

National Biodiversity Data Centre

# Draft Marine Biodiversity Citizen Science Strategy 2023-2028



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# Summary

Marine Biodiversity Citizen Science is increasingly recognised at national, European Union and international level as a valuable contributor of robust data to support marine policy reporting requirements, developing marine environmental policy, and engaging citizens in ocean literacy and marine policy. To this end the National Biodiversity Data Centre has prepared this draft Marine Biodiversity Citizen Science Strategy for consultation with key partners, stakeholders and the public.

The Ministerial declaration at the Fourth Session of the UN Environment Assembly in March 2019 stated:

*“We the Environment Ministers ... will invest in environmental research, education and awareness raising in the framework of sustainable development with a strong focus on women and youth and promote a wider use of innovative approaches, such as inclusive citizen science”.*

Our ocean provides us with ecosystem services which support our economy, security, health and wellbeing, and yet it is under increasing pressure from a range of human impacts. For Ireland to succeed in our marine conservation goals, public buy-in is essential. Lack of public awareness and understanding of the ocean, its ecosystems, and the threats facing them, are the single biggest barrier to progressing sustainable use of our ocean.

Significant gaps in our knowledge of marine biodiversity have highlighted an urgent need to integrate Marine Biodiversity Citizen Science into marine conservation, monitoring, and reporting. The EPA funded Explore Your Shore! project has shown that there is a strong appetite for Marine Biodiversity Citizen Science in Ireland. Since the project’s inception in 2019, the Data Centre has witnessed a 298% increase marine species records received via its Citizen

Science Portal, with 1,340 volunteer recorders submitting 11,000 marine biodiversity records.

The National Biodiversity Data Centre’s Marine Biodiversity Citizen Science Strategy 2023 – 2028 sets out a pathway for the Data Centre to:

- ✓ Engage and support the Irish public, NGOs, state agencies and departments, local government, and academia in conducting Marine Biodiversity Citizen Science.
- ✓ Address data gaps.
- ✓ Integrate marine biodiversity citizen science into policy.
- ✓ Coordinate initiatives with key state agencies
- ✓ Build Explore Your Shore! as a national platform for marine biodiversity citizen science.
- ✓ Encourage a culture of Open Access in marine biodiversity data.



This strategy ties in with national, EU, and international policy on using citizen science data to fill data gaps, meet monitoring and reporting requirements, and increase Ocean Literacy towards achieving an active, engaged, and well-informed European Marine Citizenship.

## Goal 1: Establish a National Platform for Marine Biodiversity Citizen Science within the National Biodiversity Data Centre.

### 7 OBJECTIVES | 20 ACTIONS

- Promote Explore Your Shore! as a National Platform for Marine Biodiversity Citizen Science.
- Promote, support, and facilitate Irish Marine Biodiversity Citizen Science initiatives.
- Establish a funding pool to support and maintain existing and new Marine Biodiversity Citizen Science projects.
- Increase the knowledge base and promote Ocean Literacy.
- Participate in the EU4Ocean coalition.
- Encourage and facilitate participation in Marine Biodiversity Citizen Science by island communities.
- Promote Marine Biodiversity Citizen Science to societal groups that are underrepresented in the current Recorder Network.



Figure 2. Explore Your Shore Training with Dublin City Council at Bull Island, Co. Dublin 2020

## Goal 2: Integrate Marine Biodiversity Citizen Science into Policy and Research

### 11 OBJECTIVES | 28 ACTIONS

- Collaborate at national and EU level on incorporating Citizen Science into EU Nature, Water and Marine Directives monitoring and reporting.
- Collaborate on incorporating Citizen Science into monitoring and implementation of the UN Sustainable Development Goals.
- Identify Marine Biodiversity data gaps which can be filled using Citizen Science.
- Identify existing monitoring and reporting requirements that can be fulfilled or enhanced by using Marine Biodiversity Citizen Science.
- Promote the use of Marine Biodiversity Citizen Science to help achieve goals and objectives, by policy makers, state agencies and government.
- Promote the use of Marine Biodiversity Citizen Science in research by Irish Universities, Institutes of Technology and Colleges.
- Encourage national research funding organisations to better promote and support Marine Biodiversity Citizen Science.
- Maintain the Data Centre's role as an active and engaged member of the European Citizen Science Association.
- Support Invasive Marine Species Monitoring in Ireland.
- Participate in the survey of Biology and Ecosystems monitoring programs in Europe (BioEco).
- Link Marine Biodiversity Citizen Science with national and EU health policy and initiatives.

### Goal 3: Deliver Enhanced Availability, Useability, and Integration of Robust Marine Biodiversity Data

#### 14 OBJECTIVES | 38 ACTIONS

- Ensure Citizen Science recorders receive appropriate acknowledgement wherever Citizen Science datasets are used.

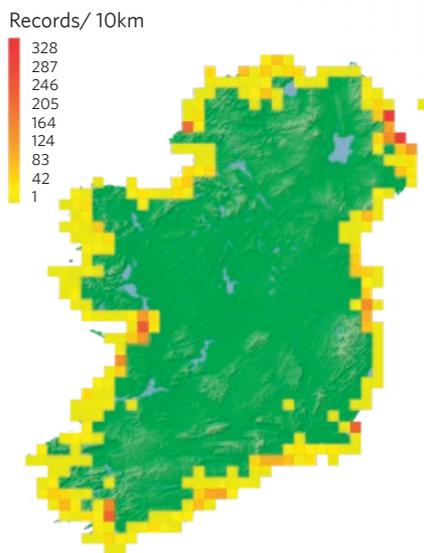


Figure 3. Map of Validated Marine Species Records per km sq. recorded in 2019 - 2021.

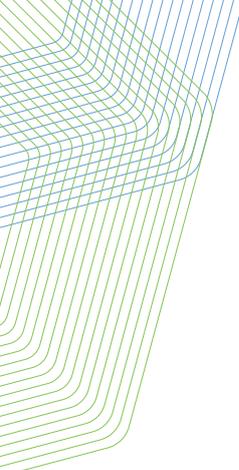
- Develop Marine Biodiversity Citizen Science Data standards, protocols, guidelines, and training.
- Review existing marine datasets on Biodiversity Maps, updating names and remove duplicates or errors as required.
- Ensure collaborators and partner projects have access to data and visualization tools that meet their requirements.
- Ensure the Biodiversity Maps marine taxonomic dictionary is kept up to date.
- Maximise availability of Marine Biodiversity Data through increasing the number of Open Access Data Sets.
- Collaborate at National, European, and international level to achieve standardisation of Marine Biodiversity Data Sets and recording parameters.

- Develop partnerships for the use of Marine Biodiversity Citizen Science Data.
- Develop a publication strategy for Marine Biodiversity Citizen Science data submitted to the National Biodiversity Data Centre.
- Generate Marine Biodiversity Indicators to feed into the Data Centre's National Biodiversity Indicators.
- Develop / upgrade a marine biodiversity recording app.
- Seek to collaborate in development of computer software for automated marine species identification.
- Explore collaborations to develop automated or crowd-sourced validation of Marine Biodiversity Citizen Science data.
- Collaborate with EU partners towards developing EU-wide Marine Biodiversity Citizen Science projects and an EU Marine Biodiversity Citizen Science data centre.

### Goal 4: Building Partnerships to Build the National Marine Biodiversity Data Resource

#### 5 OBJECTIVES | 11 ACTIONS

- Build collaborations and an active stakeholder network with a view to developing sharing of new and existing data sets with the National Biodiversity Data Set on Biodiversity Maps.
- Establish data sharing agreements with key data holders.
- Develop collaborations between state agencies, academia, and citizen science recorders.
- Update existing datasets on a regular basis.
- Develop collaborations with international (EU and non-EU) Marine Biodiversity Citizen Science practitioners.



## Goal 5: Improve our knowledge of marine species and habitats

### 10 OBJECTIVES | 36 ACTIONS

- Train and support a network of skilled and active Marine Biodiversity Citizen Science recorders.
- Maintain and promote the Explore Your Shore! suite of Marine Biodiversity Citizen Science Surveys.
- Promote Explore Your Shore! Citizen Science participation.
- Identify key indicator species for water quality and climate change to develop flagship surveys.
- Establish a network of intertidal monitoring sites around the Irish Coast.
- Highlight the links between Marine Biodiversity and Climate Change, Water Quality, Litter, and invasive species.
- Collaborate with An Taisce's Clean Coasts to grow the Clean Coasts Observer programme.
- Collaborate with Seasearch Ireland to develop a programme of sub-tidal monitoring sites around the Irish Coast.
- Engage with experts in State Agencies, Local Authorities, Government Departments, Museums and Universities to help deliver training to volunteers in marine biodiversity taxonomy and survey techniques.
- Work with partners in Northern Ireland to develop an all-Ireland Marine Biodiversity recording network.

## Goal 6: Promote Actions to Protect and Regenerate Marine Biodiversity in Ireland

### 5 OBJECTIVES | 10 ACTIONS

- Identify marine conservation actions suitable for citizen led initiatives.
- Publish guidelines on marine conservation actions for target groups, species, or habitats.
- Develop collaboration with existing marine conservation initiatives with elements suitable for public participation.
- Promote citizen-led participation in local authority BAP marine conservation goals.
- Assess feasibility of adopting flagship restoration project.

## Strategy Prerequisites

This strategy is based upon the prerequisites of securing adequate funding and support to deliver the strategy and that the National Biodiversity Data Centre's Citizen Science platforms are maintained to:

- Promote biodiversity citizen science data collection and drive local enthusiasm for biodiversity citizen science projects.
- Deliver programmes at a scale that will be valuable to communities, local government, government, EU and global partners.
- Manage national biodiversity data sets.
- Respond in an effective and efficient manner to national, EU and global data end users.
- Ensure support for genuine citizen science generated biodiversity programmes that answer real local needs.

# Introduction

Marine Biodiversity Citizen Science is increasingly recognised at national, European Union and international level as a valuable contributor of robust data to support marine policy reporting requirements, developing marine environmental policy, and engaging citizens in ocean literacy and marine policy<sup>1</sup>.

Our ocean provides us with ecosystem services which support our economy, security, health and wellbeing<sup>40</sup>, and yet it is under increasing pressure from a range of human impacts. Significant gaps in our knowledge of marine biodiversity have highlighted an urgent need to integrate Marine Biodiversity Citizen Science into marine conservation, monitoring, and reporting. However, this must be supported by a coherent strategy to ensure Marine Biodiversity Citizen Science activities produce scientific data that is both useful and robust enough to meet policy and reporting requirements.

The National Biodiversity Data Centre's Marine Biodiversity Citizen Science Strategy 2023 - 2028 sets out a pathway for the Data Centre to:

- Engage and support the Irish public in Marine Biodiversity Citizen Science and Ocean Literacy.
- Address data gaps in the national knowledge of marine (and in particular intertidal) biodiversity with robust validated data.
- Better integrate marine biodiversity citizen science into national policy and education.
- Continue building Explore Your Shore! as a national platform for marine biodiversity citizen science.

- Collaborate with stakeholders including Citizen Scientists, NGOs, state agencies and academics in developing and supporting Marine Biodiversity Citizen Science initiatives in Ireland.
- Work with key state agencies to coordinate national Marine Biodiversity Citizen Science activities in supporting their core objectives.

This strategy ties in with the Aarhus Convention on the right to citizen participation in marine policy<sup>1</sup> and has the potential to feed into Ireland's reporting requirements under the EU Habitats Directive, the water Framework Directive, the Marine Strategy Framework Directive<sup>2</sup>, and the UN Sustainable Development Goals. The Open Data policy operated by the National Biodiversity Data Centre and Explore Your Shore! will contribute to UN Goals on Open Science<sup>3</sup> and EU goals on data sharing and compatibility<sup>2</sup>, as well as feeding into important national policy including the National Marine Planning Framework<sup>4</sup>, the expansion of Marine Protected Areas for Ireland<sup>5</sup> and the management of invasive species.

Marine Biodiversity Citizen Science is a powerful tool to facilitate progressing Ocean Literacy in Ireland and working towards an active and well-informed Marine Citizenship <sup>2</sup>. Explore Your Shore! is already collaborating at EU level with the EU4Ocean coalition, the European Citizen Science Association and as partners in a Cost Action proposal on Citizen Science and the UN Sustainable Development Goals. At a national level, the EPA funded Explore Your Shore! project and the Data Centre are collaborating with national partners on the development and roll out of initiatives using Marine Biodiversity Citizen Science in teaching the Irish primary and post-primary science curriculum. This strategy will further develop these goals and look at the wider integration of Marine Biodiversity Citizen Science in Irish education and academia.

This strategy promotes the value of Marine Biodiversity Citizen Science in linking in with Public Health Policy such as the National Physical Activity Plan and targeting societal groups and communities that are currently poorly represented in citizen science.

Delivery of the strategy builds upon the National Biodiversity Data Centre's 15-year track record of delivering Biodiversity Citizen Science projects contributing the National Biodiversity Data Resource through a robust infrastructure (figure 4) of information technology systems and experienced personnel. It also builds on an active network of dedicated and experienced biodiversity recorders who have supported Irish Biodiversity Citizen Science recording over many decades.

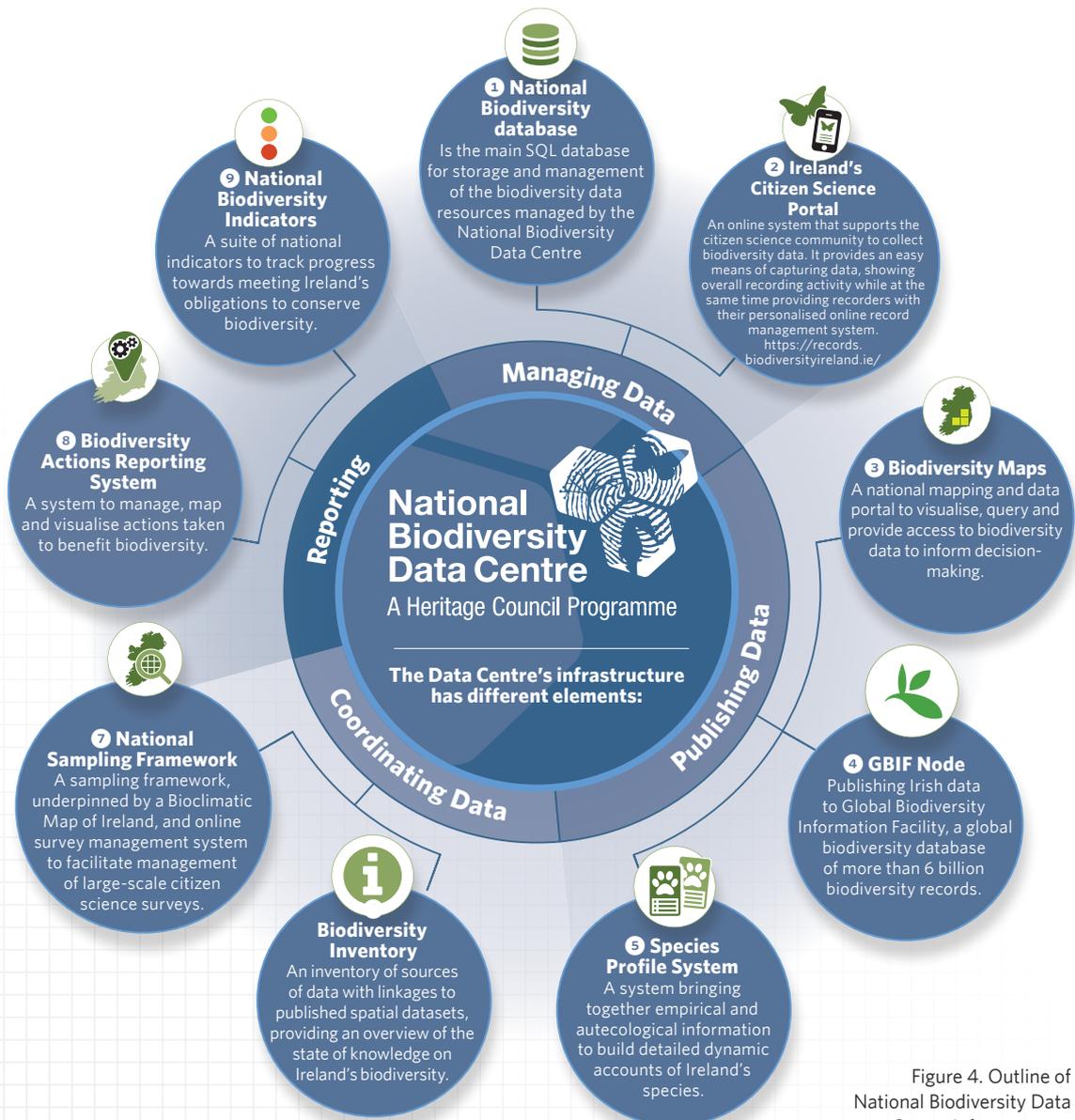


Figure 4. Outline of National Biodiversity Data Centre Infrastructure.

# Rationale

On 9th May 2019 Dáil Eireann declared a Climate and Biodiversity Emergency in Ireland, only the second country in the world to do so. In the same year, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)<sup>6</sup> reported that our ocean is experiencing increasing cumulative impacts from human activity including global warming, unsustainable fishing practices, pollution, and the introduction of invasive alien species.

The health and wellbeing of our society and our economy depend on the services of our ecosystems<sup>40</sup>. We rely on ocean biodiversity for a range of ecosystem services that sustain life on our planet, enhance human health, protect coastal areas, support mental health and wellbeing, and provide recreation. The World Economic Forum reported that biodiversity loss and ecosystem collapse are one of the biggest threats facing humanity in the coming decade<sup>44</sup>.

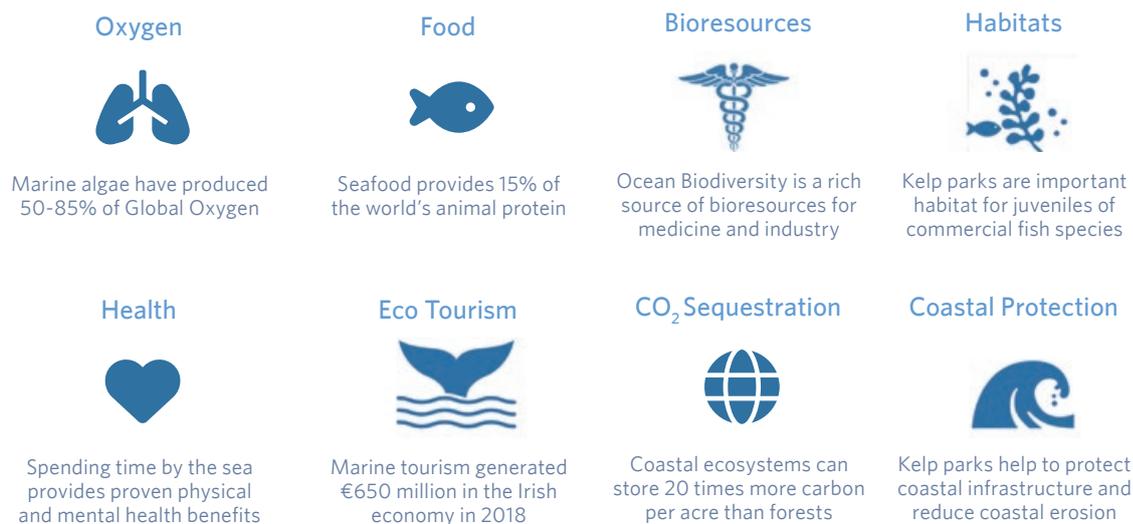
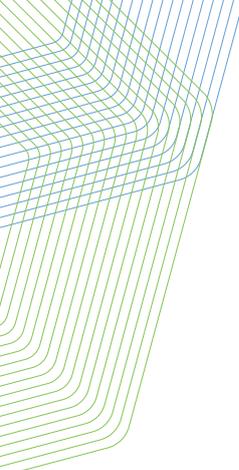


Figure 5. Some of the many valuable ecosystem services that ocean biodiversity provides.

The failure of countries to achieve the targets of the Convention on Biological Diversity by 2010 led to the Aichi Biodiversity Targets which included 20 stronger, more comprehensive, explicit, and measurable goals for 2020. The Global Biodiversity Outlook 5 report<sup>7</sup> found that, despite progress in some areas, countries again failed to meet a single Aichi biodiversity target. Part of the problem is that in many cases we lack robust and representative systems for monitoring the changing state of nature that policy makers need if they are to assess progress towards biodiversity targets<sup>8</sup>.



In Ireland species such as the angel shark continue to edge towards extinction<sup>41</sup> while others such as the purple sea urchin show few signs of recovery from overharvesting in past decades and remain absent from many areas where they were previously recorded<sup>42</sup>. While 80% of our coastal waters are at good or high ecological status, only 38% of our estuarine waters share the same status<sup>40</sup>. Our marine ecosystems remain under pressure from trawling (habitat impacts), unsustainable fishing, noise pollution, chemical pollution, litter, invasive species, and climate change. The cumulative effect of these impacts on ocean ecosystems is difficult to accurately determine and needs further assessment<sup>40</sup>. The EU Biodiversity Strategy for 2030 aims to roll back these impacts and includes marine conservation goals such as turning at least 30% of EU seas into effectively managed and coherent protected areas and tackling bycatch and seabed damage<sup>40</sup>.

Education, monitoring and citizen science initiatives are vital steps in protecting biodiversity. To promote more proactive and widespread engagement we need to continue to systematically survey habitats and species, track threats from invasive species and develop collaborative projects between scientists, marine sectors and the public<sup>40</sup>. There is an urgent need for a Marine Biodiversity Citizen Science Strategy and to integrate Marine Biodiversity Citizen Science into marine conservation, monitoring, and reporting. This was highlighted in the report of the European Marine Board Expert Working Group on Advancing Citizen Science for Coastal and Ocean Research<sup>1</sup>. The need for complementary data was identified in the European Commission's 2017 fitness check of reporting and monitoring of EU environment policy. That review concluded that tapping into new sources of data, including data collected by members of the public, could help improve and streamline reporting, and make it more reliable, thereby strengthening the evidence base for environment policy<sup>51</sup>.

The drivers for Marine Biodiversity Citizen Science to be considered at government level and integrated into marine conservation, monitoring, and reporting policy in Ireland include:

- The 2019 declaration of a Climate and Biodiversity Emergency in Ireland.
- The growing body of evidence for human-generated impacts on marine ecosystems.
- The need to fill significant data gaps in our knowledge of marine biodiversity in Ireland.
- The growing appreciation at National, EU and UN level for the value of incorporating Citizen Science approaches into new policy frameworks, and monitoring and reporting requirements.
- The opportunity to harness and use Citizen Science to help develop monitoring programmes for the Water Framework Directive and the Marine Strategy Framework Directive.
- The environmental knowledge generated in citizen science initiatives will be needed to deliver on EU ambitions, strategies and plans under the European Green Deal. Citizen Science could offer a valuable source of complementary information for the EU biodiversity strategy for 2030<sup>51</sup>.
- The growing Ocean Literacy movement in Ireland and globally, and the desire amongst citizens to participate in marine biodiversity advocacy, stewardship, monitoring and action.

*“Education, monitoring and citizen science initiatives are vital steps in protecting biodiversity. To promote more proactive and widespread engagement we need to continue to systematically survey habitats and species, track threats from invasive species and develop collaborative projects between scientists ... and the public.” – Ireland’s Environment: An Integrated Assessment, EPA 2020.*

## 2.1. MARINE BIODIVERSITY DATA

Reporting on marine biodiversity and providing conclusions on whether the loss of marine biodiversity has been halted is challenging<sup>40</sup>. One of the primary obstacles to progressing marine conservation is a lack of data on marine habitats and species<sup>9</sup> to aid decision making and drive better outcomes for biodiversity. The 2020 EU State of Nature report found that at Member State level, the status of most marine species (59%) was unknown, compared with only 8% of terrestrial species<sup>10</sup>. The lack of baseline data sets for marine species and habitats is widespread, to the extent that robust historic baseline data for marine species or habitats is very much the exception. More concerning is that even today we lack robust baseline data for many marine species, especially in intertidal, coastal and benthic habitats.

Some of our oldest marine data sets are Citizen Science data sets, for example the first atlas of breeding birds in Britain and Ireland was conducted from 1968 to 1972, largely by volunteer recorders, and includes breeding accounts for many seabird species<sup>49</sup>. Meanwhile the Continuous Plankton Recorder (CPR) Survey has been running since 1931 using volunteer vessels<sup>50</sup>. Citizen Science lends itself to the collection of long-term data sets as it is less expensive and therefore is not tied to the typical three-to-five-year funding cycle of grant funded research.

Long-term and spatially diverse marine biodiversity data sets are crucial to understanding natural fluctuations in marine species and habitats, and to enable us distinguish human-induced impacts<sup>11,12</sup>. To allow Ireland effectively plan climate change adaptation and targeted marine conservation actions, it is essential that we possess sufficient data to evaluate the current rate and extent of ecological impact, accurately predict future change, and have robust baseline data from which we can assess the impacts of our actions.

In Ireland and elsewhere a lack of robust marine biodiversity baseline data sets has resulted in the problem of shifting baselines, leading to a false perception of what healthy or untouched marine ecosystems should look like and underestimating the potential for recovery in our marine habitats. This in turn leads to low ambition in terms of marine conservation goals for marine protected areas and species management plans<sup>13,14,15,16</sup>. Marine Biodiversity Citizen Science has an important contribution to make in addressing this issue due to its ability to gather large volumes of robust data over wide geographical areas, but also to learn from citizens and their shared historical knowledge of local biodiversity.

## 2.2. MARINE BIODIVERSITY CITIZEN SCIENCE

Marine Citizen Science has lagged behind its terrestrial counterpart and heretofore has often been piecemeal and fragmented<sup>17,18</sup>. In 2019 the National Biodiversity Data Centre established Explore Your Shore! as a platform to roll out new Marine Biodiversity Recording surveys and to showcase and promote existing Irish Marine Biodiversity Citizen Science projects. The project is funded by the Environmental Protection Agency until 2022.



Figure 6. Project goals of the Explore Your Shore! Citizen Science project run by the National Biodiversity Data Centre and funded by the Environmental Protection Agency.

Citizen Science is a powerful tool for generating marine biodiversity data at geographic and temporal scales that would not be financially feasible using paid experts. It involves volunteers gathering scientific data and, in some cases, also designing scientific research projects and analysing data (see appendix II)<sup>21</sup>.



Figure 7. Some of the benefits of using Citizen Science.

Under the Aarhus Convention<sup>22</sup> citizens have a right to participate in environmental decision-making and be involved in advising, developing, and implementing marine policy. Citizen Science participation can be a channel through which citizens exercise this right<sup>1</sup>.

Citizen Science is a cost effective, but not a cost free, method of collecting Marine Biodiversity Data. The UK government<sup>23</sup> estimated the value of volunteer monitoring of UK terrestrial ecosystems alone at GBP£20 million in 2007. The contribution of volunteers engaged in biodiversity-related projects in France to delivery of the Convention on Biological Diversity (CBD) was estimated at between €0.67 and €4.41 million in 2010<sup>24</sup>. There is therefore significant value to Ireland in maintaining and supporting an active and engaged Marine Biodiversity Citizen Science community.

The willingness to participate in a Citizen Science project depends greatly on the public buying into the project goals. A project that lacks clearly defined goals is unlikely to succeed. For Citizen Science projects to be successful they generally need to be as simple as possible. The fewer the hurdles to participation, the higher the participation rate will be. A Citizen Science project is more likely to be successful where nothing must be purchased or specifically built to participate, and participation costs are minimal<sup>17</sup>. As the cost and complexity of participation and the effort required from the surveyor increases, the level of project participation decreases, however loss of participants may be balanced by the added value of the data obtained. The benefit to citizen science volunteers of skills development alone should not be undervalued and is one of the goals of Explore Your Shore!

Citizen Science projects must catch the attention of potential participants amongst the vast amount of information constantly available in everyday life. Focused recording events such as Seashore Splash! that activate a higher number of participants over a short time can help generate media interest and increase public participation. Feedback on data submission and regular communication with participants

about project progress is crucial to minimising dissatisfaction with a Citizen Science project 17. This can be achieved by volunteers having clear visibility of their individual contribution to the project. The National Biodiversity Data Centre's Citizen Science Portal not only provides immediate visual and data recognition for each record submitted but also provides volunteer recorders with a suite of tools with which to visualise and analyse their data contributions and reference their contribution to the wider data set.



Figure 8. Some challenges and opportunities of Marine Biodiversity Citizen Science.

### 2.3. OCEAN LITERACY

For Ireland to succeed in our marine conservation goals, public buy-in is required. Lack of public awareness and understanding of the ocean, its ecosystems, and the threats facing them, are the single biggest barrier to progressing sustainable use of our ocean<sup>19</sup>. Explore Your Shore! has shown that there is a strong appetite for Marine Biodiversity Citizen Science in Ireland, and we need to build on its successes to achieve an active, engaged, and well-informed Marine Citizenship to help deliver our commitments to marine environmental protection<sup>1</sup>.

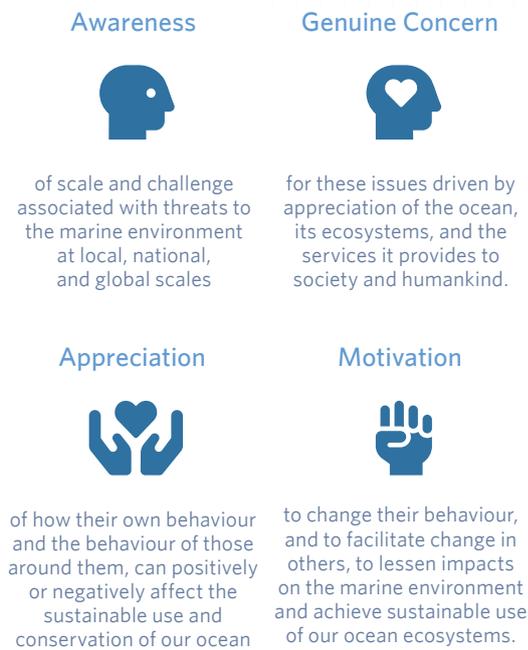


Figure 9. Characteristics of an active, engaged, and well-informed Marine Citizen<sup>1</sup>.

Ocean Literacy at its most basic is the understanding of how the ocean affects us and we affect the ocean, and has been widely adopted by educators, conservation, and environmental organisations, and increasingly by policy makers and the business sector. The Irish Ocean Literacy Network<sup>20</sup>, of which the National Biodiversity Data Centre is a member, was established in 2016 and has 100 members, from over 40 organisations.

Participating in Citizen Science has been shown to have a positive impact on the knowledge and awareness of the participants of the subject of the study<sup>47</sup>. Citizen Science participation has also been found to lead to changes in the behaviour and attitude of participants towards the study subject<sup>47</sup> leading to positive

behavioural change, with evidence that longer periods of participation can lead to greater behavioural change<sup>46</sup>. Such change can often be a primary goal of citizen science projects, with citizen science being used as a tool for public engagement and awareness raising.



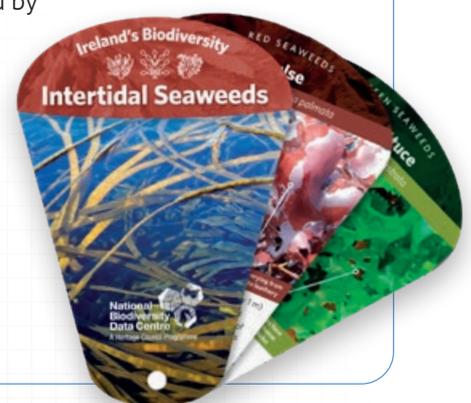
Explore Your Shore! is a Citizen Science Project run by the National Biodiversity Data Centre and funded by the Environmental Protection Agency until 2022. It was set up in 2019 with the goals of building a baseline dataset for intertidal species, exploring their potential as bio-indicators of climate change and water quality, and raising public awareness of marine biodiversity and conservation issues.

The project has sought to address the lack of a large and active community of Marine Biodiversity Citizen Science recorders in Ireland, and a paucity of marine species records in the National Biodiversity Database when compared to terrestrial taxa.

Explore Your Shore! has worked to improve this situation through actively promoting Marine Biodiversity Citizen Science recording in Ireland, providing training in species identification, publishing identification resources such as swatches and posters, and facilitating the submission of records from inexperienced marine biodiversity recorders through a robust photograph-linked record validation process.

Explore Your Shore! has shown that there is a strong appetite for Marine Biodiversity Citizen Science in Ireland. Since 2019 the project's impact has resulted in:

- 1,340 active marine biodiversity recorders.
- 11,000 Citizen Science records of marine species submitted to the Data Centre.
- An increase of 298 % in marine species records received via the Data Centre's Citizen Science Portal during the first three years of Explore Your Shore!
- 10 active project partner citizen science surveys in Explore Your Shore!
- An additional 17,943 marine biodiversity records submitted by partner surveys to the Data Centre in 2019 - 2021.
- Publication of new identification aids to intertidal seaweeds and bivalve shells, with 1,800 copies sold since publication.
- 34 talks, workshops and online videos in marine species identification and survey techniques have been delivered, engaging with over 2,700 people, despite the limitations imposed by Covid19 restrictions.



## 2.4. GENERATING ACTIONS FOR CONSERVATION

The Irish Pollinator Plan has shown us how well informed and well-motivated Citizen Science volunteers can help drive wider societal action towards conserving species and habitats in Ireland. The EPA's Ireland's Environment: An Integrated Assessment 2020 report<sup>40</sup> highlighted that overall current assessment for both marine and terrestrial biodiversity is very poor. Deteriorating trends dominate, with 85% of EU protected habitats having an unfavourable status. We are largely not on track to meet biodiversity policy objectives and transformative change is needed to achieve the vision in the National Biodiversity Action Plan 2017-2021. Biodiversity protection needs to be linked to public information and engagement campaigns that actively involve and engage citizens and foster a better appreciation of nature and its benefits to society<sup>40</sup>.

Opportunities to use Citizen Science to achieve positive outcomes for science, for the global marine environment and for society are currently being missed<sup>25</sup>. For many generations Irish citizens have largely not associated themselves with ownership of our marine habitats, seeing the sea as the realm of seafarers and fishers. However, this is changing as more and more citizens engage with the sea for recreation and wish to exert ownership and stewardship over this shared resource. We are rapidly progressing towards the point in Irish Marine Biodiversity Citizen Science where the significant effort, skills and goodwill of volunteers should be targeted towards these ends<sup>26</sup>. Such actions can contribute to 'fostering innovation throughout society' and 'linking knowledge with action', two key areas identified by the European Environment Agency as requirements for knowledge for transition to a sustainable Europe<sup>45</sup>.



Figure 10. Some of the many conservation impacts on marine ecosystems in Irish waters.

# Irish Marine Biodiversity Data Availability

## 3.1. IRISH MARINE BIODIVERSITY DATA SETS

Explore Your Shore! is not the first Marine Biodiversity Citizen Science project in Ireland. Several long-standing projects which have a focus on, or an element of, biodiversity data recording existed prior to 2019. Some projects have been established for up to 30 years and most are now partner surveys in Explore Your Shore!

One third of the Marine Biodiversity data sets mapped on Biodiversity Maps are Open Access and may be downloaded from the Data Centre. The other data sets are restricted and cannot be downloaded directly, though they can be viewed on Biodiversity Maps and the data can be requested from the data holders. Other projects maintain private databases with little public information available on the scope of, or validation processes for, those data. The National Biodiversity Data Centre actively promotes open and easy access to biodiversity data and strives to encourage a culture of Open Access in marine biodiversity data.

Table 1 shows the data sets currently mapped on the National Biodiversity Data Centre's Biodiversity Maps system and their availability status.

Database Name	Data Availability	Source
BioMar Survey of Ireland	Open Access	TCD
Chondrichthyans of Ireland	Open Access	NBDC
Coastal and Marine Species Database	Open Access	NBDC
Explore Your Shore!	Open Access	NBDC
Irish Lagoon Surveys 2016 - 2017	Open Access	Geoff Oliver and Eddie McCormack
Irish Wetland Birds Survey (I-WeBS) 1994-2001	Open Access	BirdWatch Ireland
NPWS Seal Database	Open Access	NPWS
Porcupine Marine Natural History Society Records	Open Access	Porcupine Marine Natural History Society
Rare Marine Fishes 1786 to 2008	Open Access	SFPA
Records of North Atlantic Right Whales ( <i>Eubalaena glacialis</i> ) in Irish waters	Open Access	Seán A. O'Callaghan
Rocky Shore Macroalgae	Open Access	EPA
Seabird 2000	Open Access	BirdWatch Ireland
Chondrichthyans of Ireland (Restricted Data)	Restricted	NBDC
ESAS Cetacean Sightings 1980 - 2003	Restricted	JNCC
ESAS Bird Sightings 1980 - 2003	Restricted	JNCC
Grey Seal Distribution 2009 - 2014	Restricted	UCC
Irish Federation of Sea Anglers Catch Data	Restricted	IFSA
Irish Marine Turtle Database	Restricted	Simon Berrow & Gabriel King
Irish Wire Weed ( <i>Sargassum muticum</i> ) Database	Restricted	NBDC
IWDG Basking Shark Database	Restricted	IWDG

Database Name	Data Availability	Source
IWDG Constant Effort Cetacean Sighting Scheme	Restricted	IWDG
IWDG Casual Cetacean Sightings	Restricted	IWDG
IWDG Cetacean Strandings Database	Restricted	IWDG
IWDG Ferry Survey Sightings 2001-2015	Restricted	IWDG
IWDG Heritage Council Surveys 2004	Restricted	IWDG
IWDG ISCOPE Surveys 2005 - 2009	Restricted	IWDG
IWDG Ship Surveys 2003 - 2015	Restricted	IWDG
IWDG non-effort ship sightings 2003 - 2015	Restricted	IWDG
IWDG PRECAST Surveys 2003 - 2011	Restricted	IWDG
Lichens of Rocky Seashores	Restricted	Biology.ie
Marine Species in Irish Coastal Waters	Restricted	Seasearch Ireland
North-west Ireland Machair Breeding Waders 2009.	Restricted	Birdwatch Ireland
ObSERVE Aerial Surveys for Seabirds and Cetaceans in the Irish Atlantic Margin	Restricted	DCENR
ObSERVE Towed Passive Acoustic Surveys for Cetaceans in the Irish Atlantic Margin	Restricted	DCENR
ObSERVE Visual Surveys for Cetaceans in the Irish Atlantic Margin	Restricted	DCENR
SCANS II Survey Data (2005 - Cetaceans)	Restricted	Sea Mammal Research Unit, University of St Andrews.
Seaweeds of Ireland	Restricted	The British Phycological Society/NUIG
SIAR Survey Data (2000 - Cetaceans)	Restricted	Coastal & Marine Resources Centre (CMRC)
Sponges of Rathlin Island	Restricted	Ulster Museum

Additional marine biodiversity data sets are generated by state agencies, local government, academic institutions, and commercial consultancies. Few of these data sets have been shared with the National Biodiversity Data Centre. Adoption of a default policy of publishing national marine biodiversity datasets through Biodiversity Maps is an easy way to ensure publicly funded survey data is freely available to data end users, including the public and policy makers.



Figure 11. Advantages of sharing national marine biodiversity data sets with the National Biodiversity Data Centre

### 3.2. CITIZEN SCIENCE DATA VALIDATION

The primary barrier to the use of citizen science data in research, monitoring and reporting is the question of data quality. Concerns over species identification by volunteers and validation of species records are frequently raised in Marine Biodiversity Citizen Science projects. Marine habitats, and especially intertidal habitats, are extremely biodiverse with potentially hundreds of species occurring on any given stretch of shore, and many taxonomic groups are challenging to identify, even for experts.

At a very early stage in Explore Your Shore! a decision was made to address this issue by only accepting marine species records accompanied by photographs. This provides an independent means of validating species records and is possible because most intertidal species are sessile to a greater or lesser extent and are relatively easy to photograph. Of course, not all records can be identified to species level from a photograph, but review of an identification image can often identify the record to at least genus level. Visual data validation becomes problematic as data volumes increase and future development of computer image recognition by learning methods<sup>27</sup> or a democratic system of online validation by recorders themselves may prove beneficial. To this end, the Data Centre's involvement in GBIF, as the Irish node manager, enables us keep abreast of emerging bioinformatics technologies.

### 3.3. CITIZEN SCIENCE SURVEY DESIGN

A second major criticism of citizen science is that it is prone to bias in sampling effort such as non-random distribution of effort in space and time, issues of scale, and under recording of some species. Of course, heterogeneity is inherent to citizen science but there are ways to limit its impact via survey design, volunteer training and during data analysis. Even basic training can help reduce inter-surveyor variability and errors in survey method<sup>28</sup>.

Automating data collection as far as possible also helps to reduce errors in data entry and recording (e.g., using a smart phone app with drop down menus rather than paper forms).

A problem often encountered in citizen science data is that, in the absence of a planned spatial sampling scheme, record density in space and time reflects observer activity rather than species distribution. In many cases this effect is not critical as we are often only looking at relatively coarse species distributions (e.g. 10km grid squares). Gaul *et al.*<sup>29</sup>, in analysing data from the National Biodiversity Data Centre's Biodiversity Maps system, found that sample size and the choice of modelling method may be more important than spatial bias in determining the prediction performance of species distribution models.

A well-designed Marine Biodiversity Citizen Science project with adequate training, strong data validation processes, and reviews of project progress and outputs, should result in useful and robust marine biodiversity data, and confidence in its use. As with any scientific endeavour, peer-reviewed publication of the results of Marine Biodiversity Citizen Science projects should be a primary goal.

### 3.4. OPEN ACCESS DATA

The 2020 Global Ocean Science Report<sup>3</sup> found that while countries reported that 58% of ocean data centres comply with the FAIR principles (Findability, Accessibility, Interoperability and Reusability), 60% of data centres still restrict access to certain data types and 58% of them do so for a certain period. Only 16% of data centres apply no restrictions at all to data access. The National Biodiversity Data Centre stores all validated data submitted through its Citizen Science Portal as Open Access Data, with third party data either available as Open Access data or mapped on the Biodiversity Maps system, with metadata supplied to identify the data holder.

Engendering ownership of data generated is important for the longevity of Citizen Science projects. All data generated through Explore Your Shore! and the National Biodiversity Data Centre Citizen Science Portal is available for the participants, and the public, to download through Biodiversity Maps. Giving due acknowledgement to Citizen Science recorders is crucial to the success of Marine Biodiversity Citizen Science projects and the Data Centre must ensure this happens wherever Citizen Science generated data are used. In addition to data visualisation, the Data Centre provides long-term secure storage of submitted records and data sets with a dual licensing system, offering security and peace of mind for third party data providers and Citizen Science recorders.

### 3.5. THE FUTURE OF IRISH AND EU MARINE CITIZEN SCIENCE

The recent EPA report on Ireland's Environment: An Integrated Assessment, highlighted that resourcing of citizen science is important for nature protection and needs to be further developed as citizen science can provide an important evidence base on long-term trends in species<sup>40</sup>. National citizen science projects are struggling to maintain momentum due to a lack of a coherent funding strategy for Citizen Science in Ireland, and in particular a lack of funding for long-term monitoring. Citizen Science is not free science, and it requires ongoing funding to support networks, generate data and ensure data is validated and managed on an ongoing basis.

There is growing recognition at an EU level that there is a need to progress EU-wide Marine Citizen Science recording programmes and data centres<sup>2</sup>, with multi-annual funding. There are advantages in developing such programmes and centres including:



Figure 12. Potential advantages in developing EU-wide Marine Citizen Science recording programmes and data centres

On a wider scale still, global biodiversity citizen science programmes recognised by UNESCO through their initiative on Open Science need to be progressed<sup>30</sup>. For both EU-wide and global Citizen Science projects, the vitality of citizen science at local level needs to be tapped into, to provide research and information that will be valuable at national, regional, and global levels.

Thus, it is vital that the National Biodiversity Data Centre's Citizen Science platforms are maintained to:

- Promote marine biodiversity citizen science data collection and drive local enthusiasm for biodiversity citizen science projects.
- Deliver programmes at a scale that will be valuable to communities, local government, government, EU and global partners.
- Manage national biodiversity data sets.
- Respond in an effective and efficient manner to national, EU and global data end users.
- Ensure support for genuine citizen science generated biodiversity programmes that answer real local needs.

# Integrating Marine Biodiversity Citizen Science into Policy

The 2017 European Marine Board Expert Working Group identified eight Strategic Action Areas for Marine Citizen Science in Europe including understanding the wider benefits of Citizen Science for marine policy leading to empowering Citizen Science to support marine policy<sup>1</sup> (fig. 13). The European Commission's 2017 fitness check of reporting and monitoring of EU environment policy called for more specific action to promote the wider use of citizen science and, in particular, the development of guidelines and disseminating best practices (action 8)<sup>52</sup>. In 2020 the Commission published a working document on Best Practices in Citizen Science for Environmental Monitoring<sup>51</sup>.

In 2014 the European Citizen Science Association (ECSA) was founded as a non-profit association to encourage the growth of citizen science in Europe. It now has 200 individual and institutional members across 28 countries. The EU-Citizen.Science website was funded under the European Commission's Horizon 2020 programme and has now been taken under the ECSA umbrella. The website is designed to become the reference point for citizen science in Europe through cross-network knowledge sharing for citizen science participants, practitioners, researchers, policy makers and society<sup>31</sup>.

National Citizen Science programmes are emerging within the EU, with each of these programmes developing a national Citizen Science Platform where details on best practice in citizen science are highlighted, sharing knowledge gained and lessons learned. Links are being established between these platforms and the EU-Citizen.Science Platform. These developments present opportunities to develop long-term citizen science programmes which integrate into the way EU Directives are implemented. Through the development of Explore Your Shore! the National Biodiversity Data Centre is well positioned to serve as Ireland's national platform for Marine Biodiversity Citizen Science, servicing and linking citizen scientists and data end users such as policy makers, state agencies and government.

## Shorter-term action areas



Driving good practices at European level



Understanding wider benefits of Citizen Science for marine research and policy



Cultivating Ocean Literacy



Building competencies across multiple disciplines

## Longer-term action areas



eu-citizen.science

Launching a European Marine Citizen Science platform



Improved funding opportunities



Empowering Citizen Science to support marine policy



Facilitating efficient management of citizen-generated data

Figure 13. Strategic Action Areas for Marine Citizen Science in Europe<sup>1</sup>.

#### 4.1. MARINE BIODIVERSITY CITIZEN SCIENCE INFORMING EU DIRECTIVES AND REPORTING

The European Union has committed to designating 30% of its seas as Marine Protected Areas (MPAs) by 2030, with 10% designated as highly protected MPAs<sup>32</sup>. The provision of data to underpin this network of Marine Protected Areas across Europe has become imperative. Citizen Science derived bird and butterfly data is already being used at an EU level to report on the EU Biodiversity Strategy and on the UN Sustainable Development Goals<sup>51</sup>. Irish Biodiversity Citizen Science data has to date been used to inform the designation of Special Areas of Conservation under the Habitats and Birds Directives in Ireland and the UK. Citizen Science data also contributes to Ireland's Article 17 reporting under the Habitats Directive and Article 12 reporting under the Birds Directive.

The potential for using Citizen Science data for reporting under other EU Directives (e.g. the Water Framework Directive and Marine Strategy Framework Directive) is a current 'hot topic', however many of the reporting indices for these directives are not currently compatible with Citizen Science generated data sets. Work is ongoing at national and EU level to ensure that new and revised reporting requirements can accommodate Citizen Science data sets, and to identify opportunities to collect Citizen Science data that is compatible with existing reporting requirements.

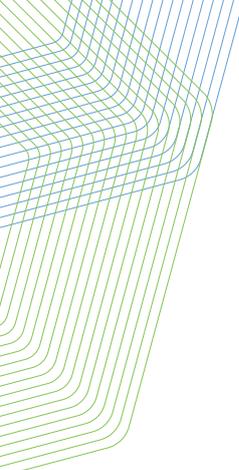
One criticism of European marine environmental legislative tools has been inadequate 'stakeholder engagement' in policymaking. Building advocacy and policy engagement through Citizen Science can provide a powerful tool in the armoury of marine management and conservation<sup>33</sup>.

#### 4.2. MARINE BIODIVERSITY CITIZEN SCIENCE SUPPORTING THE SUSTAINABLE DEVELOPMENT GOALS

In 2020 the National Biodiversity Data Centre joined a in COST Action proposal on Citizen Science and the UN Sustainable Development Goals (SDGs). Groundwork for the COST Action proposal identified a list of SDG targets/ indicators for which citizen science can contribute to monitoring and implementation. The Global Ocean Science Report<sup>3</sup> found that while 70% of responding countries had strategies and a roadmap to achieve the SDGs, only 21% reported that they had a specific strategy focusing on the ocean and working to "*conserve and sustainably use the oceans, seas and marine resources for sustainable development*" (SDG 14)<sup>34</sup>. The ocean represents the largest biome on the planet and provides essential resources supporting human life, hence by working to achieve SDG14 we also profoundly contribute to attaining all other SDGs.

The Ministerial declaration at the Fourth Session of the UN Environment Assembly made a strong commitment to investing in new approaches to environmental research, education, and awareness, including Citizen Science stating:

*"We the Environment Ministers ... will invest in environmental research, education and awareness raising in the framework of sustainable development with a strong focus on women and youth and promote a wider use of innovative approaches, such as inclusive citizen science".*



### 4.3. INTERNATIONAL COLLABORATION

Developing links with international (non-EU) Marine Biodiversity Citizen Science practitioners will also prove beneficial to developing Ireland's Marine Biodiversity Citizen Science capacity. To some degree this can be achieved through the Data Centre's membership of the European Citizen Science Association as it has members from across the world and has strong links with the US based Citizen Science Association. The National Biodiversity Data Centre also has a collaboration agreement for expertise exchange and shared learning with the South African National Biodiversity Institute (SANBI) and acts as the Irish hub for the Global Biodiversity Information Facility.

### 4.4. MARINE BIODIVERSITY CITIZEN SCIENCE CONTRIBUTING TO PUBLIC HEALTH POLICY

Public health benefits are an important ecosystem service that the ocean provides. Studies have found that living close to the sea is associated with lower levels of psychological distress<sup>35</sup> and that regular exposure to nature reduces our stress levels<sup>36</sup>. Being by the sea also encourages us to get out and exercise<sup>37</sup>. Preliminary findings from the Blue Health 2020

project<sup>43</sup> revealed that better general health appeared more prevalent in coastal areas, while psychological wellbeing (measured by the World Health Organization's WHO-5 wellbeing index) also appeared to be better in more coastal areas, but not in greener areas. People who visited various types of blue space at least once a week were also more likely to have better health and psychological wellbeing<sup>40</sup>.

Marine Biodiversity Citizen Science is a great way of encouraging the public to visit the seashore and enjoy the associated health benefits. A recent study by the Economic and Social Research Institute (ESRI) found that Irish biodiversity recorders were more physically active than the wider population<sup>48</sup>. It is important therefore, that we link Marine Biodiversity Citizen Science with government public health policies such as the National Physical Activity Plan<sup>38</sup>.

# Why the National Biodiversity Data Centre?

The National Biodiversity Data Centre is dedicated to the collection, management, analysis and dissemination of data and information on Ireland's biological diversity. We maintain the National Biodiversity Database and have developed a mapping and data portal, called Biodiversity Maps, to provide free and easy access to the data and information it contains. The system maps the distribution of over 4.48 million observations of 16,868 species from 163 different datasets.

The Data Centre plays an important role in increasing people's understanding of nature in Ireland and the challenges it faces<sup>40</sup>. Through our activities we have established a network of more than 15,000 active recorders that have generated over 711,000 records of 10,360 species from across the country. This network continues to grow rapidly as it provides a framework for people with a newfound interest in biodiversity and climate change to engage in practical recording activities. We also co-ordinate more systematic citizen science projects designed to track changes in the populations of insects and plants. A network of 433 dedicated volunteers participated in effort related surveys for pollinators, plants and marine species in 2020. Specialised training has been provided to more than 3,500 participants to make engagement with biodiversity more accessible and enjoyable.

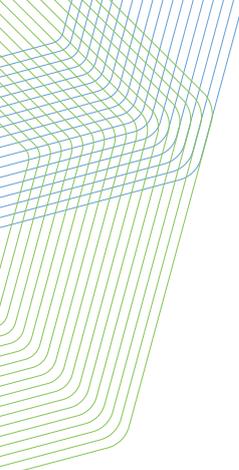
The National Biodiversity Data Centre has developed a strong reputation for working with partner organisations on the collection of biodiversity data. Explore Your Shore! currently works with ten partner projects collecting marine biodiversity data in Ireland. The Data Centre has also worked with partner organisations in the development, coordination,

and reporting on delivery of evidence-based actions for biodiversity. This is particularly the case with invasive alien species and pollinators.



Figure 14. Data Centre Staff, 2020.

This strategy envisages the Data Centre working with our network of Citizen Science Recorders and with partner organisations such as the Environmental Protection Agency, the Marine Institute and National Parks and Wildlife to develop a National Marine Biodiversity Citizen Science platform which meets the needs of Citizen Science recorders while complementing the work and data streams of data end users. The Data Centre is well placed to provide these services because of its experience to date which demonstrates that it:



- Has 14 years at the forefront of delivering Biodiversity Citizen Science projects in Ireland and is viewed as the national platform for biodiversity citizen science data collection.
- Has established a reputation for providing national leadership on evidence-based approaches to biodiversity.
- Has a strong track record in providing coordination of public bodies on project specific initiatives.
- Has a well-developed system for capturing, tracking, and reporting on progress in biodiversity recording.
- Has developed and implemented a model for engagement and delivering on the ground actions for biodiversity.
- Has robust Citizen Science data validation processes, including for marine biodiversity data.
- Has a suite of data visualisation and analysis tool for citizen science volunteer recorders to give immediate feedback on data submission and the ability to archive, view and analyse their own records.
- Ensures all Citizen Science Data submitted through the Data Centre's Citizen Science Portal is available to download as Open Access data, once validation procedures are complete.

The Data Centre has a strong track record of collaborating with and actively supporting a large volunteer Citizen Science recorder network, working with the public and private sectors, and with professional biodiversity surveyors and researchers. Additionally, the Data Centre:

- Was established in 2007 and provides a stable platform and databasing for Biodiversity Citizen Science projects beyond the typical 3-year funding cycle which often limits the lifespan of Biodiversity Citizen Science initiatives.
- Has developed a national data management infrastructure for biodiversity that meets the requirements of citizen science volunteer recorders and data end users.

The roll out of any extensive programme of work requires supporting information and management systems. The National Biodiversity Data Centre has built a reputation for strong project management, supported by a state-of-the-art information management system (see below). These systems can be utilised to ensure effective management and reporting of the entire work programme, and to show transparency of how the programme is being delivered. It can also facilitate any value for money assessment needed during the programme.

# Marine Biodiversity Citizen Science Strategy Overview and Actions

The National Biodiversity Data Centre's Marine Biodiversity Citizen Science Strategy has six overarching goals (outlined in the diagram below), with identified objectives and actions towards achieving those goals listed in the Actions Tables for each goal. Staffing requirements to enable delivery of the strategy are outlined in Appendix I.



Figure 15. National Biodiversity Data Centre Marine Biodiversity Citizen Science Strategy 2023 - 2028.

## Goal 1: Establish a National Platform for Marine Biodiversity Citizen Science within the National Biodiversity Data Centre.

Objectives	Actions
<p><b>1.1</b> Promote Explore Your Shore! as a National Platform for Marine Biodiversity Citizen Science</p>	<ul style="list-style-type: none"> <li>○ Develop Explore Your Shore! as a shop front for Marine Biodiversity Citizen Science in Ireland by increasing the number of survey partners.</li> <li>○ Formalise the role of Data Centre as a National Platform for Marine Biodiversity Citizen Science with Irish Government, ECSA and UNESCO.</li> <li>○ Meet with the ECSA national representative.</li> </ul>
<p><b>1.2</b> Promote, support and facilitate Irish Marine Biodiversity Citizen Science initiatives</p>	<ul style="list-style-type: none"> <li>○ Promote and support existing and new Marine Biodiversity Citizen Science projects on <a href="http://www.ExploreYourShore.ie">www.ExploreYourShore.ie</a></li> <li>○ Seek joint funding opportunities to support and maintain existing projects.</li> <li>○ Support existing Marine Biodiversity Citizen Science projects where possible with data management and web access services.</li> <li>○ Develop partnerships with interested national organisations and academia.</li> <li>○ Shortlist potential data acquisition focus areas</li> </ul>
<p><b>1.3</b> Establish a funding pool to support and maintain existing and new Marine Biodiversity Citizen Science projects.</p>	<ul style="list-style-type: none"> <li>○ Meet with existing Marine Biodiversity Citizen Science practitioners to assess long-term annual funding requirements.</li> <li>○ Seek to establish a funding system for Marine Biodiversity Citizen Science projects in Ireland.</li> </ul>
<p><b>1.4</b> Increase the knowledge base and promote Ocean Literacy.</p>	<ul style="list-style-type: none"> <li>○ Seek position on Steering Group of the Irish Ocean Literacy Network.</li> <li>○ Deliver Marine Biodiversity Citizen Science public events.</li> <li>○ Deliver Marine Biodiversity Citizen Science media and social media content.</li> <li>○ Develop Marine Biodiversity Citizen Science resources.</li> </ul>
<p><b>1.5</b> Participate in the EU4Ocean coalition.</p>	<ul style="list-style-type: none"> <li>○ Actively participate in two EU4Ocean events annually.</li> </ul>
<p><b>1.6</b> Encourage and facilitate participation in Marine Biodiversity Citizen Science by island communities</p>	<ul style="list-style-type: none"> <li>○ Promote Explore Your Shore! via island community contacts and organisations.</li> <li>○ Deliver one Marine Biodiversity Citizen Science training and identification workshop annually with an island community.</li> </ul>
<p><b>1.7</b> Promote Marine Biodiversity Citizen Science to societal groups that are poorly represented in the current Biodiversity Recording Network.</p>	<ul style="list-style-type: none"> <li>○ Host workshop to assess current barriers to participation.</li> <li>○ Deliver talks and workshops to target poorly represented societal groups.</li> <li>○ Develop partnerships with organisations active in target societal groups.</li> </ul>

## Goal 2: Integrate Marine Biodiversity Citizen Science into Policy and Research

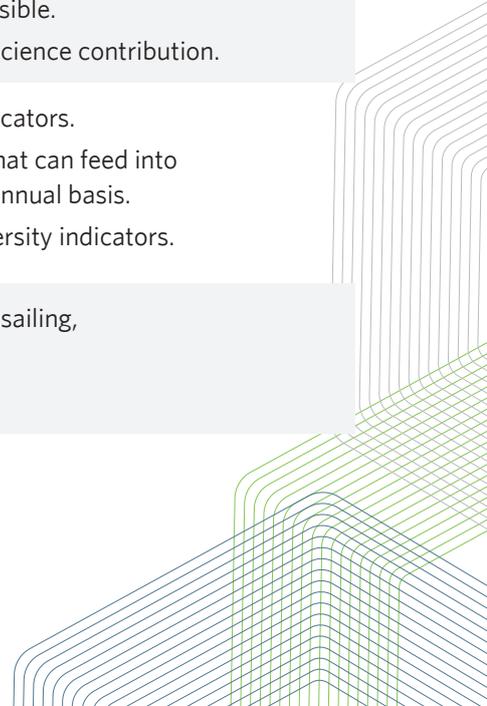
Objectives	Actions
<p><b>2.1</b> Collaborate at national and EU level on incorporating Citizen Science into EU Nature, Water and Marine Directives monitoring and reporting.</p>	<ul style="list-style-type: none"> <li>○ Attend EU working groups on use of Citizen Science data in Directives Reporting.</li> <li>○ Make submissions on national and EU policy and reporting consultations, highlighting need and benefits in using Citizen Science data.</li> <li>○ Attend Department of Housing, Local Government and Heritage MSFD Monitoring Steering Group Meetings on behalf of the Data Centre.</li> </ul>
<p><b>2.2</b> Collaborate on incorporating Citizen Science into monitoring and implementation of the UN Sustainable Development Goals.</p>	<ul style="list-style-type: none"> <li>○ Join COST Action Proposal for Citizen Science data in Sustainable Development Goals reporting.</li> </ul>
<p><b>2.3</b> Identify Marine Biodiversity data gaps which can be filled using Citizen Science.</p>	<ul style="list-style-type: none"> <li>○ Conduct a Gap Review of Irish marine biodiversity data.</li> <li>○ Identify species and habitats of conservation significance readily recorded using Citizen Science.</li> <li>○ Identify resource requirements.</li> </ul>
<p><b>2.4</b> Identify existing monitoring and reporting requirements that can be fulfilled or enhanced by using Marine Biodiversity Citizen Science.</p>	<ul style="list-style-type: none"> <li>○ Review of current EU / UN / other marine biodiversity recording requirements and progress indicators.</li> <li>○ Review and identify recording requirements and progress indicators that can be met by Marine Biodiversity Citizen Science data.</li> </ul>
<p><b>2.5</b> Promote the use of Marine Biodiversity Citizen Science to help achieve goals and objectives, by policy makers, state agencies and government.</p>	<ul style="list-style-type: none"> <li>○ Deliver talks to policy makers, state agencies and government showcasing the potential of Marine Biodiversity Citizen Science data.</li> <li>○ Make submissions to marine conservation / marine policy consultations highlighting needs and benefits in using Citizen Science data.</li> <li>○ Participate in Marine Biodiversity Data steering groups and stakeholder bodies.</li> </ul>
<p><b>2.6</b> Promote the use of Marine Biodiversity Citizen Science in research by Irish Universities, Institutes of Technology and Colleges.</p>	<ul style="list-style-type: none"> <li>○ Deliver Marine Biodiversity Citizen Science talks to Irish Universities, Institutes of Technology and Colleges.</li> <li>○ Develop Marine Biodiversity Citizen Science module(s) in partnership with Irish Universities, Institutes of Technology and Colleges as part of undergraduate/postgraduate courses.</li> </ul>
<p><b>2.7</b> Encourage national research funding organisations to better promote and support Marine Biodiversity Citizen Science.</p>	<ul style="list-style-type: none"> <li>○ Make submissions to funding policy makers and consultations.</li> <li>○ Participate in relevant stakeholder meetings and discussions.</li> </ul>

Objectives	Actions
<b>2.8</b> Maintain the Data Centre's role as an active and engaged member of the European Citizen Science Association.	<ul style="list-style-type: none"> <li>○ Attend ESCA annual conference.</li> <li>○ Join and participate in relevant ECSA working groups.</li> <li>○ Make submissions on relevant ECSA policies.</li> <li>○ Develop networking and partnership opportunities.</li> </ul>
<b>2.9</b> Support Invasive Marine Species Monitoring in Ireland.	<ul style="list-style-type: none"> <li>○ Validate marine invasive species records submitted to the Data Centre.</li> <li>○ Support the Data Centre Invasive Species Officer in marine invasive species monitoring.</li> <li>○ Contribute to the development of marine invasive species status reviews and action plans.</li> </ul>
<b>2.10</b> Participate in Survey of Biology and Ecosystems monitoring programs in Europe (BioEco).	<ul style="list-style-type: none"> <li>○ Continue to participate in the UNESCO Intergovernmental Oceanographic Commission GOOS Survey of Biology and Ecosystems monitoring programs in Europe.</li> </ul>
<b>2.11</b> Link Marine Biodiversity Citizen Science with national and EU health policy and initiatives.	<ul style="list-style-type: none"> <li>○ Make submissions at policy level highlighting the links between Marine Biodiversity Citizen Science and health and wellbeing.</li> <li>○ Participate in relevant stakeholder meetings and discussions.</li> <li>○ Promote the benefits to physical and mental health of participating in Marine Biodiversity Citizen Science.</li> <li>○ Highlight ways in which to link the National Physical Activity Plan with Marine Biodiversity Citizen Science.</li> </ul>

## Goal 3: Deliver Enhanced Availability, Useability, and Integration of Robust Marine Biodiversity Data

Objectives	Actions
<b>3.1</b> Ensure Citizen Science recorders receive appropriate acknowledgement wherever Citizen Science datasets are used.	<ul style="list-style-type: none"> <li>○ Recorder acknowledgement to be included wherever the Data Centre generates reports or publications with Citizen Science generated data sets.</li> <li>○ Add standard acknowledgement text for use in publications and reports that is part of the requirement for the download of Citizen Science generated data sets.</li> <li>○ Where Citizen Science data is used in a peer reviewed publication, the preferred position is to include volunteer recorders as co-authors.</li> <li>○ Draft Data Centre policy on formal acknowledgement of Citizen Science recorders where Citizen Science Data is used.</li> </ul>
<b>3.2</b> Develop Marine Biodiversity Citizen Science Data standards, protocols, guidelines, and training.	<ul style="list-style-type: none"> <li>○ Review current data standards.</li> <li>○ Identify areas where data QC might be improved and draft improved standards.</li> <li>○ Identify and formalise data validation pathways.</li> <li>○ Prepare and publish guidance for volunteers on CS data standards, validation and uses.</li> <li>○ Ensure adequate training for CS participants in correct protocols for data collection and upload.</li> </ul>

Objectives	Actions
<p><b>3.3</b> Review existing marine datasets on Biodiversity Maps, updating names and remove duplicates or errors as required.</p>	<ul style="list-style-type: none"> <li>○ Review taxon names and change to reflect current taxonomy and new understanding of species distributions.</li> <li>○ Remove duplicates identified in data sets.</li> <li>○ Address record queries from recorders, data providers and data users.</li> <li>○ Check data positions and address off-the-shore errors</li> </ul>
<p><b>3.4</b> Ensure collaborators and partner projects have access to data and visualization tools that meet their requirements.</p>	<ul style="list-style-type: none"> <li>○ Consult with data end users to address gaps in data and visualization tools to meet their needs.</li> </ul>
<p><b>3.5</b> Ensure the Biodiversity Maps Marine Taxonomic dictionary is regularly updated.</p>	<ul style="list-style-type: none"> <li>○ Update the Marine Taxonomic Dictionary.</li> <li>○ Conduct annual review of changes to marine taxonomic names and required changes to the Marine Taxonomic Dictionary.</li> </ul>
<p><b>3.6</b> Maximise availability of Marine Biodiversity Data through increasing the number of Open Access Data Sets.</p>	<ul style="list-style-type: none"> <li>○ Work to secure Open Access data agreements for all new marine datasets.</li> <li>○ Advocate with government and funding agencies for default inclusion of requirement for submission of data from funded projects to the Data Centre.</li> <li>○ Negotiate with current data providers for Open Access data agreements for current data or data older than 5 years.</li> </ul>
<p><b>3.7</b> Collaborate at a National, European, and international level to achieve standardisation of Marine Biodiversity Data Sets and recording parameters.</p>	<ul style="list-style-type: none"> <li>○ Attend meetings, networking events and conferences with a focus on Marine Biodiversity Citizen Science data integration and standardisation.</li> <li>○ Seek to work with National, EU and Non-EU biodiversity data centres to agree standard data dictionaries.</li> </ul>
<p><b>3.8</b> Develop partnerships for the use of Marine Biodiversity Citizen Science Data.</p>	<ul style="list-style-type: none"> <li>○ Identify potential data use partners in Government, Policy makers, State Agencies and Academia.</li> <li>○ Promote the Marine Biodiversity data sets held on Biodiversity Maps.</li> </ul>
<p><b>3.9</b> Develop a publication strategy for Marine Biodiversity Citizen Science data submitted to the National Biodiversity Data Centre.</p>	<ul style="list-style-type: none"> <li>○ Identify data end users with publication potential.</li> <li>○ Identify opportunities for shared data analysis and progress co-authored papers where possible.</li> <li>○ Include required recognition of Citizen Science contribution.</li> </ul>
<p><b>3.10</b> Generate Marine Biodiversity Indicators to feed into the Data Centre's National Biodiversity Indicators.</p>	<ul style="list-style-type: none"> <li>○ Review possible marine biodiversity indicators.</li> <li>○ Identify marine biodiversity indicators that can feed into the National Biodiversity Indicators on annual basis.</li> <li>○ Generate annual data for marine biodiversity indicators.</li> </ul>
<p><b>3.11</b> Develop / upgrade a marine biodiversity recording app</p>	<ul style="list-style-type: none"> <li>○ Interface based on recorder activity e.g. sailing, diving, rock pooling, sea angling etc...</li> <li>○ User friendly species ID and navigation</li> </ul>



Objectives	Actions
<p><b>3.12</b> Seek to collaborate in development of computer software for automated marine species identification.</p>	<ul style="list-style-type: none"> <li>○ Review literature and current project status.</li> <li>○ Seek collaborators with existing or new automated species identification software developers.</li> </ul>
<p><b>3.13</b> Explore collaborations to develop automated or crowd-sourced validation of Marine Biodiversity Citizen Science data.</p>	<ul style="list-style-type: none"> <li>○ Identify and meet with potential collaborators.</li> <li>○ Identify potential funding streams</li> </ul>
<p><b>3.14</b> Collaborate with EU partners towards developing EU-wide Marine Biodiversity Citizen Science projects and an EU Marine Biodiversity Citizen Science data centre.</p>	<ul style="list-style-type: none"> <li>○ Attend working groups on developing EU-scale projects.</li> <li>○ Attend EU working groups on data compatibility, integration, and storage.</li> <li>○ Make submissions on National and EU policy and reporting reviews, highlighting need and benefits in EU-scale projects, data compatibility and data storage.</li> </ul>

## Goal 4: Building Partnerships to Build the National Marine Biodiversity Data Resource

Objectives	Actions
<p><b>4.1</b> Build collaborations and an active stakeholder network with a view to sharing new and existing marine biodiversity data sets on the National Biodiversity Data Centre's Biodiversity Maps platform.</p>	<ul style="list-style-type: none"> <li>○ Identify potential partners holding or generating Marine Biodiversity Data, including: <ul style="list-style-type: none"> <li>– NGOs</li> <li>– private sector (e.g. consultancies)</li> <li>– philanthropic organizations</li> <li>– academia</li> <li>– community-based organisations</li> <li>– education institutions</li> <li>– state agencies</li> <li>– local government</li> <li>– private research centres</li> </ul> </li> <li>○ Publish a flyer highlighting the benefits to data owners of sharing Marine Biodiversity Data sets with the Data Centre.</li> </ul>
<p><b>4.2</b> Establish data sharing agreements with key data holders.</p>	<ul style="list-style-type: none"> <li>○ Meet with key data holders including: <ul style="list-style-type: none"> <li>– EPA</li> <li>– Marine Institute</li> <li>– NPWS</li> <li>– BIM</li> </ul> </li> <li>○ Develop automated data sharing links with key data holders.</li> <li>○ Agree MOU for regular data sharing with key data holders.</li> </ul>

Objectives	Actions
<p><b>4.3</b> Develop collaborations between state agencies, academia, and citizen science recorders.</p>	<ul style="list-style-type: none"> <li>○ Deliver talks showcasing potential of Marine Biodiversity Citizen Science data.</li> <li>○ Deliver networking and discussion events between Irish Marine Biodiversity Citizen Science groups, marine biodiversity policy makers, state agencies, and academia.               <ul style="list-style-type: none"> <li>– Develop better understanding of how Citizen Science can be used to co-develop policy.</li> <li>– How can Citizen Science can be integrated into current and future national and EU policies.</li> </ul> </li> </ul>
<p><b>4.4</b> Update existing datasets on a regular basis.</p>	<ul style="list-style-type: none"> <li>○ Approach data holders to update existing data sets every 2-3 years.</li> </ul>
<p><b>4.5</b> Develop collaborations with international (EU and non-EU) Marine Biodiversity Citizen Science practitioners</p>	<ul style="list-style-type: none"> <li>○ Attend ECSA Conferences and working groups to network with EU and non-EU ECSA members</li> <li>○ Subscribe to Citizen Science Association newsletter and track potential collaboration opportunities.</li> <li>○ Explore the potential for developing collaboration in Marine Biodiversity Citizen Science with the South African National Biodiversity Institute through the existing Data Centre MOU.</li> </ul>

## Goal 5: Improve our knowledge of marine species and habitats.

Objectives	Actions
<p><b>5.1</b> Train and support a network of skilled and active Marine Biodiversity Citizen Science recorders.</p>	<ul style="list-style-type: none"> <li>○ Run marine biodiversity identification and survey training workshops.</li> <li>○ Publish identification resources.</li> <li>○ Develop an online Marine Biodiversity Citizen Scientist Course for Adults.</li> <li>○ Promote or jointly run training events with partner organisations e.g. Seasearch Ireland, IWDG, Coastwatch etc.</li> <li>○ Implement and roll out a Marine Biodiversity Citizen Scientist Course for Primary and Second level schools with the Educational Training Boards.</li> <li>○ Review and update the Explorers Seashore Guide Workbook with Marine Institute Marine Explorers programme.</li> <li>○ Meet with An Taisce's Green/Blue schools' programme to explore collaborative actions on Marine Biodiversity Citizen Science.</li> </ul>
<p><b>5.2</b> Maintain and promote the Explore Your Shore! suite of Marine Biodiversity Citizen Science Surveys.</p>	<ul style="list-style-type: none"> <li>○ Maintain the three core Explore Your Shore! surveys:               <ul style="list-style-type: none"> <li>– Seashore Spotter</li> <li>– Rocky Shore Safari</li> <li>– Big Beach Biodiversity Survey</li> </ul> </li> <li>○ Review the status of additional surveys annually, discontinue if not performing and trial new surveys.               <ul style="list-style-type: none"> <li>– Seashore Snapshots</li> <li>– An Ebbing Tide</li> </ul> </li> </ul>

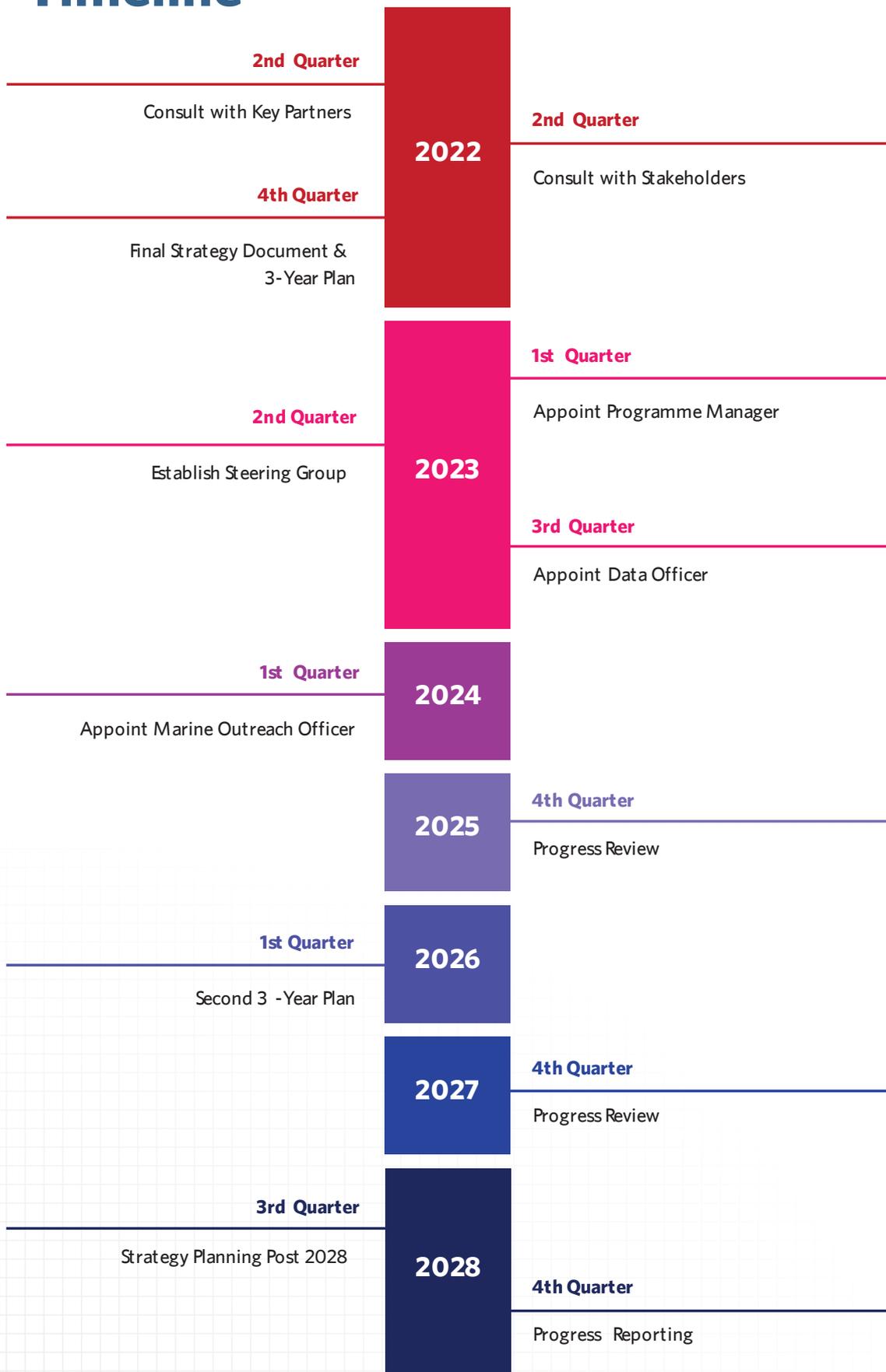
Objectives	Actions
<p><b>5.3</b> Promote Explore Your Shore! Citizen Science participation</p>	<ul style="list-style-type: none"> <li>○ Deliver Explore Your Shore talks to community groups, events, and organisations.</li> <li>○ Host Explore Your Shore! stand at events, conferences, festivals etc.</li> <li>○ Create online content to promote Explore Your Shore!</li> <li>○ Collaborate with newspapers, radio, and television to promote Explore Your Shore!</li> <li>○ Issue project update newsletters (email)</li> <li>○ Print and distribute flyers and stickers.</li> <li>○ Print and distribute species identification posters.</li> <li>○ Run two focused recording activities such as Seashore Splash or Bioblitz per annum</li> </ul>
<p><b>5.4</b> Identify key indicator species for water quality and climate change to develop flagship surveys.</p>	<ul style="list-style-type: none"> <li>○ Support a national seagrass survey with key partners e.g., Coastwatch, Seasearch.</li> <li>○ Establish a national phenology survey for marine species as indicators of climate change.</li> </ul>
<p><b>5.5</b> Establish a network of intertidal monitoring sites around the Irish Coast</p>	<ul style="list-style-type: none"> <li>○ Review Intertidal Citizen Science Monitoring methods.</li> <li>○ Work with active Marine Biodiversity Citizen Science recorders and groups to establish test sites for monitoring.</li> <li>○ Roll out monitoring sites as recorder training, experience, and capacity allow.</li> </ul>
<p><b>5.6</b> Highlight the links between Marine Biodiversity and Climate Change, Water Quality, Litter, and invasive species.</p>	<ul style="list-style-type: none"> <li>○ Setup page on Exploreyourshore.ie for information on bioindicators.</li> <li>○ Setup page on Exploreyourshore.ie to highlight pressures on the marine environment.</li> <li>○ Post regular social media messages on marine biodiversity and climate change, water quality, litter and invasives.</li> </ul>
<p><b>5.7</b> Collaborate with An Taisce's Clean Coasts to grow the Clean Coasts Observer programme.</p>	<ul style="list-style-type: none"> <li>○ Develop talks and activities for Clean Coasts Observer groups.</li> <li>○ Develop online content specific to the Clean Coasts Observer programme.</li> <li>○ Develop links between Clean Coasts and Explore Your Shore! objectives.</li> </ul>
<p><b>5.8</b> Collaborate with Seasearch Ireland to develop a programme of sub-tidal monitoring sites around the Irish Coast</p>	<ul style="list-style-type: none"> <li>○ Meet with Seasearch Ireland to discuss requirements to expand participation.</li> <li>○ Examine technical requirements to upload images with each record.</li> <li>○ Examine technical requirements to create online data upload form.</li> <li>○ Examine technical requirements to create online photo dump for underwater photographers.</li> </ul>

Objectives	Actions
<p><b>5.9</b> Engage with experts in State Agencies, Local Authorities, Government Departments, Museums and Universities to help deliver training to volunteers in marine biodiversity taxonomy and survey techniques.</p>	<ul style="list-style-type: none"> <li>○ Schedule three specialist courses per annum focusing on species group taxonomy and/or survey techniques, to be led by an external expert.</li> </ul>
<p><b>5.10</b> Work with partners in Northern Ireland to develop and all-Ireland Marine Biodiversity recording network.</p>	<ul style="list-style-type: none"> <li>○ Collaborate with Ulster Wildlife's Shore NI programme <ul style="list-style-type: none"> <li>– Joint training workshops</li> <li>– Joint events.</li> </ul> </li> <li>○ Collaborate with the Centre for Environmental Data and recording in sharing records and working on joint initiatives.</li> <li>○ Collaborate with the Ulster Museum and independent experts in Northern Ireland on species identification and citizen science training.</li> </ul>

## Goal 6: Promote Actions to Protect and Regenerate Marine Biodiversity in Ireland.

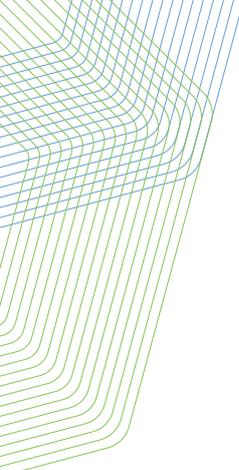
Objectives	Actions
<p><b>6.1</b> Identify marine conservation actions suitable for Citizen led initiatives.</p>	<ul style="list-style-type: none"> <li>○ Conduct literature review of citizen-led marine conservation actions worldwide.</li> <li>○ Develop a spreadsheet of suitable and achievable initiatives.</li> </ul>
<p><b>6.2</b> Publish guidelines on marine conservation actions for target groups, species, or habitats.</p>	<ul style="list-style-type: none"> <li>○ Review existing guidelines for citizen led marine conservation actions.</li> <li>○ Identify suitable citizen-led actions and prepare guidelines on their implementation.</li> </ul>
<p><b>6.3</b> Develop collaboration with existing marine conservation initiatives with elements suitable for public participation.</p>	<ul style="list-style-type: none"> <li>○ Review existing marine conservation initiatives.</li> <li>○ Develop collaboration with suitable initiatives e.g. Clean Coasts</li> </ul>
<p><b>6.4</b> Promote citizen-led participation in local authority BAP marine conservation goals.</p>	<ul style="list-style-type: none"> <li>○ Review Marine Biodiversity objectives within council BAPs</li> <li>○ Identify objectives which may be progressed by public participation.</li> <li>○ Meet with relevant local authority Biodiversity/Heritage Officers.</li> </ul>
<p><b>6.5</b> Assess feasibility of adopting a flagship restoration project.</p>	<ul style="list-style-type: none"> <li>○ Conduct feasibility assessment of species restoration projects such as seagrass or oyster beds at one or more locations around the Irish coast.</li> </ul>

# Timeline

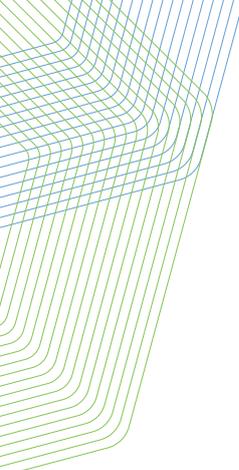


# References

- 1 Garcia-Soto, C., van der Meeren, G. I., Busch, J. A., Delany, J., Domegan, C., Dubsky, K., Fauville, G., Gorsky, G., von Juterzenka, K., Malfatti, F., Mannaerts, G., McHugh, P., Monestiez, P., Seys, J., W sławski, J.M. & Zielinski, O. (2017)** Advancing Citizen Science for Coastal and Ocean Research. *French, V., Kellett, P., Delany, J., McDonough, N. [Eds.] Position Paper 23 of the European Marine Board, Ostend, Belgium. 112pp. ISBN: 978-94-92043-30-6*
- 2 European Commission (2020) “** Best Practices in Citizen Science for Environmental Monitoring”. European Commission. Brussels, 27.7.2020 SWD(2020) 149 final.
- 3 IOC-UNESCO. 2020.** Global Ocean Science Report 2020–Charting Capacity for Ocean Sustainability. *K. Isensee (ed.), Paris, UNESCO Publishing.*
- 4 Department of Housing, Planning and Local Government (2020)** National Marine Planning Framework Consultation Draft. <https://www.gov.ie/en/publication/a4a9a-national-marine-planning-framework/>
- 5 Marine Protected Area Advisory Group (2020).** Expanding Ireland’s Marine Protected Area Network: A report by the Marine Protected Area Advisory Group. *Report for the Department of Housing, Local Government and Heritage, Ireland.*
- 6 IPBES (2019).** Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. *E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.*
- 7 Secretariat of the Convention on Biological Diversity (2020)** Global Biodiversity Outlook 5. *Montreal.*
- 8 Xu, H., Cao, Y., Yu, D., Cao, M., He, Y., Gill, M., & Pereira, H. M. (2021).** Ensuring effective implementation of the post-2020 global biodiversity targets. *Nature Ecology & Evolution, 1-8.*
- 9 Broderick, A. C. (2015).** Grand challenges in marine conservation and sustainable use. *Frontiers in Marine Science, 2, 11.*
- 10 Naumann, Sandra & Noebel, Rebecca & Gaudillat, Zelmira & Stein, Ulf & Röschel, Lina & Ittner, Sophie & Davis, Mckenna & Staneva, Anna & Rutherford, Claire & Romão, Carlos & schock, michael. (2020).** State of nature in the EU. Results from reporting under the nature directives 2013-2018. DOI: 10.2800/088178.
- 11 Hughes, B.B., Beas-Luna, R., Barner, A.K., Brewitt, K., Brumbaugh, D.R., Cerny-Chipman, E.B., Close, S.L., Coblenz, K.E., De Nesnera, K.L., Drobnitch, S.T. and Figurski, J.D. (2017)** Long-term studies contribute disproportionately to ecology and policy. *BioScience, 67(3), pp.271-281.*
- 12 Wolfe, D. A., Champ, M. A., Flemer, D. A., & Mearns, A. J. (1987).** Long-term biological data sets: their role in research, monitoring, and management of estuarine and coastal marine systems. *Estuaries, 10(3), 181-193.*
- 13 Plumeridge, A. A., & Roberts, C. M. (2017).** Conservation targets in marine protected area management suffer from shifting baseline syndrome: A case study on the Dogger Bank. *Marine pollution bulletin, 116(1-2), 395-404.*
- 14 Soga, M., & Gaston, K. J. (2018).** Shifting baseline syndrome: causes, consequences, and implications. *Frontiers in Ecology and the Environment, 16(4), 222-230.*
- 15 Bohnsack, J. A. (2003).** Shifting baselines, marine reserves, and Leopold’s Biotic Ethic. *Gulf and Caribbean Research, 14(2), 1-7.*
- 16 Guerrero-Gatica, M., Aliste, E., & Simonetti, J. A. (2019).** Shifting gears for the use of the shifting baseline syndrome in ecological restoration. *Sustainability, 11(5), 1458.*
- 17 Roy, H.E., Pocock, M.J.O., Preston, C.D., Roy, D.B., Savage, J., Tweddle, J.C. & Robinson, L.D. (2012)** Understanding Citizen Science & Environmental Monitoring. Final Report on behalf of UK-EOF. *NERC Centre for Ecology & Hydrology and Natural History Museum.*

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- 18 Theobald, E.J., Ettinger, A.K., Burgess, H.K., DeBey, L.B., Schmidt, N.R., Froehlich, H.E., Wagner, C., HilleRisLambers, J., Tewksbury, J., Harsch, M.A. and Parrish, J.K. (2015).** Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation*, 181, pp.236-244.
- 19 Easman, E., Abernethy, K. & Godley, B. (2018).** Assessing public awareness of marine environmental threats and conservation efforts. *Marine Policy*. 87. 234-240. [10.1016/j.marpol.2017.10.030](https://doi.org/10.1016/j.marpol.2017.10.030).
- 20 IOLN (2021)** Irish Ocean Literacy Network Website. Accessed on 21 April 2021.
- 21 Robinson, L.D., Cawthray, J.L., West, S.E., Bonn, A. and Ansine, J. (2018).** Ten principles of citizen science. In *Citizen science: Innovation in open science, society and policy* (pp. 27-40). UCL Press.
- 22 United Nations (2021)** "United Nations Treaty Collection". Treaties. [un.org](https://treaties.un.org). Retrieved 21 April 2021.
- 23 Robinson, A., Newton, N. & Cheffings, C. (2018)** Terrestrial Evidence Review Part 1: The value of JNCC's Terrestrial Evidence Programme. *JNCC*, Peterborough.
- 24 Levrel, H., Fontaine, B., Henry, P. Y., Jiguet, F., Julliard, R., Kerbiriou, C., & Couvet, D. (2010).** Balancing state and volunteer investment in biodiversity monitoring for the implementation of CBD indicators: A French example. *Ecological economics*, 69(7), 1580-1586.
- 25 Bonney, R., Shirk, J.L., Phillips, T.B., Wiggins, A., Ballard, H.L., Miller-Rushing, A.J. and Parrish, J.K. (2014).** Next steps for citizen science. *Science*, 343(6178), pp.1436-1437.
- 26 Henderson, S.A.N.D.R.A., Ward, D.L., Meymaris, K.K., Alaback, P.A.U.L. and Havens, K.A.Y.R.I. (2012).** Project Budburst: Citizen science for all seasons. *Citizen science: Public participation in environmental research*, pp.50-57.
- 27 Joly, A., Goëau, H., Glotin, H., Spampinato, C., Bonnet, P., Vellinga, W.P., Champ, J., Planqué, R., Palazzo, S. and Müller, H., (2016).** LifeCLEF 2016: multimedia life species identification challenges. In *International Conference of the Cross-Language Evaluation Forum for European Languages* (pp. 286-310). Springer, Cham.
- 28 Holt, B.G., Rioja Nieto, R., MacNeil, M.A., Lupton, J. and Rahbek, C., (2013).** Comparing diversity data collected using a protocol designed for volunteers with results from a professional alternative. *Methods in Ecology and Evolution*, 4(4), pp.383-392.
- 29 Gaul W, Sadykova D, White HJ, Leon-Sanchez L, Caplat P, Emmerson MC, Yearsley JM. (2020).** Data quantity is more important than its spatial bias for predictive species distribution modelling. *PeerJ* 8:e10411 <https://doi.org/10.7717/peerj.10411>.
- 30 UNESCO (2021)** Draft text of the UNESCO Recommendation on Open Science. SC-PCB-SPP/2021/OS-IGM/WD3. Accessed at <https://en.unesco.org/> on 21 April 2021.
- 31 EU.Citizen.Science (2021)** The EU-Citizen.Science website. <https://eu-citizen.science/> Accessed on 21 April 2021.
- 32 European Commission (2020)** "EU Biodiversity Strategy for 2030". <https://ec.europa.eu>. Retrieved 21 April 2021.
- 33 Kelly, R., Fleming, A., Pecl, G. T., Richter, A., & Bonn, A. (2019).** Social license through citizen science. *Ecology and Society*, 24(1).
- 34 UN (2021)** The 17 Sustainable Development Goals. <https://sdgs.un.org/goals> Accessed on 21 April 2021.
- 35 Garrett, J. K., Clitherow, T. J., White, M. P., Wheeler, B. W., & Fleming, L. E. (2019).** Coastal proximity and mental health among urban adults in England: The moderating effect of household income. *Health & place*, 59, 102200.

- 36 Ewert, Alan; Chang, Yun. (2018).** "Levels of Nature and Stress Response" *Behav. Sci.* 8, no. 5: 49. <https://doi.org/10.3390/bs8050049>
- 37 White, M. P., Wheeler, B. W., Herbert, S., Alcock, I., & Depledge, M. H. (2014).** Coastal proximity and physical activity: is the coast an under-appreciated public health resource?. *Preventive Medicine*, 69, 135-140.
- 38 Carlin, C., Kindermann, G., Britton, E., Cormican, M., Domegan, C., Gormally, M., & O'Donovan, D. (2020)** Nature and Environment to Attain and Restore Health (NEAR Health). *EPA Research Report No. 348, Environmental Protection Agency, Johnstown Castle, Co. Wexford, Ireland.*
- 39 Mac Domhnaill, C., Lyons, S., & Nolan, A. (2020).** The citizens in citizen science: demographic, socioeconomic, and health characteristics of biodiversity recorders in Ireland. *Citizen Science: Theory and Practice*, 5(1).
- 40 EPA (2020)** Ireland's Environment: An Integrated Assessment. Brendan Wall, Annette Cahalane and Jonathan Derham (Editors), Environmental Protection Agency, Johnstown Castle, Co. Wexford, Ireland.
- 41 Shephard S., Wögerbauer C., Green P., Ellis J.R. and Roche, W.K., (2019).** Angling records track the near extirpation of angel shark *Squatina* from two Irish hotspots. *Endangered Species Research* 38: 153-158.
- 42 National Biodiversity Data Centre (2021).** National Biodiversity Data Centre Ireland, *Paracentrotus lividus*, accessed 14 July 2021, <https://maps.biodiversityireland.ie/Species/27638>
- 43 Blue Health 2020.** Blue Health 2020 Project Website: <https://bluehealth2020.eu/>
- 44 World Economic Forum (WEF), 2020.** The Global Risks Report 2020. Available online: <https://www.weforum.org/reports/the-global-risks-report-2020>
- 45 EEA (European Environment Agency), (2019).** The European Environment – State and Outlook 2020. Knowledge for Transition to a Sustainable Europe. EEA, Copenhagen. Available online: <https://www.eea.europa.eu/soer>
- 46 Morrow, A., (2013).** The Impact of Citizen Science Activities on Participant Behaviour and Attitude: Review of Existing Studies. 2017-05-25]. <http://www.environment.scotland.gov.uk/media/16542/The-impact-of-Citizen-Science-activities-on-participant-behaviour-and-attitude.pdf>.
- 47 Santori, C., Keith, R.J., Whittington, C.M., Thompson, M.B., Van Dyke, J.U. and Spencer, R.J., (2021).** Changes in participant behaviour and attitudes are associated with knowledge and skills gained by using a turtle conservation citizen science app. *People and Nature*, 3(1), pp.66-76.
- 48 Mac Domhnaill, C., Lyons, S. and Nolan, A., (2020).** The citizens in citizen science: demographic, socioeconomic, and health characteristics of biodiversity recorders in Ireland. *Citizen Science: Theory and Practice*, 5(1).
- 49 BirdWatch Ireland (2011).** The First Atlas of Breeding Birds in Britain and Ireland: 1968-1972., National Biodiversity Data Centre, Ireland, accessed 21 July 2021: <https://maps.biodiversityireland.ie/Dataset/20>
- 50 Marine Biological Association (2021).** The Continuous Plankton Recorder web page. <https://www.mba.ac.uk/fellows/cpr-survey>
- 51 European Commission (2020).** Best Practices in Citizen Science for Environmental Monitoring. *Brussels, 27.7.2020 SWD(2020) 149 final.*
- 52 European Commission (2017).** Fitness Check of Reporting and Monitoring of EU Environment Policy. *Brussels, 9.6.2017 SWD(2017) 230 final.*



# Appendix I - Strategy Delivery

This Strategy will be delivered by the National Biodiversity Data Centre. It is considered that a minimum of three staff are required to help implement the strategy, in addition to a separate budget for resources development, training and other support.

Management of strategy delivery will be headed up by a **Programme Officer** with responsibility for overall project management and implementation. A **Data Officer** will be employed to deliver on Data Management Tasks including maximising data quality, working to secure data sharing of marine data sets from third parties, and integrating Marine Biodiversity Data Sets into EU and International data platforms. A **Marine Outreach Officer** will be employed to promote Marine Biodiversity Citizen Science in Ireland, liaise with recorders, integrate Marine Biodiversity Citizen Science into Irish Ocean Literacy initiatives, and promote Marine Biodiversity Citizen Science at an EU level through platforms such as EU4Oceans and the European Citizen Science Association.

This strategy is aimed at establishing a National Marine Biodiversity Citizen Science Platform delivering Marine Biodiversity Citizen Science capacity, oversight, guidelines, standards, and results in terms of data, policy and actions that can feed into the requirements of a range of State Agencies and Government Departments.

As such, funding to support the project is sought across departments and agencies, with the goal of achieving cross-department / agency support to fund the platform over the 6-year lifetime of the strategy.

# Appendix II – ECSA Ten Principles of Citizen Science<sup>21</sup>



## Ten principles of citizen science

Citizen science is a flexible concept which can be adapted and applied within diverse situations and disciplines. The statements below were developed by the 'Sharing best practice and building capacity' working group of the European Citizen Science Association, led by the Natural History Museum London with input from many members of the Association, to set out some of the key principles which as a community we believe underlie good practice in citizen science.

- 1. Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.**
- 2. Citizen science projects have a genuine science outcome.** For example, answering a research question or informing conservation action, management decisions or environmental policy.
- 3. Both the professional scientists and the citizen scientists benefit from taking part.** Benefits may include the publication of research outputs, learning opportunities, personal enjoyment, social benefits, satisfaction through contributing to scientific evidence e.g. to address local, national and international issues, and through that, the potential to influence policy.
- 4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process.** This may include developing the research question, designing the method, gathering and analysing data, and communicating the results.
- 5. Citizen scientists receive feedback from the project.** For example, how their data are being used and what the research, policy or societal outcomes are.
- 6. Citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for.** However unlike traditional research approaches citizen science provides opportunity for greater public engagement and democratisation of science.
- 7. Citizen science project data and meta-data are made publicly available and where possible results are published in an open access format.** Data sharing may occur during or after the project, unless there are security or privacy concerns that prevent this.
- 8. Citizen scientists are acknowledged in project results and publications.**
- 9. Citizen science programmes are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.**
- 10. The leaders of citizen science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities.**

September 2015, London