Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

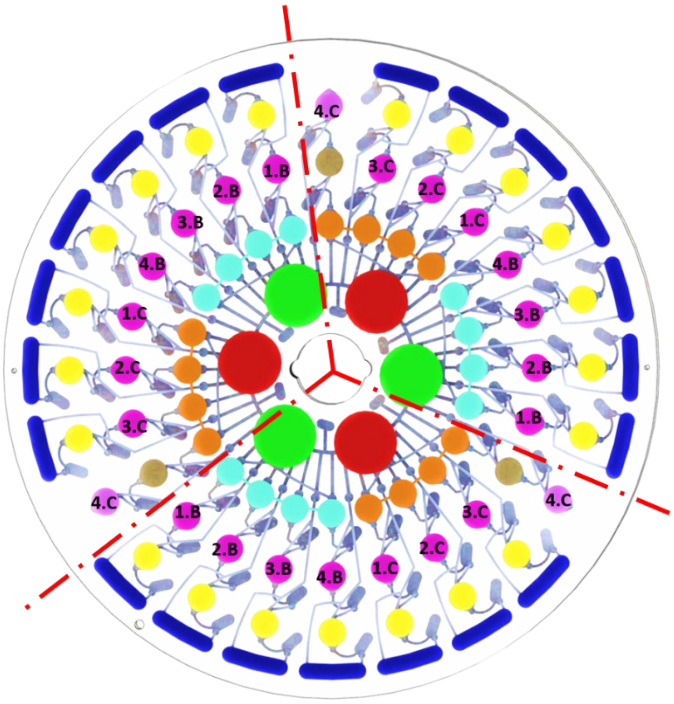
Water Institute

Marine

Knowledge Transfer Report

Project Title:
Creating an Autonomous and Deployable Sea Monitoring System

MARIABOX



Synopsis:

This project involves the development of a highly-sophisticated marine sensing technology capable of real-time detection priority **biological toxins** and **chemical pollutants**, as well as standard routine water characterisation (**Temperature, pH, Conductivity and dissolved oxygen**).

Dr. Jenny Fitzgerald of the DCU Water Institute inspecting the SmartBay Buoy, on which the MARIABOX Platform was installed.

Abstract

The **MARIABOX** Project (MARINE environmental *in-situ* Assessment and monitoring tool BOX) was coordinated by the Cyprus research and Innovation Center (CyRIC). The aim of the project was to develop a buoy-based platform which could monitor biological toxins (microcystin, saxitoxin, domoic acid and azaspiracid) and chemical pollutants (naphthalene, perfluorooctanoic acid, camphechlor and total heavy metals) in marine water. This platform was then deployed at EU pilot locations (Ireland, Spain, Norway, and Cyprus) taking account oflocal environmental conditions (monitoring also temperature, pH, conductivity and dissolved oxygen). This novel sensor platform could then be used in providing a forecasting tool for the aquaculture industry across Europe.

Overall Impact of MARIABOX:

- Provide a large increase in the temporal and geographic coverage from in-situ marine sensors to enhance the European contribution to Global Monitoring of the Oceans.
- Increase availability of standardised in-situ data that is suitable for integration within key marine observation, modelling and monitoring systems and reduce ocean modelling uncertainty.
- Reduce cost of data collection system in support of fisheries management.
- Advance competitiveness for European Industry's & particularly SME's within the Marine sensing sector
- Enable better cooperation between key sectors (Manufacturing Industry, ICT, Maritime Industry, Marine Science, Fisheries etc.)
- Support implementation of European Maritime Policies.
- Promote new discoveries leading to better understanding of the seas
- Protect the production of aquaculture in the European Union (estimated to be worth €4 billion in 2015)

Knowledge Need

The volume of aquaculture production in the European Union was estimated to be 1.3 million tonnes in 2015, worth €4 billion. Harmful algal bloom events, which result in the release of highly potent toxins, and chemical waste can devastate aquafarming produce resulting in the loss of millions in equity. Therefore, viability of the European aquaculture industry is largely dependent on the strengthening of current risk and impact prediction tools to offer advice in asset management. On top of this, the real-time data produced can assist in investigation and understanding of harmful algae bloom events.

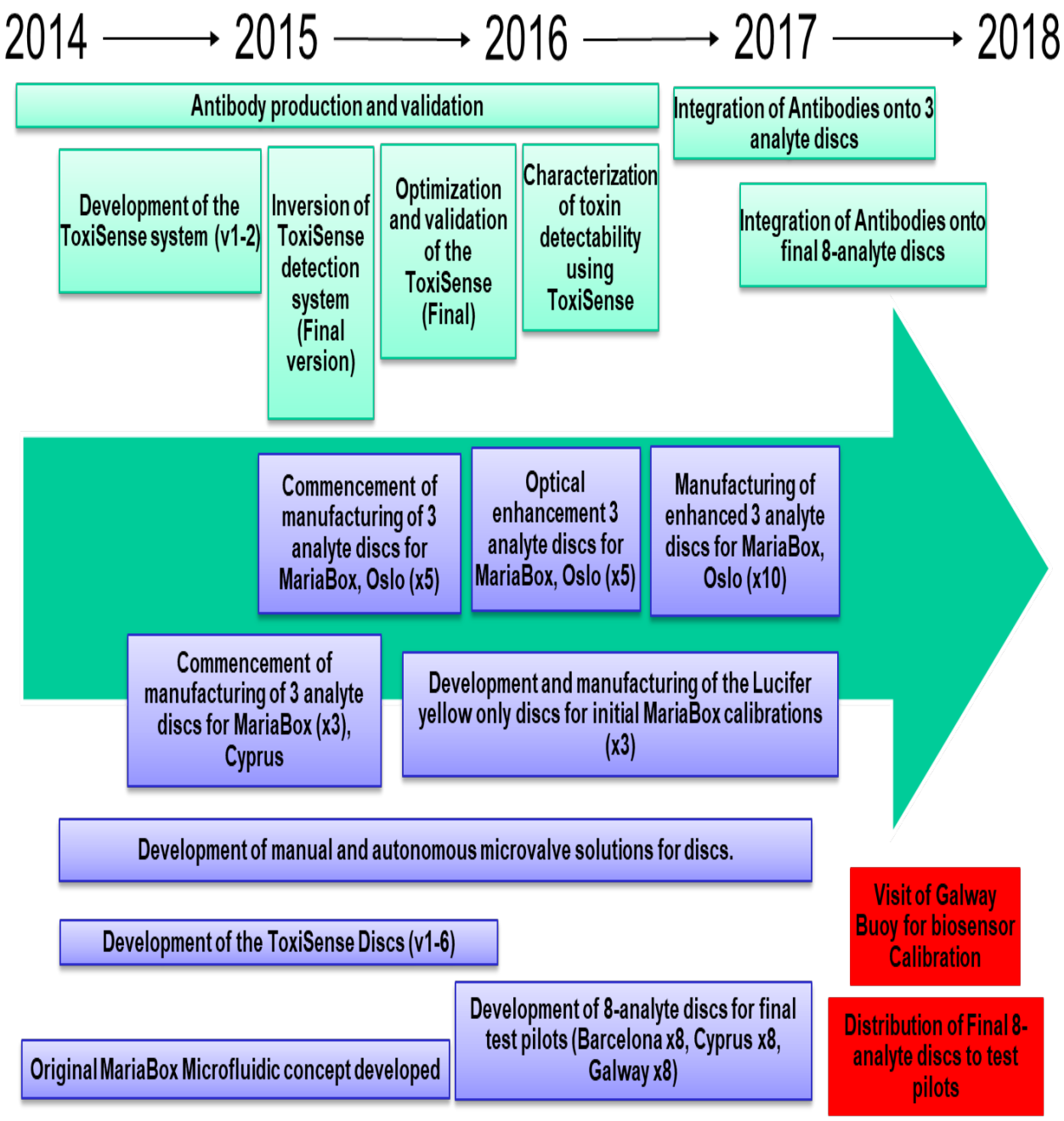
Knowledge Output

The MARIABOX project has delivered a number of different scientific and technical results throughout its four years. Key outputs associated with this project include:

- Development of a fully-automated smart buoy with on-board data processing, biosensors storage and management, both long and short distance communication utilities, and integrated power strategies for up to 6 months targeted deployment.
- Highly-integrated **novel centrifugal-microfluidic** biosensor technology with sensitive engineered antibodies and chemical pollutant detection strategies for the detection of up to 8 analytes hazardous to the aquaculture environment.
- **Sophisticated designs** were developed providing know-how to enable the building of multi-analyte platforms that are scalable and manufacturable.
- **Publications** -Novel Microfluidic Analytical Sensing Platform for the Simultaneous Detection of Three Algal Toxins in Water (https://pubs.acs.org/doi/abs/10.1021/acsomega.8b00240)

Knowledge Transfer Act and Target Users

The target users are the stakeholders of both individual, governmental agencies (e.g. Marine Institute) and industrial aquafarming within the European Union. Potential end-users and future stakeholders were targeted through the attendance and dissemination of project representatives, including the running of three workshops, ten conference presentations and six (with two further pending) scientific publications.



Knowledge Output Pathway

Measured Impact

The measured impact of this project was determined on the number of individually and collectively marketable assets produced during the course of the project.

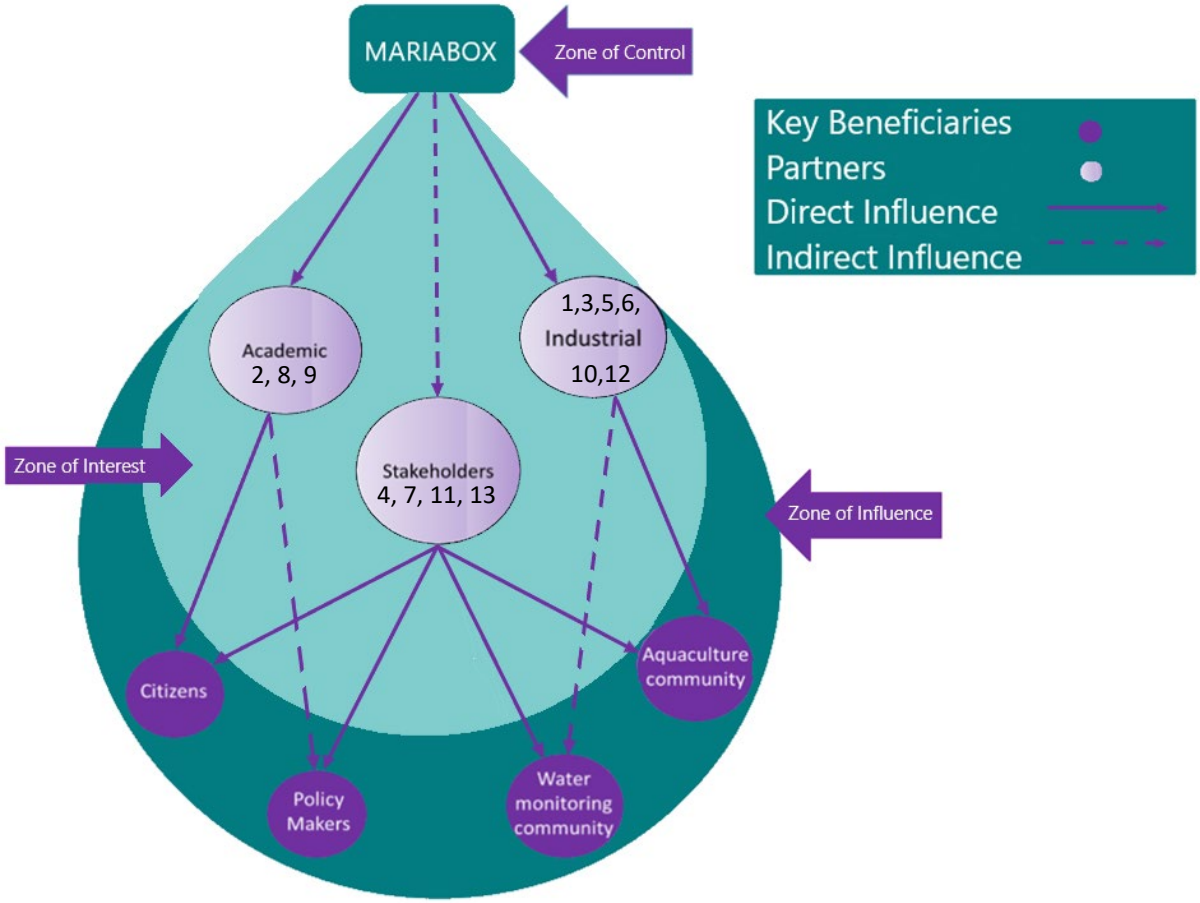
Firstly, four novel and highly selective antibody clone libraries produced for the detection of toxin, of which had not been previously been constructed.

Secondly, a microfluidic platform which incorporated complex microvalving strategies for high precision sample and reagent manipulation with capabilities for triplicate testing of eight analytes per disc.

Thirdly, these in combination with the MARIABOX platform, resulted in an industry focused, fully autonomous and deployable asset.

Next steps

Following the project, an individual, project-specific 'Key Beneficiaries Impact Assessment' was performed, thereby allowing successful knowledge transfer and avenues of collaboration can be fully investigated. This is outlined in the figure below:



Project Funding

MARIABOX | MARINE environmental *in-situ* Assessment and monitoring tool BOX

FP7 – OCEAN - 2013| Project ID: 614008**Value:** €7.1 Million (European Commission contribution € 5.2 million)
Timeline: Feb 2014 – Feb 2018

Consortium Management Leader

Cyprus Research and Innovation Center Ltd | **CYRIC** | Nicosia, Cyprus|**www.cyric.eu**

Social Media

Twitter: @mariaboxfp7Website: http://www.mariabox.net/

Final project report available at: https://cordis.europa.eu/project/rcn/191259/reporting/en

Key Dissemination Elements

Novel Microfluidic Analytical Sensing Platform for the Simultaneous Detection of Three Algal Toxins in Water
(https://pubs.acs.org/doi/abs/10.1021/acsomega.8b00240)

MariaBox: First prototype of a novel instrument to observe natural and chemical pollutants in seawater
(https://ieeexplore.ieee.org/abstract/document/8084860)

Detection of naphthalene in sea-water by a label-free plasmonic optical fiber biosensor
(https://www.sciencedirect.com/science/article/pii/S003991401831083X)

A centrifugal microfluidic-based approach for multi-toxin detection for real-time marine water-quality monitoring
(https://ieeexplore.ieee.org/abstract/document/8084975)

Convenient 'one-step' extraction method for autonomous sensing of marine algal toxins

(https://ieeexplore.ieee.org/abstract/document/8084971)

A High Sensitivity Biosensor to detect the presence of perfluorinated compounds in environment
(https://www.sciencedirect.com/science/article/pii/S003991401731069X)

Partners

1. **Cyprus Research and Innovation Center (CYRIC) Ltd,** 72, 28th October Avenue, Office: 301, Engomi, Nicosia 2414, Cyprus
2. **DCU Water Institute,** Prof. Fiona Regan – Fiona.regan@dcu.ie School of Chemical Sciences, School Of Biotechnology, School Of Physics, Dublin City University (DCU), Glasnevin, Dublin 9, Ireland
3. **Acorde Technologies S.A.,**Calle el Castro, 22N, 39011 Santander, Cantabria, Spain
4. **Smartbay Ireland Limited, Marine Institute,**Rinville West, Oranmore, Co. Galway
5. **Holloway Immunology Ltd,** Royal Holloway, Egham Hill, Egham TW20 0EX, UK
6. **Kontor 46,** Via Sant'Anselmo, 32, 10125 Torino TO, Italy
7. **Institute of Food Science,**ConsiglioNazionaleDelleRicerche (CNR), Via Roma, 52, 83100 Avellino AV, Italy
8. **Università Di Napoli Federico II (FUN),**Corso Umberto I, 40, 80138 Napoli NA, Italy
9. **NorskInstitutt for Vannforskning (NIVA),**Gaustadalléen 21, Oslo 0349, Norway
10. **Ateknea Solutions Catalonia S.A.,**Carrer Can Rosés, 45, (Ex Víctor Pradera), 08940 Cornellà de Llobregat, Barcelona, Spain
11. **AgenciaEstatalConsejo Superior De InvestigacionesCientificas,** Barcelona, Spain
12. **Signalgenerix Ltd,** Grigori Afxentiou 23c, Mesa Geitonia, Limassol, Cyprus, Limassol 4003, Cyprus
13. **Ministry of Agriculture, Natural Resources and Environment Of Cyprus,**Amfipoleos 6, Nicosia, Cyprus

DCU Water Institute
dcuwater
E: waterinstitute@dcu.ie
www.dcuwater.ie