Users and to answer any questions they had in relation to the Knowledge Output.

STEP 4

Transfer -
Developing a KTP
Apr - Aug 2016

Knowledge Output Pathway

Whilst the 8MW Reference Turbine was released in 2016, it had not been utilised in designs. **COLUMBUS** agreed to support the transfer of the reference turbine to relevant individuals within the offshore wind energy sector.

The intended eventual impact of this Knowledge Output Pathway is: to observe the 8MW Reference Turbine being used in the development of offshore wind installations.

The pathway to achieving this eventual impact would require:

1. Providing access to the 8MW Reference Turbine to offshore wind developers.
2. Applying the 8MW Reference Turbine in concept development by these developers.
3. Constructing an offshore installation with a design that utilised the 8MW Reference Turbine in its development.

STEP 2

Analysis –
Developing a KOP
Nov 2015 –
Mar 2016



STEP 5

KT activity and
measure impact
Aug 2016 –
Dec 2017

Measured Impact

Despite being a published study, the Reference Turbine was not known, or used, by any of the Target Users in advance of the **COLUMBUS** intervention. Now, several of the target users are actively using the Knowledge Output in their work:

- NTNU are using the Knowledge Output and are planning further use of it for onsite installation analysis and for comparison with other reference wind turbines (5MW and 10MW).
- Floating Power Plant is currently in the process of updating the design of their commercial wind turbine and the team is planning to use the **LEANWIND** Reference Turbine as part of this development. The Floating Power Plant team also secured funding from MaRINET 2 (an EU project in offshore wind, wave and tidal technology) enabling them to test their product in France in 2017.

Next Steps

Knowledge Holder, Dr Cian Desmond, had the opportunity to discuss his work at length with six industry experts. Realising the interest, and based on the feedback he received, he is now planning to further develop the Knowledge Output so that it has greater applicability to the industry. DNV-GL has not yet used the Knowledge Output but is planning to do so when the timing is right within their current work. "We consider that it is essential for the industry development with this initiative, which clearly enables and motivates innovation."

PROJECTS

LEANWIND | Logistic Efficiencies and Naval architecture for Wind Installations with Novel Developments | www.leanwind.eu

FP7 - TRANSPORT | Project ID: 614020

Value: €14.9 million (European Commission contribution: €10.0 million)

Timeline: Dec 2013 - Nov 2017

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Jennifer Fox, Tom Remy (**Aquatera**), Cian Desmond (**University College Cork**)

SENSORS FOR MEASURING LARGE SCALE HYDRODYNAMICS

THIS CASE STUDY SAW A KNOWLEDGE OUTPUT - A SENSOR FOR MEASURING LARGE SCALE HYDRODYNAMICS - TRANSFERRED TO AN ORGANISATION WHO AGREED TO INSTALL AND TEST THE TECHNOLOGY WITHIN THE MARINE ENVIRONMENT.

The **Lakshmi** project (Sensors for LArge scale HydrodynaMic Imaging), coordinated by Tallinn University of Technology (Estonia), focused on developing “a new technology that cost-effectively measures hydrodynamic variables at high resolution and on large scales.” **Lakshmi** provides a low-cost solution for ocean monitoring.

OVERALL IMPACT OF COLUMBUS: PLANS FOR INSTALLATION OF AN ARRAY OF SENSORS FOR TESTING

“The COLUMBUS project team has been crucial to effectively transferring the innovative and great potential of the new ocean sensor under development in the Lakshmi Project to the Oceanic Platform of the Canary Islands (PLOCAN). The knowledge transferred open clear opportunities of collaboration that could lead to mutual benefits: PLOCAN may increase its services portfolio based on the new capacities provided by this innovative sensor while, at the same time, the developers will find a real marine test-site scenario for sensor validation and comparison.”

Dr Ayoze Castro Alonso, Head of the Innovation Unit, PLOCAN

Knowledge Need

Subsurface flow – the movement of water at depth – plays an important role in both the water cycle and marine ecosystems. However, to date there remain significant gaps in our understanding of subsurface flow, including its dynamics and long-term influences on the environment. This has been largely due to the absence of suitable measurements available for a continuous and long-term study, particularly on water layers close to the seabed.

While surface layers of the ocean are regularly and effectively sampled, under-sampling of the subsurface water column and significant aliasing errors (i.e. the misidentification of a signal frequency, introducing distortion or error) have contributed to a poor understanding of its subsurface water mechanisms.

Knowledge Output

Lakshmi has built a macroscopic sensor array for hydrodynamic (the study of liquids in motion) visualisation and large-scale oceanography. This device is scalable up to kilometres long and is designed to enhance our understanding of complex subsurface flow conditions. The **Lakshmi** approach is inspired by the biophysics of the fish lateral line organ, by far the most sophisticated, reliable, versatile, and robust mechanosensory (sensing of stimuli as pressure or vibration) organ for hydrodynamic sensing known.

STEP 1

Collection
Jul 2016

STEP 3

Analysis – Profiling
Target User
Sep 2016

Knowledge Transfer Activity and Target Users

On 23 November 2017, **COLUMBUS** organised a Brokerage Event entitled “Knowledge Transfer in Maritime Sensing Technologies”, which facilitated the interaction of more than 130 experts on ocean observation and monitoring and related maritime technologies. Target Users identified included marine

research centres, marine observatories and data networks, and maritime infrastructure (i.e. ports). In addition, the new sensor and its capabilities for ocean monitoring was presented and explained to participants including the AtlantOS project (a project aimed at optimising and enhancing the integrated Atlantic Ocean observing systems).

STEP 4

Transfer –
Developing a KTP
Oct – Nov 2016

Knowledge Output Pathway

Besides recording ocean bottom dynamics, the sensor could be used for monitoring flows around underwater structures. Accordingly, **COLUMBUS** was interested in determining if the Knowledge Output could be applied by marine monitoring or offshore development stakeholders.

The intended eventual impact of this Knowledge Output Pathway is: to fill gaps in ocean data and improve long-term ocean observation.

The pathway to achieving this eventual impact would require:

1. Raising awareness of maritime industries and marine research stations of the knowledge.
2. Testing of the sensor array at marine sites, particularly those with little to no monitoring or data available.
3. Developing next stage agreements to scale up the sensor.

STEP 2

Analysis –
Developing a KOP
Aug 2016



STEP 5

KT activity and
measure impact
Dec 2017

Measured Impact

The Oceanic Platform of the Canary Islands (**PLOCAN**) expressed interest in testing the sensor at its test site in Gran Canaria (Spain) to gather long-term data of their facilities and data for third party organisations also testing their technologies on site. **PLOCAN** is a multipurpose service centre designed to support and research technology development and innovation in the marine and maritime sector. This **COLUMBUS** brokerage event made it possible to match the results of the **Lakhsmi** project with the needs and services of **PLOCAN**.

Next Steps

Lakhsmi and **PLOCAN** are in the process of evaluating potential sensor array installation sites, and are concurrently working to finalise a collaboration agreement.

PROJECTS

Lakhsmi | Sensors for LArge scale HydrodynaMic Imaging | www.lakhsmi.eu

H2020- BG-09-2014 | Project ID: 635568

Value: €3.0 million (European Commission contribution: €3.0 million)

Timeline: Apr 2015 – Apr 2019

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Jennifer Fox, Natalia Rojas (**Aquatera**), Ayoze Castro (**PLOCAN**)

STATE-OF-THE-ART MUTUALLY SUPPORTING SYSTEMS FOR OFFSHORE AQUACULTURE

THIS CASE STUDY HAS SEEN A CLUSTER OF KNOWLEDGE OUTPUTS TRANSFERRED TO AN ACTIVE SCIENCE-INDUSTRY CONSORTIUM EXPLORING OPPORTUNITIES FOR ALTERNATIVE RENEWABLES IN OFFSHORE AQUACULTURE FACILITIES ON MULTI-USE PLATFORMS.

The **H2Ocean** project was coordinated by AWS Truepower (Spain) and funded by the European Commission's 7th Framework Programme. The project focused on developing a wind-wave power open-sea platform, equipped for hydrogen generation with support for multiple users of energy. The result was an innovative design which supports an economically and environmentally sustainable, multi-use open-sea platform. Multi-use platforms enable several activities, such as renewable energy, aquaculture and maritime transport, to coexist in the same shared space. This not only reduces operational costs but also the demand on the space needed for different activities.

OVERALL IMPACT OF COLUMBUS: CONSORTIUM FORMED TO EXPLORE ALTERNATIVE ENERGY FOR OFFSHORE AQUACULTURE

"The COLUMBUS project team actively transferred the outputs of the H2Ocean project to our consortium at a scheduled meeting in Stavanger in December 2016. It was very useful for us to be made aware of the outputs of the H2Ocean project and we plan to incorporate and build upon the outputs of H2Ocean in the project proposal that we are currently building."

Jean-Baptiste Curien, CEO of Gwind

Knowledge Need

According to the Food and Agriculture Organisation, fish accounted for 17% of all animal protein consumed by the global population in 2013 with 49% of this figure provided by aquaculture. As the population continues to grow, the market for aquaculture continues to increase. However, the current scale of operations is not keeping up with this trend.

The expansion of traditional near-shore aquaculture facilities is slow and limited; yet, offshore facilities are a viable solution to the planet's increasing demand for aquaculture-produced fish.

Offshore aquaculture is becoming increasingly popular and offers the potential to strengthen the growth and sustainability of marine and maritime sectors – a long term strategy known as “Blue Growth”. However, the growth of offshore aquaculture has been limited by the challenges of working in an offshore environment, one of which is the greater costs associated with the increased energy use due to the distance from shore to fish farm. The solution to this problem could be the use of renewable energy – which would also have the benefit of reducing the carbon footprint of the aquaculture sector.

Knowledge Outputs

The **H2Ocean** project aimed to develop an innovative design for an economically and environmentally sustainable multi-use open-sea platform. These goals resulted in a cluster of Knowledge Outputs providing a solution to the energy requirements of offshore aquaculture through wind and anaerobic digestion. These solutions promise to save the aquaculture sector both time and money.

The Knowledge Outputs were:

- An anaerobic digestion process for wet waste.
- A technique to make anaerobic digestion more tolerant to saline.
- An anaerobic digester to produce biogas from organic waste, such as dead salmon.
- Nano membrane-based, marinised desalination system for electrolysis.
- Adaption of electrolysis for offshore deployment.
- Safety and security measures: devices and procedures to secure the safe performance of offshore hydrogen production, storage and distribution systems.

STEP 1

Collection
Oct 2015

STEP 3

Analysis – Profiling
Target User
Dec 2016

Knowledge Transfer Activity and Target Users

COLUMBUS Knowledge Fellows, working in the areas of Marine Physical Resources and Marine Fisheries, recognised that their networks could mutually benefit from the advancement of Knowledge Outputs related to using renewable energy in the aquaculture sector. Experts from the aquaculture and renewables industries, with an interest in offshore multi-use structures were meeting to discuss Knowledge Outputs from the DeepWind project at the University of Stavanger, Norway. **COLUMBUS** recognised this as an opportunity to brainstorm potential applications of the cluster of Knowledge Outputs from the **H2Ocean** project. The meeting also needed to determine if Horizon 2020 (an EU research and innovation programme) would support the technology's development for aquaculture application, therefore reducing the need for external investment.

The Target Users included:

- Several experts in offshore wind and aquaculture technology from the University of Stavanger.
- The CEO of **Gwind** – a company that develops innovative designs and applications for wind energy, including a floating vertical axis wind turbine (VAWT).
- DTU Wind Energy representing expertise in MET-Ocean conditions and in deep sea floating offshore VAWTs (DeepWind).
- An engineer and expert in land-based VAWTs based at Uppsala University, Sweden.
- An electrical machine design expert from Aalborg University, Denmark.

STEP 4

Transfer –
Developing a KTP
Dec 2016

Knowledge Output Pathway

COLUMBUS recognised that the anaerobic digestion system on a multi-use platform could be driven by waste from aquaculture. Further research would be required to determine if these Knowledge Outputs could be utilised on a multi-use platform with an aquaculture facility.

The intended eventual impact of this Knowledge Output Pathway is: to provide a green solution to increased energy costs associated with offshore aquaculture development using renewable energy on a multi-use platform.

STEP 2
Analysis –
Developing a KOP
Oct 2015

The pathway to achieving this eventual impact would require:

1. Developing a consortium of experts with an interest in exploring the application of **H2Ocean** results on a multi-use platform with an aquaculture facility.
2. Supporting the consortium in sourcing suitable funding opportunities to execute a project to create an economically and environmentally sustainable solution for offshore aquaculture.
3. Implementing the project and successfully demonstrating the Knowledge Output cluster in an offshore aquaculture pilot on a multi-use platform.
4. Disseminating the outputs of the project to drive industry-adoption of these technological advancements.



STEP 5
KT activity and
measure impact
Dec 2016 –
Dec 2017

Measured Impact

During the meeting, all Target Users agreed that they were interested in collaborating to develop this Knowledge Output cluster in an offshore aquaculture setting. Following the meeting, it was agreed that there was not enough time to construct a competitive application for an identified Horizon 2020 funding call. However, the discussions produced sufficiently mature ideas and the consortium has agreed to actively pursue further funding opportunities.

Next Steps

Since, the 2018-2020 Horizon 2020 Work Programme became publicly available, **COLUMBUS** have analysed the funding call topics and communicated the opportunities for future research and development to the newly-formed consortium. The consortium is actively pursuing this and will make an application in 2018.

PROJECTS

H2Ocean | Development of a wind-wave power open-sea platform equipped for hydrogen generation with support for multiple users of energy | www.h2ocean-project.eu
FP7 – TRANSPORT | Project ID: 288145

Value: €6.5 million (European Commission contribution: €4.5 million)

Timeline: Jan 2012 – Dec 2014

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Jennifer Fox, Tom Rémy, Ian Hutchison (**Aquatera**)

NEW ENVIRONMENTALLY-FRIENDLY BIOFOULING AND CORROSION PREVENTION COATING FOR MARINE RENEWABLES

THIS CASE STUDY SET UP THE NEXT PHASE OF TESTING OF THE ACORN COATING - A TECHNOLOGY DESIGNED TO PREVENT BIOFOULING AND CORROSION - IN A COMMERCIAL SETTING.

The **ACORN** project (Advanced coatings for offshore renewable energy), coordinated by TWI Limited (United Kingdom), focused on the development of a new, patentable and long-lasting solution to the problem of marine biofouling, offering specific advantages for static offshore structures such as wind turbine towers and ocean energy generators.

OVERALL IMPACT OF COLUMBUS: COATING ADOPTED BY INDUSTRY FOR UPCOMING INSTALLATION

“The COLUMBUS project has given me the unique opportunity to speak in detail with four potential users of our technology and allowed us to set up opportunities to test the ACORN Coating in a commercial setting.”

Luis San Segundo, Managing Director of Degima
(Knowledge Holder; ACORN Coating)

Knowledge Need

Despite considerable development in the field of protective coatings for marine structures, there is still significant room for improvement. Biofouling is the accumulation of microorganisms, plants, algae, or animals on wetted surfaces which have the potential to cause corrosion and adverse effects on structural loading. Long-lasting coating systems (which last 20 years or more) that offer reliable, dual protection against corrosion and biofouling are not available. The need for such coatings is especially apparent in the case of static offshore structures where dry docking is not an option. The market for such a paint is vast as it could be used on many built marine structures ranging from offshore wind turbine foundations to ocean energy devices.

Knowledge Output

The Knowledge Output is a coating of thermally sprayed aluminium (TSA) developed by **ACORN** which includes environmentally-friendly, anti-fouling substances in very small concentrations (<1%). These anti-fouling substances will be gradually exposed at the active surface of the coating as the TSA corrodes away at rate of 10µm per year. This means that the protection will be long-lasting. The eco-friendly, anti-fouling substances were chosen based on their performance, commercial availability and regulatory approval for use in EU waters. The **ACORN** Coating represents an entirely new, efficient approach to the long-term protection of offshore structures.

STEP 1

Collection
Mar 2016 -
Jan 2017

STEP 3

Analysis - Profiling
Target User
Feb 2017 -
Jul 2017

Knowledge Transfer Activity and Target Users

Through an intensive analysis phase, the **COLUMBUS** Marine Physical Resources Node Team identified 38 potential Target Users from the marine renewable energy industry. Initial email correspondence with all Target Users was undertaken to inform them about the **COLUMBUS** project and **ACORN**. The **ACORN** project was also presented at two **COLUMBUS** Brokerage Events – “Blue Growth Knowledge Transfer on Marine Physical Resources and Observations” in Dublin on 24 May 2017, organised by SmartBay Ireland, and “Cutting Edge Solutions for Marine Coatings - Innovation that Ignites Protection and Performances” in Brussels on 16 May 2017, organised by ECMAR.

This interaction was followed by a series of meetings between the Target Users and the Knowledge Holders organised by **COLUMBUS**. The objective of the meetings was to fully explain the Knowledge Output to the Target Users and to answer any questions that they had in relation to it.

STEP 4

Transfer -
Developing a KTP
Feb 2017 -
Jul 2017

Knowledge Output Pathway

To transfer this product to in the marine renewable energy industry, the efficacy of the coating in a commercial setting must be demonstrated. If the cost reduction through using the Knowledge Output can be demonstrated in an offshore renewable energy project, this will streamline the development and deployment of offshore marine energy devices and ultimately increase the likelihood of long-term success for those projects.

STEP 2

Analysis –
Developing a KOP

Nov 2016 –
Feb 2017

The intended eventual impact of this Knowledge Output Pathway is: to facilitate cost-efficient, long-term, environmentally friendly biofouling and corrosion protection on offshore marine energy devices.

The pathway to achieving this eventual impact would require:

1. Demonstrating the efficiency and cost effectiveness of the coating in a commercial setting.
2. Carrying out further testing and development of the coating.
3. Commercialising the coating and making it available for use.



STEP 5

KT activity and
measure impact

Jul 2017 –
Dec 2017

Measured Impact

Following these brokerage events, the **ACORN** team signed a non-disclosure agreement with Jeremy Smith, CEO of QED Naval to allow for the exchange of technical detail of a QED Naval foundation structure to enable the demonstration of the coating. Unfortunately, this was unfeasible due to the cost implication. More positively, Andrew Hynd, Engineer in Offshore Wind Energy at Atkins Global, agreed to use the coating in projects that move to the installation phase in 18-24 months' time. Finally, Yuri Wentzel, Managing Director for Tidal Energy Developer SeaCurrent, is keen to use the **ACORN** Coating and will remain in contact with the **ACORN** team to pursue this opportunity beyond the lifetime of the **COLUMBUS** project.

Next Steps

During this case study, the **ACORN** team have separately gained funding through OCEANERA-NET to carry out further testing of the **ACORN** coating. This project is called "**MAT4OEC**" and is due for completion in December 2019.

PROJECTS

ACORN | Advanced Coatings for Offshore Renewable Energy | www.acorn-project.eu

FP7 - SME | Project ID: 605955

Value: €1.3 million (European Commission contribution: €1.0 million)

Timeline: Nov 2013 - Feb 2016

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

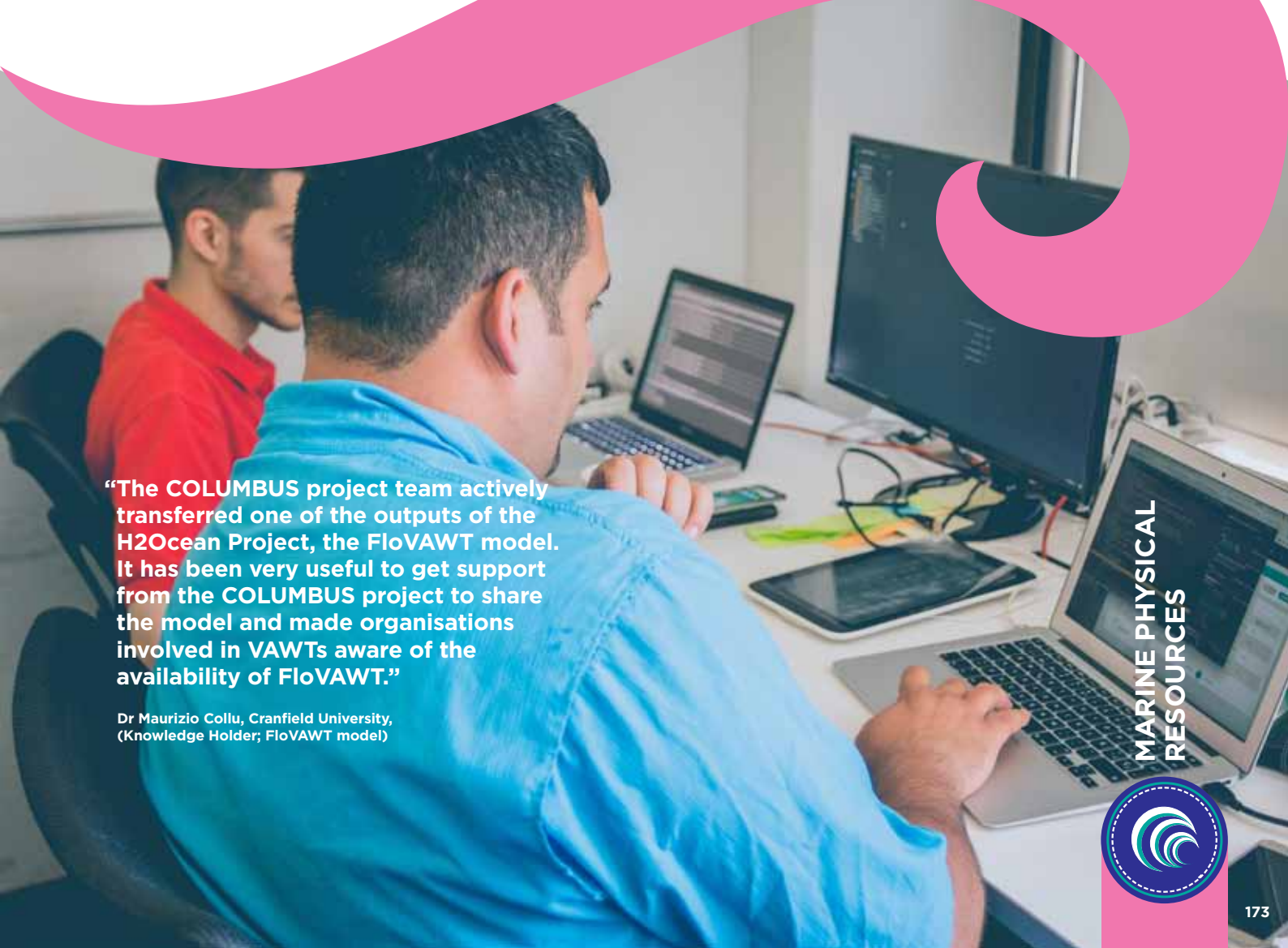
Jennifer Fox, Ian Hutchison (**Aquatera**)

NEW MODEL PROPELS THE DEVELOPMENT OF FLOATING VERTICAL AXIS WIND TURBINES

THIS CASE STUDY HAS SEEN THE DEVELOPMENT OF A MODEL THAT PROVIDES INSIGHT INTO THE BEHAVIOUR OF FLOATING PLATFORMS IN OFFSHORE ENVIRONMENTS. IT WAS SPECIFICALLY DESIGNED FOR VERTICAL AXIS WIND TURBINES (VAWT) AND CAN PROPEL FUTURE RESEARCH, DESIGN AND DEVELOPMENT OF THESE TYPES OF STRUCTURES.

The **H2Ocean** project was coordinated by AWS Truepower (Spain) and funded by the European Commission 7th Framework Programme. The project focused on developing a wind-wave power open-sea platform. This platform would be equipped for hydrogen generation with support for multiple users of energy. The result was an innovative design which supported an economically and environmentally sustainable, multi-use open-sea platform.

OVERALL IMPACT OF COLUMBUS: PROVIDED DEVELOPERS OF FLOATING VAWTS WITH A MODEL THAT CAN HELP REDUCE THEIR CAPITAL EXPENDITURE THROUGH MORE EFFICIENT *IN-SILICO* TESTING



“The COLUMBUS project team actively transferred one of the outputs of the H2Ocean Project, the FloVAWT model. It has been very useful to get support from the COLUMBUS project to share the model and made organisations involved in VAWTs aware of the availability of FloVAWT.”

Dr Maurizio Collu, Cranfield University,
(Knowledge Holder; FloVAWT model)

Knowledge Need

Multi-use platforms enable several activities, such as renewable energy, aquaculture and maritime transport, to coexist in the same shared space. This not only reduces operation costs but also the demand on the space needed for different activities. The installed cost of a wind power project is dominated by the upfront capital cost (often referred to as CAPEX) for the wind turbines, including towers and installation. According to a 2012 study by the International Renewable Energy Agency, this can be as much as 84% of the total installed cost. This high upfront cost impedes more wind power projects from being launched. Reducing the CAPEX of VAWT installation is therefore instrumental for the sector to move forward. In order to do so, understanding how floating platforms respond in an offshore environment is key to designing VAWTS which are cost-effective.

Knowledge Output

The **FloVAWT** model, developed by **Cranfield University**, is an innovative solution to providing preliminary assessments of the dynamics and performances of VAWT systems. Through the development of the model, existing tools and capabilities were further developed and refined to create a more efficient tool. The model provides insights into the behaviour of floating platforms in the offshore environment. It assesses the time response of floating platforms to aerodynamics, hydrodynamics and mooring dynamics. It can also assess the platform motion, system loading and power prediction. By using this model, developers can create a more viable, efficient and cost-effective floating platform. The model is fully operational as it has been validated against experimental field measurements (at a number of scales, up to 0.5MW) and against different VAWT configurations and a wind-wave energy converter.

STEP 1

Collection
Oct 2015

STEP 3

Analysis – Profiling
Target User
Dec 2016

Knowledge Transfer Activity and Target Users

A technical brief on the **FloVAWT** model, outlining the unique properties, advantages and access information on the model was developed by the **COLUMBUS** team. This was shared with more than 50 potential Target Users identified as being involved in either research or industry around the development of floating wind platforms and wind turbine construction.

STEP 4

Transfer –
Developing a KTP
Dec 2016

Knowledge Output Pathway

VAWTs are in a very early stage of deployment and there are a very small number of developers implementing the technology due to the uncertainty of the technology itself. Very few models have been developed for VAWTs. However, these technologies tend to be promising alternatives for clean energy generation in the offshore market. The **COLUMBUS** team recognised that the **FloVAWT** model could enhance European competitiveness in the offshore wind energy sector by providing wind turbine developers with the means to save time and money.

STEP 2
Analysis –
Developing a KOP
Oct 2016

The intended eventual impact of this Knowledge Output Pathway is: to enable the cost-effective installation of VAWTs offshore by reducing its CAPEX.

The pathway to achieving this eventual impact would require:

1. Contacting organisations involved in floating wind turbine research and inform them of the model and how to access and make use of it.
2. Developing the model to develop more economically and technically viable floating VAWTs.
3. Developing the model for other offshore energy technologies.



STEP 5
KT activity and
measure impact
Dec 2016 –
Nov 2017

Measured Impact

At this stage (January 2018), none of the targeted organisations have acted on this transfer. However, if in the future they decide to utilise **FloVAWT** they now have the information needed to do so.

Next Steps

Continue to identify and target organisations involved in research and developing VAWTs that may have an interest in using the **FloVAWT** model.

PROJECTS

H2Ocean | Development of a wind-wave power open-sea platform equipped for hydrogen generation with support for multiple users of energy | www.h2ocean-project.eu
FP7 – TRANSPORT | Project ID: 288145

Value: €6.5 million (European Commission contribution: €4.5 million)

Timeline: Jan 2012 – Dec 2014

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Natalia Rojas, Jennifer Fox (**Aquatera**), Maurizio Collu (**Cranfield University**)

MULTIMEDIA E-LEARNING TOOL PROMOTING EDUCATION OF AQUATIC RENEWABLE ENERGY TECHNOLOGIES

THIS CASE STUDY HAS SEEN THE TRANSFER OF EASY-TO-DIGEST EDUCATIONAL MATERIAL CENTRED ON MARINE RENEWABLE ENERGY SOURCES - OFFSHORE, WIND, WAVE, TIDAL STREAM, TIDAL RANGE AND RUN-OF RIVER ENERGY.

The **AquaRET** project (Aquatic Renewable Energy Technologies) was coordinated by AquaTT in Ireland. The project focused on the creation of e-learning modules designed to promote aquatic renewable technologies using the latest multimedia tools. Users would learn about existing marine renewable energy technologies, how aquatic renewable energy technologies work, how they fit into the landscape and how they benefit the economy.

OVERALL IMPACT OF COLUMBUS: PRODUCING RESOURCES FOR EDUCATORS ON MARINE RENEWABLE ENERGY

“AquaRET is a handy source of information about ocean energy. We use the illustrations and materials for presentations, proposals, and some campaign materials. It is also helpful for stakeholders who are not in the field but are interested to know more about ocean energy.”

Mary Ann Joy Quirapas, OceanPixel, National University Singapore

MARINE PHYSICAL
RESOURCES



Knowledge Need

The Kyoto Protocol is an international treaty brought into effect in 2005 that commits countries to reduce their greenhouse gas emissions. Europe needs to provide more electricity generated by renewable energy if it is to meet the targets outlined by the Kyoto Protocol, as well as other European Union climate and energy regulations and agreements. Consequently, there has been a growth of interest in aquatic renewable energy technologies, i.e. offshore wind, wave, tidal stream, impoundment (a large hydropower system using a dam to store water), and run-of-river (a large hydropower system, using flowing water without a reservoir).

Knowledge Output

The Knowledge Output is a suite of readily available and easily digestible, secondary school level, e-learning modules using the latest multimedia tools to inform a wide range of stakeholders of the existence, importance and necessity of renewable energy technologies. These stakeholders include the public, planners, energy advisors, developers and people working in ancillary sectors. The material is ready and free to use as a completed product or as a complementary supplement to a school's curriculum. An online textbook that providing a comprehensive introduction to the marine renewable energy sector is also available. Furthermore, there are a range of animations that can be used to convey the various methods for transforming energy in the marine environment into electrical energy as well as information posters to display in classrooms and public spaces.

STEP 1

Collection
Nov 2016

STEP 3

Analysis – Profiling
Target User
Oct – Dec 2017

Knowledge Transfer Activity and Target Users

The **COLUMBUS** team identified and approached thirty nine Target Users, involved in education, providing a concise summary of the **AquaRET** project and the resources available.

The identified Target Users identified covered many sectors, including teachers and lecturers (all levels), marine users, stakeholders within the marine supply chain, public education authorities and organisations that have a connection with the marine renewable energy sector.

STEP 4

Transfer –
Developing a KTP
Nov 2017

Knowledge Output Pathway

As Europe continues to diversify its energy production portfolio to include the marine environment, there comes an ever-growing need for education to promote understanding across professional sectors as well as the public. To raise awareness of the marine renewable sectors across a wide scope of demographics, the provision of free educational material through a variety of media was recognised as the first step.

The intended eventual impact of this Knowledge Output Pathway is: to promote a better understanding of the potential and benefits of marine renewable energy sectors.

The pathway to achieving this eventual impact would require:

1. Measuring interest in adopting the materials by education providers.
2. Providing access to the educational material.
3. Incorporating education modules on marine renewable energy sources into secondary schools.

STEP 2

Analysis –
Developing a KOP
Oct 2017



STEP 5

KT activity and
measure impact
Jan 2018

Measured Impact

Of the potential users targeted, eleven were interested in disseminating the information further and six reported on how they would apply the knowledge:

- John Macleod, Leask Marine (Scotland) will use the posters in the field during instruction discussions with new small technology developers.
- Dr Erland Johnston, Kirkwall Grammar School (Scotland) will incorporate the AquaRET resources into the school's curriculum.
- James Murray, Scotrenewables (Scotland) will use the material to encourage local young people's interest in marine renewable energy.
- Mark Shiner, University of the Highlands and Islands (Scotland) will expand the educational resources for mariners and secondary school pupils.
- Jean Ward, Orkney Islands Council (Scotland) will use the materials to encourage school aged pupils to follow into a career in the sciences.
- Babette Hegarty, Stromness Academy (Scotland) will use the posters as an educational resource.

Next Steps

In the immediate future, engagement will continue with the eleven active Target Users to further highlight the scope of the materials available.

PROJECTS

AquaRET | Aquatic Renewable Energy Technologies | www.aquaret.com | Lifelong Learning Programme (Leonardo da Vinci sub-programme) | Project ID: 2006-IRL/06/B/F/PP-153111

Value: €0.397 million (European Commission contribution: €0.297 million)

Timeline: Oct 2006 – Sep 2008

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Jennifer Fox, Peter Long (**Aquatera**)

DEVELOPING A CONSISTENT AND PROPORTIONATE APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT OF MARINE RENEWABLE ENERGY IN THE UK

THIS CASE STUDY HAS INITIATED THE DEVELOPMENT OF SUMMARIES OF KEY ENVIRONMENTAL ISSUES RELATED TO THE MARINE RENEWABLE ENERGY (MRE) INDUSTRY THAT WILL ALLOW STAKEHOLDERS IN THE UK TO HAVE A CONSISTENT AND PROPORTIONATE APPROACH TO THE POTENTIAL ENVIRONMENTAL IMPACTS OF MRE.

The **Ocean Energy Systems (OES)** Annex IV programme, coordinated by Pacific Northwest National Laboratory (USA), was established to examine environmental effects of MRE development, with a focus on summarising the science of the interactions of MRE devices with the marine environment. The programme resulted in the publication of a State of the Science Report.

OVERALL IMPACT OF COLUMBUS: SUMMARIES OF MRE STATE-OF-THE-SCIENCE DEVELOPED

“Using the OES Annex IV State of the Science Report, and other relevant information, to develop a series of Knowledge Summaries on key issues will provide stakeholders in the Marine Renewable Energy industry with a consistent and robust evidence base to inform consenting for wave and tidal energy projects in the UK.”

Dr Kate Smith, Marine Renewable Energy Advisor, Natural Resources Wales

MARINE PHYSICAL
RESOURCES



Knowledge Need

An Environmental Impact Assessment (EIA) is the process of examining, to ultimately mitigate, the anticipated environmental effects of a proposed project. Uncertainty around the potential environmental impacts of marine renewable energy (MRE) is a key challenge for the offshore renewables industry. To reduce this uncertainty, there is a need for coordinated, strategic research into the potential impacts of wave and tidal energy deployments on the environment. It is important for all MRE stakeholders to be aware of the existing evidence base regarding the potential environmental impacts of marine renewables on marine animals. This is to avoid duplication of effort and unnecessary delays and cost within the consenting process.

Additionally, there is a need for regulating bodies, statutory advisors, technology and project developers, and other stakeholders in the UK (and around the world), to be aware of – and in agreement on – the science relating to potential environmental impacts of MRE.

Knowledge Output

The 2016 OES Annex IV “State of the Science Report” summarises the state-of-the-science of interactions and effects of MRE devices on marine environments, the animals that live there, and the habitats that support them. The information presented in this report can help inform regulatory and research investigations of the potential risks to marine animals and habitats from tidal and wave installations. It can also assist MRE developers in developing engineering, siting and operational strategies, and aid monitoring options for projects that minimise encounters with marine animals and help diminish the effects if such encounters occur.

STEP 1

Collection
Sep 2016

STEP 3

Analysis – Profiling
Target User
Dec 2016

Knowledge Transfer Activity and Target Users

Exploitation Partners were identified that could facilitate the development of the State of the Science Report into a series of Knowledge Summaries. An initial meeting with these Exploitation Partners was organised by **COLUMBUS** and a series of follow up meetings and correspondence was conducted to begin the process of developing the series of Knowledge Summaries.

Once finalised, these will result in a consistent knowledge base and approach to consenting issues across regulators and stakeholders in the UK.

STEP 4

Transfer –
Developing a KTP
Dec 2016

Knowledge Output Pathway

COLUMBUS recognised the value of developing a series of “Knowledge Summaries” based on the State of the Science Report to help reduce time, risk and costs associated with the consenting process whilst ensuring that the relevant legislative requirements are met.

The intended eventual impact of this Knowledge Output Pathway is: to provide knowledge and recommendations to allow regulators to make better informed decisions with regards to the potential impacts of MRE projects.

The pathway to achieving this eventual impact would require:

1. Developing Knowledge Summaries in close consultation with Exploitation Partners.
2. Transferring these to seven identified stakeholders, including regulating bodies, statutory nature conservation bodies and developers in the UK.
3. Consulting with stakeholders to finalise and accept Knowledge Summaries.
4. Using the Knowledge Summaries in the planning and consenting process of MRE developments in the UK.

STEP 2

Analysis –
Developing a KOP
Sep - Nov 2016



STEP 5

KT activity and
measure impact
Jan – Mar 2017

Measured Impact

Funding was awarded from Marine Scotland and Natural Resources Wales in March 2017 to allow the **Offshore Renewables Joint Industry Programme (ORJIP) Ocean Energy** to develop a series of Knowledge Summaries from the OES Annex IV State of the Science Report. The Knowledge Summaries are being reviewed by the ORJIP Ocean Energy Steering Group, which contains representatives from regulators, researchers, developers and academia within the UK. Once completed, the Knowledge Summaries will be branded under the ORJIP Ocean Energy label to give weight to them in the UK sector and improve confidence in the End Users. As of January 2018, the Knowledge Summaries on the topics of Electromagnetic Fields and Project Design Envelopes are under development. Further funding is being sought to continue this work by the current Exploitation Partners and is hoped to be secured in the first quarter of 2018.

Next Steps

The Electromagnetic Fields Knowledge Summary will be completed in the first quarter of 2018 and will then be transferred to Target Users for consultation and feedback. The outlines of a further two Knowledge Summaries have been completed on the topics of Entanglement and Underwater Noise. These will also be finalised in 2018 and will then be transferred to Target Users for consultation.

Marine Scotland and Natural Resources Wales will use these Knowledge Summaries to allow regulators to make better informed decisions with regards to the potential impacts of marine energy projects.

PROJECTS

OES Annex IV | State of the Science Report | www.tethys.pnnl.gov/publications/state-of-the-science-2016

Value: €0.397 million (European Commission contribution: €0.297 million)

Timeline: Oct 2006 – Sep 2008

COMPETENCE NODE LEADER

Marine Physical Resources | **Aquatera** | Orkney, UK | www.aquatera.co.uk

CREDITS

Jennifer Fox, Ian Hutchison (**Aquatera**)

ENVIRONMENTALLY-FRIENDLY ANTI-FOULING PAINT FOR MARINE OBSERVATION DEVICES

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT TRANSFERRED ACROSS SECTORS, FROM THE SHIPPING SECTOR TO THE MARINE OBSERVATIONS SECTOR, TO DEVELOP NEW ANTI-FOULING TECHNOLOGY.

The **Selektope** project, coordinated by Swedish I-Tech AB as the sole project partner, aimed to introduce a new sustainable, anti-fouling technology to the global maritime market. The project was funded by an “Eco-Innovation” focused call under the “Entrepreneurship and Innovation” strand of the European Commission’s Competitiveness and Innovation Framework Programme.

OVERALL IMPACT OF COLUMBUS: FIELD TESTING OF ORGANIC, COPPER-FREE, ANTI-FOULING PAINT ON BUOYS

“Our main benefits from COLUMBUS are new application methods and matrices as well as contacts with European SMEs who, in a future perspective, may see market potential in the offshore industry.”

Dr Lena Lindblad, R&D Director, I-Tech AB

MARITIME TRANSPORT
AND LOGISTICS



Knowledge Need

Biofouling can occur on a micro- and macro-scale. This can include non-calcareous (i.e. lacking in calcium carbonate) soft fouling such as biofilm formation, bacterial adhesion and seaweed attachment. It can also include hard fouling: the attachment of calcareous organisms, for example barnacles. Biofouling has a significant impact on the fuel consumption of marine vessels, stemming from increased frictional drag of up to 80%. Fouled hulls can also transport invasive aquatic species, resulting in increased regulatory attention and vessels being refused entry to ports. While removal of organisms is possible, it can be expensive and may require mechanical means. Anti-fouling paint is widely recognised as a proven preventative measure. This paint is applied to a ship's hull and stops the adhesion of barnacles and other macro-organisms. However, current anti-fouling coatings are often made with copper and other heavy metals. **COLUMBUS** recognised that there is a large market demand for more sustainable anti-fouling coatings, both within and outside the shipbuilding sector – including application on marine monitoring equipment.

Knowledge Output

The Knowledge Output is a raw material: a biocide (a substance that destroys or inhibits the growth or activity of living organisms) that can be used to develop an organic, copper-free, anti-fouling paint. Named “**Selektope**” (after the project title), this material stimulates the movement of barnacle larvae. This prevents them from fixing onto the hull of the ship and other such surfaces. **Selektope** is proven to be cost-effective and can potentially save 30-40% on fuel costs by reducing the frictional drag. I-Tech, the Knowledge Owner, has gained regulatory approval for all relevant uses in Europe and gained approval for new builds and dry-docking in China, South Korea and Japan. The regulatory approval process has also been initiated in North America.

STEP 1

Collection
Mar 2016

STEP 3

Analysis – Profiling
Target User
Aug 2016

Knowledge Transfer Activity and Target Users

COLUMBUS recognised the potential application of the **Selektope** paint within the marine observation sector and that it would first need to be tested in the field.

COLUMBUS organised an information exchange with **I-Tech AB**, LEFANT AB (the paint manufacturer) and the Marine Technologies Unit at **CETMAR** in Vigo, Spain. Subsequently, a testing programme for **Selektope** application on oceanographic buoys in Galicia was developed between **CETMAR**, **I-Tech AB** and LEFANT AB.

STEP 4

Transfer –
Developing a KTP
Sep 2016

Knowledge Output Pathway

Marine monitoring technology – in terms of memory storage, power and sampling capacity, and quality of results – has evolved to enable data collection to take place over longer periods of time. This is important for ensuring marine protection and optimising sustainable marine exploitation. However, marine monitoring equipment (such as buoys) must be serviced on a regular basis due to fouling. This incurs high costs and negates the advantages of these technologies. **COLUMBUS** recognised that the application of an anti-fouling paint on marine monitoring equipment would save the need for such maintenance visits.

The intended eventual impact of this Knowledge Output Pathway is: to determine if **Selektope** can replace traditional anti-fouling agents on marine monitoring equipment.

The pathway to achieving this eventual impact would require:

1. Establishing a field-testing programme for Selektope on marine monitoring equipment.
2. Further investigations of the technology to monitor long-term performance.
3. Valuing of market share, manufacturing costs and volume of sales.
4. Commercialising of anti-fouling paint within the marine research sector, and exploration of new sectors.

STEP 2

Analysis –
Developing a KOP
Jul – Aug 2016



STEP 5

KT activity and
measure impact
Oct 2016 –
Apr 2017

Measured Impact

Two oceanographic monitoring buoys were painted and deployed – one half of each buoy was coated with **Selektope** and the other half with a traditional anti-fouling paint. These buoys were checked five times to examine the performance of the paints. Samples from the areas painted with **Selektope** and the traditional anti-fouling paint were collected. From this, a list of species found on each of the samples was prepared. The initial results showed that a traditional copper-based paint had a higher performance for preventing soft fouling. Following these initial results, **I-Tech AB** and **LEFANT AB** have begun investigations into improving the performance of the paint against soft fouling. Whilst testing is on-going, the pilot demonstration of the Knowledge Output to a new market has been successful.

Next Steps

Establishing hard fouling (including barnacles) on marine monitoring equipment takes at least three to four months. Therefore, further validation is required to collect more representative results. If the results are positive, further transfer to end-users (such as buoy manufacturers) is planned.

PROJECTS

Selektope | Introduction of a new sustainable antifouling technology to the global maritime market | www.selektope.com | CIP ECO-INNOVATION | Project ID: 304329

Value: €1.2 million (European Commission contribution: €0.6 million)

Timeline: Aug 2012 – Aug 2014

COMPETENCE NODE LEADER

Marine Transport and Logistics | **CMT** | Hamburg, Germany | www.cmt-net.org

CREDITS

Meike Neufeld, Lars Molter (**CMT**), Rosa Fernandez (**CETMAR**), Lena Lindblad (**I-Tech AB**)

NOVEL SOLUTION FOR COMPOSITE-STEEL JOINTS

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT PROVIDING AN INNOVATIVE APPROACH TO JOINING FIBRE-REINFORCED PLASTICS (FRP) WITH STEEL TO ENHANCE THEIR USE IN THE MARITIME SECTOR.

FAUSST is an ongoing German Industrial Collective Research project funded by the Federal Ministry for Economic Affairs and Energy (BMWi). Its aim is to join fibre-reinforced structures and steel – without the need of additional materials – using common processes from both the composite and shipbuilding industry.

**OVERALL IMPACT OF COLUMBUS:
SHIPBUILDERS AND SUPPLIERS TEST
NOVEL NON-ADHESIVE TECHNIQUE**

“We consider FAUSST as a remarkable solution in combination with our SAERTEX LEO® materials for highest fire protection. It combines the advantages of steel and composites with extreme opportunities for marine, railway and construction applications.”

Jörg Bünker, SAERTEX GmbH & Co. KG

MARITIME TRANSPORT
AND LOGISTICS



Knowledge Need

Adhesive joining is currently the most used joining technique for dissimilar materials. However, all structures must abide by certain high standards. This is especially true in the shipbuilding industry where the entire structure of a ship must prove its performance under extreme conditions for periods of up to 20 years. However, adhesive joining is not yet ready for use in most maritime applications. As a result, innovative alternative solutions using proven and approved materials and processes are required.

Knowledge Output

The Knowledge Output combines a multi-material hybrid fabric (a material consisting of steel fibres and glass fibres and made by warp knitting) and a steel to fibre-reinforced plastics (FRP) transition joint. This joint uses standard processes like welding and laminating to join structures made from steel and FRP. With this combination, a non-adhesive transition joint for steel and glass fibre was produced that is suitable for use in the maritime industry.

STEP 1

Collection
Jun 2017

STEP 3

Analysis - Profiling
Target User
Aug 2017

Knowledge Transfer Activity and Target Users

During a series of face-to-face-meetings and technical consultancy, the Knowledge Output was presented to three Target Users: **SAERTEX GmbH & Co. KG** (the global market leader in the manufacture of multiaxial fabrics and core materials for the production of fibre-reinforced composites); a shipyard that builds river cruise and specialised ships; and, a shipyard that builds individual yachts, including high-tech racers in carbon fibre.

COLUMBUS provided the Target Users with sufficient knowledge to produce and use a FRP structure and understand the benefits of the Knowledge Output. In addition, a technical brief was developed in preparation for a joint brokerage event on lightweight materials together with the European Network for Lightweight Applications at sea (E-LASS) in October 2017 in Pula, Croatia. The Knowledge Output was presented to a large audience mainly consisting of shipyard engineers, suppliers and material developers.

STEP 4

Transfer -
Developing a KTP
Aug - Sep 2017

Knowledge Output Pathway

The current trend in shipbuilding is to use more multi-material joints with advantages such as potentially decreasing the overall weight of a ship. **COLUMBUS** believed that the Knowledge Output concept of a non-adhesive transition joint for steel and glass fibre would provide an innovative and effective alternative in this field.

The intended eventual impact of this Knowledge Output Pathway is: to boost the use of non-adhesive transition joints for steel and glass fibre in the maritime sector.

The pathway to achieving this eventual impact would require:

1. Determining if there is a market demand for the use of a non-adhesive transition joint for steel and glass fibre within maritime companies.
2. Developing prototypes to assess the strength of the joint in comparison to other state-of-the-art technologies.
3. Updating current product designs considering the advantages and disadvantages of the new innovative technology.

STEP 2

Analysis –
Developing a KOP
Jul 2017



STEP 5

KT activity and
measure impact
Oct – Nov 2017

Measured Impact

Following the face-to-face meetings and consultancy, **SAERTEX** informed **CMT** that they had taken up the knowledge. **SAERTEX** found that the Knowledge Output led to new ideas for the implementation of steel components into their products – the first tests of which showed promising results. Furthermore, the shipyard that builds river cruises and specialised ships sees the Knowledge Output as a solution to overcome one of the major problems in the use of composite materials: the joining of these materials to steel structures. Finally, the shipyard that specialises in building individual yachts implemented the Knowledge Output for non-loaded structures and will consider it an option for joining composite materials to steel in the future.

Next Steps

The Target Users will further assess the potential application of the Knowledge Output within their companies. **SAERTEX** has already started building a prototype while the other Target Users will start with prototype building in 2018. Regarding upcoming orders and the potential use of composite materials on-board ships, the clustered Knowledge Output can be impactful in terms of cost, production, design and reliability in the future.

PROJECTS

FAUSST | Faserverbundwerkstoff-und-Stahl-Standard Verbindung (The Union of Fibre Reinforced Materials and Steel) | www.fausst.com | iGF; BMWi | AiF-Nr. 18785 BG

Value: €0.4 million

Timeline: Feb 2016 – Jan 2018

COMPETENCE NODE LEADER

Marine Transport and Logistics | **CMT** | Hamburg, Germany | www.cmt-net.org

CREDITS

Meike Neufeld, Lars Molter, Rafael Luterbacher (**CMT**), **SAERTEX GmbH & Co. KG**

APPLICATION OF NEW INNOVATIVE COMPOSITE MATERIALS FOR RIVER CRUISE SHIPS

THIS CASE STUDY HAS SEEN A KNOWLEDGE OUTPUT INCREASE IN TECHNOLOGY READINESS LEVEL AS IT HAS BEEN TRANSFERRED AS A FULL-SCALE DEMONSTRATOR AND APPLIED BY THE MARKET.

The **ThroughLife** project was coordinated by MEYER WERFT GmbH & Co. KG shipyard. It was funded to “develop and prove new approaches for through-life asset management for selected technologies and application scenarios” within the shipping sector. In the past, the European shipping sector was primarily focused on reducing production costs to stimulate competitive prices. However, the focus has since changed, and the sector is focused mainly on optimising lifecycle costs, which can lead to competitive advantages and enable new business opportunities. This new approach is known as “through-life asset management”.

OVERALL IMPACT OF COLUMBUS: APPLICATION OF NEW COMPOSITE MATERIAL IN CRUISE SHIP DESIGN RESULTING IN ECONOMIC AND ENVIRONMENTAL BENEFITS OVER EXISTING DESIGNS

Using its expertise from recent research projects, COLUMBUS provided an overview of feasible materials and structures for lightweight construction which was integrated into a new design concept for one extraordinary and sophisticated project.

Jens Meyer, Director of KJH Schiffbaukontor
Koelln-Jacoby

MARITIME TRANSPORT
AND LOGISTICS



Knowledge Need

The European river cruise market grew about 3% in 2016. The German market alone generated a turnover of approximately €450 million according to statistics released by the German Travel Association (DRV). Thus, Europe's river cruise market makes a significant contribution to the Blue Economy.

One of the main challenges faced by this sector is overcoming low water levels associated with dry seasons which prevents access to certain routes all year around. Cruise ship operators are continuously looking for potential improvements to the functional and aesthetic design of riverine cruise ships which could lead to improved competitiveness. Innovations in robust lightweight materials suitable for application in ship building is a priority as they could help reduce fuel consumption resulting in lower levels of emissions.

Knowledge Output

In response to the market need for lightweight materials, the **ThroughLife** project developed a large-scale composite sundeck as a demonstrator and tested it during the project lifetime. The demonstrator had dimensions of 11.4 x 11.2 m, representative of the width of a contemporary river cruiser and the length of four cabins. The tests proved that building river cruiser sundecks out of composite materials was feasible. This sundeck is therefore a greener, lightweight option and costs less in maintenance because of its less corrosive material. Furthermore, due to the weight saving of using composite materials over current designs, the ship is light and thus permits ships to enter previously inaccessible shallow water routes. The potential to extend the amount of cruise days per year is a key selling point for ship operators to adopt the new technology.

STEP 1

Collection
Mar 2016

STEP 3

Analysis – Profiling
Target User
Jan 2017

Knowledge Transfer Activity and Target Users

A user-friendly description of this Knowledge Output was distributed to a German cluster network for the shipbuilding industry. The group comprised of: 10 shipyards, 26 marine suppliers, 33 academic organisations and six associate members.

Following the Knowledge Transfer activity, the engineering office of **Schiffbaukontor Koelln-Jacoby (KJH)**, approached **COLUMBUS** Partner **CMT** (Hamburg) showing interest in applying the Knowledge Output directly in their projects.

In response, a technical brief was developed with further information about the Knowledge Output and a face-to-face meeting took place with **KJH** in February 2017. **CMT**, on behalf of **COLUMBUS**, also offered support to further transfer the Knowledge Output to another end user, a European shipyard identified as a potential customer.

STEP 4

Transfer –
Developing a KTP
Feb 2017

Knowledge Output Pathway

The concept of using composite materials for a sundeck was originally targeted at the river cruise market, yet **COLUMBUS** saw the potential cross applicability by the maritime community.

The intended eventual impact of this Knowledge Output Pathway is: for river cruise ships to utilise the composite sundeck to decrease the weight of their vessel resulting in reduced fuel consumption and lower levels of emissions.

The pathway to achieving this eventual impact would require:

1. Promoting the new knowledge to cluster organisations to determine if there is an application for the composite sundeck and/or technology behind composite materials to the river cruise sector and other related marine/maritime sectors.
2. Demonstrating the composite sundeck to ship builders and suppliers of high-end craft materials.
3. IPR management and potential licencing arrangements for the underlying technology to allow a supply chain actor to manufacture the materials to supply potential customers.

STEP 2

Analysis –
Developing a KOP
Dec 2016 – Jan 2017



STEP 5

KT activity and
measure impact
Mar – May 2017

Measured Impact

Prior to **COLUMBUS** involvement, **KJH** was unaware of the feasibility and potential for advancing these materials for ship design. Within three months, **KJH** informed **COLUMBUS** that they had taken up the Knowledge Output and applied it to a bespoke river cruiser design. After the ongoing certification of the lightweight design is finished, it is expected that the river cruiser will be able to reduce draught by about 5%. This will lead to an increase in operating days as well as a reduction in fuel consumption compared to using standard materials.

Next Steps

KJH intends to further use this new lightweight material in their future design concepts, whilst protecting the intellectual property behind the design during the manufacturing process. Ideally, the wider marine and maritime community would be made aware of the application of these composite materials.

PROJECTS

ThroughLife | Development and proof of new approaches for through-life asset management based on next generation of materials and production technology | www.throughlife.eu
FP7 - TRANSPORT | Project ID: 265831

Value: €3.6 million (European Commission contribution: €2.5 million)

Timeline: Apr 2011 – Mar 2014

COMPETENCE NODE LEADER

Marine Transport and Logistics | **CMT** | Hamburg, Germany | www.cmt-net.org

CREDITS


Meike Neufeld, Lars Molter, Jens Meyer (**KJH Schiffbaukontor Koelln-Jacoby**)

SELF-HEALING COATINGS AS CORROSION PROTECTION IN MARITIME SHIPPING

THIS CASE STUDY HAS SEEN THE KNOWLEDGE OUTPUT OF AN INNOVATIVE TECHNOLOGY FOR CORROSION PROTECTION ON SHIPS TRANSFERRED TO RELEVANT INDUSTRY STAKEHOLDERS.

The **ThroughLife** project was coordinated by MEYER WERFT GmbH & Co. KG shipyard. It was funded to “develop and prove new approaches for through-life asset management for selected technologies and application scenarios” within the shipping sector. In the past, the European shipping sector was primarily focused on reducing production costs to stimulate competitive prices. However, the focus has since changed. Nowadays the sector is focused mainly on optimising lifecycle costs. The belief is that this can lead to competitive advantages and enable new business opportunities. This new approach is known as “through-life asset management”.

OVERALL IMPACT OF COLUMBUS: FACILITATION OF FURTHER RESEARCH AND DEVELOPMENT TO ENABLE UPTAKE BY THE MARITIME SHIPPING INDUSTRY



“Self-healing coatings offer great potential for corrosion protection in the maritime sector. COLUMBUS provided support to establish further contacts for future development of this coating technology to progress towards market uptake.”

Dr. Volkmar Stenzel, Fraunhofer IFAM,
Department Paint/Lacquer Technology



Knowledge Need

Due to harsh environmental conditions at sea, structural materials and steel require robust protection against weathering and degradation. Most ships have ballast water tanks that suffer from corrosion, which often starts with minor damage to the outer protective layer (i.e. the coating). Such small damage can be difficult to detect by eye but may quickly evolve into larger cracks, disrupting the protective effect of the coating. This damage can be costly to fix as well as requiring significant time to carry out repair work.

To significantly lower maintenance costs in the process, solutions are required to reduce the corrosion rate of marine vessels; particularly for areas that are difficult to access and more difficult to repair, like ballast water tanks.

Knowledge Output

The Knowledge Output is a so-called “self-healing coating”. It consists of a model coating system that contains different concentrations of microcapsules filled with a healing agent and a corrosion inhibitor.

Microcracks develop due to stress and strain endured by individual, structural parts of a ship. When damage to the coating occurs, the microcapsules break apart at the point of impairment. The healing agent is then released, and the damaged area undergoes repair. This mechanism allows structural cracks to be mended. It prevents cracks from spreading and causing damage to the underlying materials.

STEP 1

Collection
Mar 2016

STEP 3

Analysis – Profiling
Target User
Nov 2016

Knowledge Transfer Activity and Target Users

The Target User was identified as a representative from the Paint/Lacquer Technology Department at **Fraunhofer IFAM** – a large research institution in Europe for adhesive bonding technology, surfaces, shaping and functional materials. During a face-to-face meeting with the Target User and external (coating) experts, the status of the Knowledge

Output and its potential for corrosion protection in the maritime sector was discussed. The **COLUMBUS** team organised a Brokerage Event “Cutting Edge Solutions for Marine Coatings - Innovation that Ignites Protection and Performances” on 16 May 2017 in Brussels, where the Knowledge Output was presented to invited stakeholders from the maritime shipping industry.

STEP 4

Transfer –
Developing a KTP
Jan – Feb 2017

Knowledge Output Pathway

The Knowledge Output concept of self-healing coatings has yet to be used in the shipping sector. **COLUMBUS** believed that the Knowledge Output could provide an innovative solution for corrosion protection in ballast water tanks of ships. To do this, the technology would require further development, including understanding longer term results and cost benefits, to achieve market uptake by the industry.

The intended eventual impact of this Knowledge Output Pathway is: to supply self-healing coatings for corrosion protective to the maritime market.

The pathway to achieving this eventual impact would require:

1. Determining the development requirements to adapt the self-healing coating for use in the maritime shipping sector
2. Raising awareness of the potential and benefits of the self-healing coating to the maritime shipping industry
3. Finding funding to develop the knowledge further, according to the identified requirements
4. Commercialising the adapted technology for the maritime shipping sector

STEP 2

Analysis –
Developing a KOP
Oct – Nov 2016



STEP 5

KT activity and
measure impact
Mar – Jun 2017

Measured Impact

Following the face-to-face meeting and the brokerage event, the Target User established additional contacts outside the original project consortium and discussed the further technical development of the Knowledge Output. Together, they are collaborating on a funding proposal with the aim of further developing the knowledge for future market uptake.

Next Steps

The Target User will continue with research in the field of self-healing coatings and participate in a new research project related to the topic. Once it has been developed further, commercialisation will allow it to be utilised widely.

PROJECTS

ThroughLife | Development and proof of new approaches for through-life asset management based on next generation of materials and production technology | www.throughlife.eu
FP7 – TRANSPORT | Project ID: 265831

Value: €3.6 million (European Commission contribution: €2.5 million)

Timeline: Apr 2011 – Mar 2014

COMPETENCE NODE LEADER

Marine Transport and Logistics | **CMT** | Hamburg, Germany | www.cmt-net.org

CREDITS

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GLOSSARY

COLUMBUS DEFINITIONS

Knowledge Transfer: The term for the overall process of moving knowledge between knowledge sources to targeted potential users of knowledge. Knowledge Transfer consists of a range of activities which aim to capture, organise, assess and transmit knowledge, skills and competence from those who generate them to those who will utilise them.

Knowledge Output: A unit of knowledge or learning generated by or through research activity. They are not limited to de-novo or pioneering discoveries but may also include new methodologies/processes, adaptations, insights, alternative applications of prior know-how/ knowledge.

Knowledge Output Pathway: This can be one step, or a series of steps required to carry a Knowledge Output to its Eventual Impact. Where there are a series of steps, it will include detailed mapping of the steps, the users involved at each step and their predicted role in the pathway to Eventual Impact.

Eventual Impact: The ultimate end benefit of the application of the Knowledge Output. It is defined as an enhanced situation that is contributing to “Blue Growth” including the implementation of the Marine Strategy Framework Directive (MSFD).

Transfer Impact: The demonstrable evidence that a Knowledge Output has travelled down a single step on the Knowledge Output Pathway.

Target User(s): The individual(s) identified in the Knowledge Output Pathway to whom the Knowledge Output should be transferred.

End User(s): The individual(s) who will apply the Knowledge Output at the end of the Knowledge Output Pathway.

Exploitation Partner: An external organisation/institution/individual who has an interest and/or expertise that may assist in transferring the Knowledge Output down the Knowledge Output Pathway to its Eventual Impact.

COLUMBUS ABBREVIATIONS

EC European Commission

IP Intellectual Property

KO Knowledge Output

KOP Knowledge Output Pathway

KOT Knowledge Output Table

KT Knowledge Transfer

KTP Knowledge Transfer Plan

MSFD Marine Strategy Framework Directive

COLUMBUS IS VERY MUCH AT THE FOREFRONT OF THE EUROPEAN COMMISSION BLUE GROWTH AGENDA, AS ITS OVERARCHING OBJECTIVE IS TO ENSURE THAT APPLICABLE KNOWLEDGE GENERATED THROUGH EU-FUNDED SCIENCE AND TECHNOLOGY RESEARCH CAN BE TRANSFERRED EFFECTIVELY TO ADVANCE THE GOVERNANCE OF THE MARINE AND MARITIME SECTORS. THE PROJECT'S AMBITION HAS BEEN TO HELP INCREASE THE COMPETITIVENESS OF EUROPEAN COMPANIES BY UNLOCKING THE POTENTIAL OF THE OCEANS TO CREATE FUTURE JOBS AND ECONOMIC GROWTH IN EUROPE.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652690. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.