

**doing it  
together  
science**

**Grant agreement no. 709443**

**DITOs**

**Doing It Together science**

*Coordination & Support Action*

## D4.1 Initial Policy Briefs

Work Package: 4

Due date of deliverable: Month 12

Actual submission date: 31 / 05 / 2017

Start date of project: June 01 2016

Duration: 36 months

Lead beneficiary for this deliverable: European Citizen Science Association (ECSA)

Contributors: Kersnikova Institute, Centrum Szkolen I Rozwoju Osobistego Meritum, Institut Royal des Sciences Naturelles de Belgique, Tekiu Limited, University College London, Universite de Geneve; Universite Paris Descartes, Waag Society

Reviewer: Muki Haklay (UCL), Christian Nold (UCL), Patricia Tiago (Centre for Ecology, Evolution and Environmental Changes, Portugal), participants at Biofabbing conference (various)

Project co-funded by the European Commission within the H2020 Programme (2014-2020)		
PU	Public	<b>X</b>
CO	Confidential, only for members of the consortium (including the Commission Services)	
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)	
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)	
EU-SEC	EU-SEC Classified Information: SECRET UE (Commission Decision 2005/444/EC)	



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 709443

## Disclaimer

The content of this deliverable does not reflect the official opinion of the European Union. Responsibility for the information and views expressed herein lies entirely with the author(s).

All 'Doing It Together science' (DITOs) consortium members are also committed to publish accurate and up to date information and take the greatest care to do so. However, the DITOs consortium members cannot accept liability for any inaccuracies or omissions nor do they accept liability for any direct, indirect, special, consequential or other losses or damages of any kind arising out of the use of this information.

## Copyright Notice



This work by Parties of the DITOs Consortium is licensed under a Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>).

## Acknowledgement



The DITOs project has received funding from the European Union Horizon 2020 programme under grant number 709443.

## Reference

Please cite this work as:

DITOs Consortium, 2016. *Doing It Together science: Initial Policy Briefs* UCL, London.

**Document Identification Sheet**

<b>Project ref. no.</b>	709443
<b>Project acronym</b>	DITOs
<b>Project full title</b>	Doing It Together Science
<b>Document name</b>	DITOs-D4.1-20170531.pdf
<b>Security (distribution level)</b>	Public
<b>Contractual date of delivery</b>	Month 12, 31 05 2017
<b>Actual date of delivery</b>	31.05.2017
<b>Deliverable number</b>	D4.1
<b>Deliverable name</b>	Initial Policy Briefs
<b>Type</b>	Report
<b>Status &amp; version</b>	Version 1.0
<b>Number of pages</b>	33
<b>WP/Task (responsible)</b>	WP4 / T2 (ECSA)
<b>Author(s)</b>	ECSA: Gaia Agnello Waag Society: Pieter van Boheemen
<b>Other contributors</b>	ECSA: Claudia Göbel ECSA BioBlitz Working Group: Lucy Robinson, Andrea Sforzi, Matt Postles, Jack Sewell, Liam Lysaght, Ana Cristina Cardoso, Konstantinos Tsiamis, John Harlin, Libby Hepburn, Alison Young, Jaume Piera, Dacha Atienza Ariznavarreta, Daniela Campobello KI: Simon Gmajner Meritum: Pawel Wyszomirski RBINS: Carole Paleco Tekiu: Aleksandra Berditchevskaia UCL: Muki Haklay, Christian Nold, Judy Barrett UNIGE: Bruno Strasser UPC: Imane Baiz Waag Society: Wieke Betten
<b>Project Officer</b>	Colombe Warin
<b>Abstract</b>	DITOs policy briefs: good practices and standards on Biodesign regulations and adaptation potentials, and cross-border research and cooperation for Environmental Sustainability.
<b>Keywords</b>	citizen science, DITOs BioBlitz, biodiversity, DIY science, Do it Yourself, DIYBio, biotechnology
<b>Sent to peer reviewer</b>	11/05/17
<b>Peer review completed</b>	18/05/17
<b>Supervisory Board approval version 1.0</b>	30/05/17

---

## Table of contents

1	Version log .....	5
2	Definitions and acronyms .....	6
3	Management summary .....	7
4	Introduction .....	8
5	Activities carried out and results.....	8
5.1	Initial fact finding and review .....	8
5.2	Sources of information and methods of working .....	9
5.3	Environmental sustainability policy brief considerations.....	11
5.4	Biodesign policy brief considerations .....	12
5.5	Design and presentation of policy briefs .....	13
5.6	Dissemination of policy briefs.....	13
6	Conclusions .....	13
7	Bibliography / References .....	14
8	<i>APPENDICES</i> .....	14
8.1	Appendix 1 – Environmental Sustainability Policy Brief .....	15
8.2	Appendix 2 – Biodesign Policy Brief.....	23

## 1 Version log

<b>Version</b>	<b>Date</b>	<b>Released by</b>	<b>Nature of Change</b>
V0.1 BioBlitz	17/02/2017	Gaia Agnello (ECSA)	Suggestion of outline for Policy Brief
V0.1 DIYBio	02/03/2017	Pieter van Boheemen (Waag Society)	Suggestion of outline for Policy Brief
V0.2 BioBlitz	26/04/2017	Gaia Agnello (ECSA)	Draft compiled contend
V0.2 DIYBio	19/04/2017	Pieter van Boheemen (Waag Society)	Draft compiled contend
V0.3 BioBlitz	03/05/2017	Gaia Agnello (ECSA)	Consortium Review
V0.3 DIYBio	03/05/2017	Pieter van Boheemen (Waag Society)	Consortium Review
V0.4 BioBlitz	04/05/2017	Gaia Agnello (ECSA)	External Review
V0.4 DIYBio	11/05/2017	Pieter van Boheemen (Waag Society)	External Review
V0.5 BioBlitz	16/05/2017	Gaia Agnello (ECSA)	Updated version
V0.5 DIYBio	18/05/2017	Pieter van Boheemen (Waag Society)	Updated version
V0.6 BioBlitz	30/05/2017	Gaia Agnello (ECSA)	Modified version
V0.6 DIYBio	30/05/2017	Pieter van Boheemen (Waag Society)	Modified version
V1.0 BioBlitz	31/05/2017	Claudia Göbel (ECSA)	Release pre-formatting
V1.0 DIYBio	31/05/2017	Claudia Göbel (ECSA)	Release pre-formatting

## 2 Definitions and acronyms

<b>Acronyms</b>	<b>Definitions</b>
CSA	Coordination and Support Action
DITOs	Doing It Together science
DIY	Do It Yourself
DIYBio	Do It Yourself Biotechnology
ECSA	European Citizen Science Association / Verein der Europäischen Bürgerwissenschaften
Eutema	EUTEMA GMBH
GA	Grant Agreement
H2020	Horizon 2020 Programme
KI	Kersnikova Institute
M	Month
Meritum	Centrum Szkolen i Rozwoju Osobistego Meritum
RBINS	Institut Royal des Sciences Naturelles de Belgique
RRI	Responsible Research and Innovation
Tekiu	Tekiu Limited
UCL	University College London
UNIGE	Université de Genève
UPD	Université Paris Descartes
WG	Working Group
WP	Work Package
WS	Waag Society

### 3 Management summary

DITOs initial policy briefs focus on two themes: Biodesign and environmental sustainability.

The initial brief on environmental sustainability focuses on BioBlitz, an increasingly common citizen science methodology. A BioBlitz is an event during which members of the public, professional scientists and voluntary naturalists work together to record as many species as possible within a delimited geographical area over a defined time period. The topic of this policy brief is the field of biodiversity covering a wide range of policy and research areas including biodiversity conservation (e.g., species and protected areas), invasive alien species, coastal and marine management, and strategies for public engagement. The purpose of the policy brief is to synthesise evidence of the use of this methodology, highlight the valuable contribution it makes to public engagement, science, environmental management and policy, and explore how these potentials of the BioBlitz methodology can be enhanced by increasing cross-boundary exchange of experience and cooperation.

The initial brief on biodesign focuses on a particular area of biodesign known as Do It Yourself Biotechnology (DIYBio). The application of design methodologies on biotechnology has greatly reduced the required means and resources to participate, which has led to the establishment of a worldwide movement of enthusiasts working with biotechnology in informal settings. For example, the tools and materials for doing genetic engineering, molecular diagnostics or tissue culturing are affordable enough for individuals to use. The purpose of the policy brief is to describe the implications and potential understandings of this phenomenon; in particular how the relationship between formal and informal biotechnology could lead the way to a more open, inclusive and responsible sector.

Both policy briefs are informed by initial fact finding and review work (WP4T1) of good practices and policy guidelines, based on which scope and potential contributors have been identified. A community-oriented approach was then chosen for determining the specific topics of each brief and elaborating the content. The BioBlitz policy brief has been developed as collaborative process by a newly founded ECSA working group on BioBlitz that brings together organisers of such activities from around the world. The DIYBio policy brief has been elaborated in dialogue with DIYBio practitioners. Contributions were collected via the DITOs stakeholder round tables in Berlin and Paris, 20 videos submitted by DIY science practitioners from around Europe, via responses to the 7 vlogs published in the DITOs YouTube channel, and other DITOs events. As external review a draft version of the policy brief was presented and discussed at a practitioner conference. Within this process, the initial topic of regulations has been modified to focus more broadly on the various potentials of DIYBio for research, innovation and education.

This deliverable concludes the successful first stage of WP4 based on key achievements regarding the elaboration of guidelines, mechanisms and institutions to facilitate policy engagement for RRI as well as internal consolidation of project workflows. Future briefs (M24 and M36) will further expand this work on the themes of biodesign and environmental sustainability and will address in detail the four key principles of RRI (gender equality and the inclusion of disadvantaged groups, open access, data and science, ethics and quality evaluation and the involvement of SMEs and industry). Sources of information will be continually expanded.

DITOs 'Initial Policy Briefs' is Deliverable 4.1 (D4.1) from the coordination and support action (CSA) Doing It Together science (DITOs), grant agreement 709443.

## 4 Introduction

DITOs' Work Package 4 (WP4) concerns policy engagement for Responsible Research and Innovation (RRI) within DITOs' two defined themes, namely biodesign and environmental sustainability. From the consortium Grant Agreement (GA), the objectives of WP4 are:

To develop clear guidelines, mechanisms and institutions to extend the development of policy engagement in citizen science and DIY science across Europe, fostering Responsible Research and Innovation (RRI), linking the pan-European citizen science and DIY science community to decision-makers at various levels and supporting innovation by:

- Elaborating, sharing and providing policy support on good practices of RRI activities with a focus on DITOs;
- Mainstreaming gender equality, ethics and quality evaluation as RRI standards for DITOs activities in Europe;
- Channelling societal inputs regarding responsible R&I policies to policy makers at different levels, especially in the fields of Biodesign and Environmental Sustainability.

WP4 is designed to strengthen the two-way link between the DITOs network and policy makers to promote sustainable and resilient RRI governance. It will guide a learning process among DITOs practitioners, elaborate and mainstream RRI standards, and engage policy and decision-makers at local, regional, national, EU and international levels.

Activities in WP4 include structured knowledge creation and exchange, development of guidelines (policy briefs), mechanisms for engagement (stakeholder roundtables and pan-European policy forum) and sustainable institutions (namely the European Citizen Science Association - ECSA) for policy engagement.

ECSA leads WP4 which runs from Month 1 to month 36 of the project. During this time, three sets of policy briefs will be produced (M12, M24 and M36). This deliverable covers the production of the initial set of briefs (M12), namely:

- Cross-border research and cooperation for environmental sustainability;
- Biodesign regulations and adaptation potentials.

This deliverable outlines the process followed to produce the briefs and the sources of information as well as the content of the briefs themselves.

## 5 Activities carried out and results

### 5.1 Initial fact finding and review

Initial fact finding and review (WP4T1) was conducted in phase 1 of the project to review current good practices and policy guidelines with regards to citizen science and DIY approaches. A collection of guidelines and scientific publications is publicly available on ECSA website (<https://ecsa.citizen-science.net/blog/collection-citizen-science-guidelines-and-publications>). The review provided an overview of existing guidelines and supporting resources, which provided evidence base for the elaboration of the policy briefs.



For the case of the BioBlitz methodology, documents that have been identified were mainly user guides for running BioBlitz activities focusing on citizen science practitioners. Although a couple of such guidelines exist, the consultation with practitioners improved the understanding and knowledge over the broad variety of BioBlitz activities that is currently being carried out, both in terms of format and duration of events as well as regarding the areas, goals and desired outcomes of the study. Since an informative documentation of BioBlitz activities along with their potential for public engagement and policy in a format addressing decision makers was missing, the policy brief was oriented to provide this content. In addition, the fact finding and review helped to identify potential contributors to the policy brief.

For the case of DIYBio, documents identified included general descriptions of the actors, practice and places in which DIY biology and biotechnology is conducted in Europe and the United States, academic and popular science discussions on specific aspects of the practice, such as ethical or security questions, as well as policy briefs. A public reference database was created on Zotero ([https://www.zotero.org/groups/doing\\_it\\_together\\_science/items](https://www.zotero.org/groups/doing_it_together_science/items)), in which additional relevant articles were collected. Since the descriptions of the DIYBio movement in academic articles were rather fragmented, and no previous European policy briefs on DIYBio existed, it was decided to focus the present policy brief on furthering the understanding of DIYBio as a movement promoting openness and inclusiveness, new ways to organize moral deliberations, innovation in business and education.

## 5.2 Sources of information and methods of working

The information presented in both policy briefs rests on the initial fact finding and review exercise (WP4T1), which included materials from other EU reference projects, such as CAPS, PLACES, Citizens Observatories, Everyaware, Geo-Wiki, RRI Toolkit, Societize, Synenergene, as well as other projects and institutions, such as the Joint Research Center and the Hackteria network. In addition, scientific and popular science literature has been consulted as well as grey literature by practitioners from the respective fields. Since both citizen science and DIY science are emerging fields, it was a main aim behind the creation of these policy briefs to make more information about these practices available. For this reason, a community-oriented approach has been chosen for determining the specific topics of each brief (in the framework of the broader topics stipulated by DITOs) and elaborating the content. To facilitate such a community-oriented approach, knowledge and experience from practitioners, within the DITOs consortium and beyond, has been collected through various processes described below for each policy brief. The European Stakeholder Round Table on Citizen Science, DIY Science and RRI organized by ECSA in November 2016 in Berlin served as kick-off for both participatory writing processes. At this round table, both policy brief topics were presented and workshops held with practitioners and other stakeholders to refine the general orientations of the policy briefs, find experts interested in contributing and discuss tentative timelines.

The **BioBlitz policy brief** has been developed with contributions from a network of BioBlitz organisers from around the world. Many ECSA members and non-members have experience in implementing this methodology and have expressed an interest in sharing their experience enabling the sharing of good practice between countries. During ECSA General Assembly (GA) in January 2016, ECSA established a working group (WG) on BioBlitz with the aim of connecting people, communities and organisations involved in the organisation of BioBlitz events, to facilitate the sharing

of good practice and to build capacity for this type of event across Europe. The activity to develop a policy brief using a participatory approach was proposed and accepted during the GA and therefore included in the work plan of the group. The establishment of a BioBlitz network with ECSA is supported by DITOs by providing opportunities for networking and exchange of knowledge. The online event calendar on the DITOs website ([togetherscience.eu](http://togetherscience.eu)) offers to members the opportunity to showcase their BioBlitz events happening in Europe, enabling practitioners and researchers to link up and promote events widely reaching civil society, policy makers and other relevant stakeholders. Members of the WG belong to the following organisations: Bristol Natural History Consortium (UK); Natural History Museum London (UK); Open University (UK); Natural History Museum Maremma (Italy); Natural History Museum of Barcelona (Spain); Marine Biological Association (UK); LAS Alpine Institute (Switzerland); National Biodiversity Data Center (Ireland); Center for Ecology, Evolution and Environmental Change (Portugal); University of Tartu (Estonia); CREAM & Natusfera (Spain); Spanish National Research Council (Spain); Parco Regionale Oglia Sud (Italy); Junior Research Center - European Alien Species Information Network (Italy); cNature (Israel); University of Palermo (Italy); LIFE project MIPP (Italy); University of Trieste (Italy); Atlas of Life (Australia); National Geographic (US); California Academy of Science (US); Natural History Museum of Los Angeles (US).

The development of the policy brief was the first task assigned to the WG for 2017. Online meetings were held regularly to allow everyone to participate in the development of the document. The outline of the policy brief was first agreed with DITOs partners. Members of the WG were invited to attend the first online meetings to learn about the objectives and work plan of the group, with particular attention to introduce the policy brief. During this first meeting, the purpose, target audience and agreed outline were presented and discussed with the WG members. The timeline for the development of the document was made explicit during the meeting, and members who expressed interest in contributing to the document accepted the proposed deadlines and specified the section of the outline they would contribute to.

Members of the group chose how to contribute, for example by providing input for the content of the policy brief, BioBlitz case example to include in the document in the format of a box, or feedback on content and drafts. A working document with the outline of the policy brief was created on an online collaboration platform, where contributors were assigned to each section of the outline (as for their preference) to allow them to provide relevant key arguments in bullet points or text. In order to make sure that important aspects were not missing, this first effort of contributions were reviewed during an online meeting set up via Adobe Connect. Reminders were sent via email to the members to encourage punctuality in including their input in the draft.

In order to bring evidence of events organised in different format and context and to highlight the possible outcomes and values of BioBlitz, case examples were provided by the members and included in the form of a box. Recommendations were given to members on how to describe the event, in order to provide a good representation of the different formats and impacts that BioBlitz can have.

Contributions were merged in a homogeneous style into a first draft by the WG coordinator, which is the policy brief author, and the draft was sent around for different rounds of feedback. The draft was reviewed by the members of the group, then shared with DITOs consortium and sent to the selected internal and external reviewer for their feedback.

The **DIYBio policy brief** has been developed based on an initial planning at the end of 2016. This planning was shared with the consortium members and adjusted when needed in online conference calls.

The plan included multiple strategies towards gathering information about the DIYBio movement by the consortium members. Contributions were collected via the DITOs stakeholder round tables in Berlin and Paris, 20 videos submitted by DIY science practitioners from around Europe and via responses to the 7 vlogs published in the DITOs YouTube channel. It was decided to use vlogs to engage the DIYBio movement because the majority of the practitioners are organized in informal online networks, in which written documents do not get shared frequently. Videos were expected to be more suitable to that end and indeed reached about 3,000 views.

The vlog episodes touched upon several dimensions of the DIYBio movement, including regulatory aspects, business innovation, interaction with science centres, the size of the movement, as well as the process of writing the policy brief itself in an attempt to make that more transparent as well. Each video was published in several online channels, including the global DIYBio Google Group on which online public discussion took place. Furthermore, the videos called upon DIY Biologists to respond and received reactions from dozens of viewers via email. A number of DIY Biologists were then interviewed for the following episodes, including the DIYBio community in Heidelberg, the lab manager of BioTehna (Slovenia), the coordinator of the Citizen DNA Barcoding project and manager of the biotech start-up incubator RebelBio.

During this process, several WP1 Biodesign activities took place that offered additional opportunities to gather information and opinions. In particular, Waag Society's "Het Praktikum" evenings and UPD's educational workshops have been included as case examples in the policy briefs.

As soon as a sufficient amount of information was gathered through these activities, in addition to the literature review, tasks were divided to write the policy brief itself within the DITOs consortium. Using an online collaborative platform, a working document was created, which outlined the main sections and boxes for case examples. Each consortium partner was made responsible for different elements. Once these were filled in, the task leader condensed the document into a coherent narrative.

A summary of this initial policy brief was transformed into a public presentation, which was held at the BioFabbing conference in Geneva in the presence of dozens of DIYBio practitioners from all over Europe and the world. The discussions at this event served as external review of the policy brief, and feedback from that event as well as the internal review by the DITOs consortium fed into the final version.

### 5.3 Environmental sustainability policy brief considerations

**Title:** BioBlitz: promoting cross-border research and collaborative practices in Europe through Citizen Science

**Outline:**

1. Advances in Citizen Science: The Bioblitz approach
2. What is a BioBlitz
3. Technology-enabled biodiversity monitoring
4. Background: the need for monitoring biodiversity

5. Added value and outcomes of BioBlitz: Public engagement with science and policy
  - a. Individual and community outcomes
  - b. Scientific and environmental outcomes
  - c. Policy and management outcomes
6. How to increase BioBlitz impact: Fostering networking and capacity building
7. Recommendations

**Target audience:** policy/decision-makers and civil servants who come across the term BioBlitz and want to learn about it.

**Purpose:** informing stakeholders on what a BioBlitz is and why is a 'good' citizen science methodology.

The full content of the '*BioBlitz: promoting cross-border research and collaborative practices in Europe through Citizen Science*' brief can be found in Appendix 1 – Environmental Sustainability Policy Brief.

## 5.4 Biodesign policy brief considerations

Initially, the policy brief was planned to focus on regulations concerning DIYBio and their adaption potential at European level as well as within member states. This topic was presented at the European Stakeholder Round Table on Citizen Science, DIY Science and RRI in November 2016. At this event, the consensus of DIYBio practitioners was that the topic of this initial policy brief should be broader, focusing on the various potentials of DIYBio for research, innovation and education, and should be more informative in nature. The theme of the policy brief was adapted to accommodate this.

**Title:** Do It Yourself Biotechnology' (DIYBio) for open, inclusive, responsible biotechnology

**Outline:**

1. Executive Summary
2. Understanding the potential of DIYBio
  - a. Potential for inclusivity and openness in science
  - b. Potential for ethics
  - c. Potential for innovation
  - d. Potential for education: project and practice based learning
3. Considerations when adjusting funding mechanisms and regulation
4. Recommendations

**Target audience:** policy/decision-makers and civil servants.

**Purpose:** informing stakeholders on the potentials of DIYBio.

The full content of the '*Do It Yourself Biotechnology*' (DIYBio) for open, inclusive, responsible biotechnology' brief can be found in Appendix 2 – Biodesign Policy Brief.

## 5.5 Design and presentation of policy briefs

A short format has been chosen for the policy briefs in order to give a condensed summary of relevant developments in the fields of citizen science and DIY science to decision makers. Examples are provided in boxes to illustrate the arguments made with existing cases. The policy briefs have been designed in accordance with the branding and publication standards defined in D6.2 in order to continue building the DITOs brand regarding information material.

Policy briefs have been included in the appendices in an unformatted full version and with combined end notes for the purpose of this deliverable. Formatted versions that might differ in length will be produced and distributed following the submission of the deliverable.

## 5.6 Dissemination of policy briefs

Policy briefs will be distributed online (through the DITOs and partners websites and mailing lists, via online discussion lists and social media, accompanying blog posts, etc.), in print (as hand-outs to decision makers), and via events and presentations. Policy briefs will also be presented, handed out and discussed at future DITOs and partners' events to attract additional attention, such as stakeholder round tables and conferences. Finally, the community-oriented process of writing the policy briefs will also be leveraged for their distribution.

## 6 Conclusions

This deliverable concludes the successful first stage of WP4 and the timely deliverable of two policy briefs evidences a firm foundation and network on which to extend the consortium's activities on policy engagement for RRI. The key achievements in this phase have been:

- **Guidelines:** Publishing two initial policy briefs focusing on good practices of RRI activities regarding public engagement in research for environmental sustainability and DIYBio, which can now be leveraged for supporting policy and further developing policy engagement in citizen science and DIY science;
- **Guidelines:** Collecting, reviewing and making key best practice documents on citizen science and DIY science openly accessible as reference source that can be expanded over the course of the project and beyond;
- **Mechanisms:** Establishing collaborative, open networks around the topics of BioBlitz and DIYBio between DITOs partners, external practitioners of citizen science and DIY science, their organisations, policy makers and other stakeholders that support learning and can stimulate innovation;
- **Mechanisms:** Carrying out two open and community-oriented processes for determining the specific themes and contents of the policy briefs and thereby piloting participatory processes along with accompanying communication strategies to be built on for future deliverables;
- **Institutions:** Extending ECSA's and DITOs' capacities as de facto sources of information for policy makers throughout Europe;

- **Institutions:** Developing institutional structures – creation of ECSA WG on BioBlitz in Europe and linking to existing DIYBio community networks – to build capacities for sustainable networking and policy engagement for citizen science and DIY science communities;
- **Internal:** Successfully integrating WP4 (Policy Engagement) activities with WP1 (Environmental Sustainability) / WP2 (Biodesign) activities through identification of relevant and actionable topics of concern, thereby providing tangible examples of processes and outputs of the implementation of the matrix structure behind the DITOs project;
- **Internal:** Linking the work on policy briefs to other WP4 activities, especially stakeholder round tables, carried out by various partners thus improving programmatic cohesion as well as coordination and cooperation between partners;
- **Internal:** Establishing a common look and feel for DITOs policy briefs.

Future briefs (M24 and M36) will further expand this work on the themes of biodesign and environmental sustainability and will address in detail the four key principles of RRI (gender equality and the inclusion of disadvantaged groups, open access, data and science, ethics and quality evaluation and the involvement of SMEs and industry). The sources of information will be continually expanded and updated. In addition, future policy briefs will pilot further ways of mobilizing input by linking to other WP4 activities, especially discovery trips, as well as WP1 and 2 activities, especially feedback on exhibits, activities and outputs of deliberation. Next to the policy briefs, also mechanisms and institutions for policy engagement of citizen science and DIY science communities across Europe will be developed further. Altogether, this work aims at contributing to work towards maximising the innovation potential of Europe, building trust in R&I activities and closing the research and innovation capabilities gap. Within the RRI framework, data ownership and IPR will receive special attention, in consultation with legal experts.

## 7 Bibliography / References

References are included as endnotes to the appendices.

## 8 APPENDICES

## 8.1 Appendix 1 – Environmental Sustainability Policy Brief

### ***BioBlitz: Promoting cross border Research and collaborative Practices for Biodiversity Conservation***

#### **Advances in Citizen Science: the Bioblitz Approach**

Citizen Science approaches – the involvement of non-professionals in scientific research - are increasingly effective and relevant sources of data for improving knowledge of biodiversity, whilst simultaneously increasing public engagement in science<sup>i</sup>. Among the vast array of tools available in environmental Citizen Science, BioBlitz events are being adopted as an effective methodology for conducting a rapid assessment of biodiversity, thus contributing to the evidence base for managing and preserving biodiversity and ecosystem services<sup>ii</sup>.

This policy brief has been developed with contributions from a vast network of BioBlitz organisers internationally. It aims to inform policy and decision-makers including public administration, local authorities and donors, on the BioBlitz approach and its potential for achieving local and national biodiversity goals. By showcasing initiatives implemented in Europe, this document highlights the potential of a BioBlitz to make a valuable contribution to science, environmental management, policy and public engagement. It concludes by advocating for the BioBlitz approach and proposing the establishment of an EU wide network of practitioners and BioBlitz organisers to foster cross border research and collaboration in biodiversity conservation.

This policy brief is developed within the framework of the Horizon 2020 ‘Doing It Together Science’ (DITOs) project to establish a collaborative and open network between DITOs partners, external organisations and policy-makers throughout Europe.

#### **What is a BioBlitz?**

During a BioBlitz event (from Bio = life and Blitz = something quick and intense) members of the public, professional scientists and voluntary naturalists work together to record as many species as possible within a delimited geographical area over a defined time period. The first BioBlitz was organised in Washington D.C. in 1996 by the National Park Service and the National Biological Service, both part of the U.S. Department of the Interior. Ever since, BioBlitz has become a very common approach especially in the USA, UK (BOX 1) and Australia. To a smaller extent, BioBlitzes are being carried out in other European countries in a constantly increasing trend, as Citizen Science popularity increases, even in countries with little tradition of public participation in science.

Commonly, the event is organised as a 24-hour blitz to create a broad biodiversity inventory of a geographical site. Yet, if the goal is to capture a snapshot of a target species or ecosystem, a shorter ‘mini-BioBlitz’ (three hours to half a day) is an adequate format. This versatility means BioBlitzes can make a meaningful contribution to a number of EU environmental policy areas such as invasive alien species (IAS) and marine biodiversity monitoring (*BOX 2 and 3*). The typical short time frame of this event delivers rapid datasets providing a complementary approach to long-term inventories and contributing to reporting progress towards national targets as well as informing decision-making processes.

Usually delivered by partnerships of academia, natural history or science museums, education institutes and NGOs, BioBlitz events are an opportunity to collaborate with stakeholders who are usually not directly involved in conservation, therefore promoting interdisciplinary collaboration and increasing opportunities to support campaigns to protect the local environment. Citizen Science practitioners globally have shared their experiences and designed user guides to running a BioBlitz<sup>iii,iv</sup>, enabling the sharing of good practices between countries and encouraging new BioBlitz organisers to implement this activity.

### **Technology-enabled Biodiversity Monitoring**

Engaging the public in mapping species is becoming an easier task thanks to advances in technology. However, when involving non-professionals in collection of biodiversity data, the quality of the data collected is an issue to be addressed. Developments of tools such as web platforms and mobile apps to record data from the field (e.g. iNaturalist, IAS Europe, Natusfera, iRecord, BioDiversity4All) are quickly moving forward in response to this challenge. The use of accessible technologies facilitates inclusiveness as well as processes for data quality control. Uploaded observations containing a photograph of the species, date and location information, are made available in real-time, thus enabling verification by experts at any time and with an increased speed of data sharing. BioBlitzes can contribute observations to national and international biodiversity databases, allowing their use to answer large-scale scientific and management questions (*BOX 4, 5*).

### **Background: The need for Monitoring Biodiversity**

Biodiversity is threatened by the effects of human activities on the environment such as climate change, habitat loss and introduction of IAS. The value of biological diversity has been recognised in legal instruments such as the Convention for Biological Diversity (UNEP, 1993) adopted by 196 countries worldwide. The framework, provided in the ten-year strategic plan for 2011-2020, includes the Aichi Biodiversity Targets and is reflected in the EU 2020 Biodiversity Strategy and translated into national strategies<sup>v</sup>. EU Institutions and Member States are responsible for ensuring that objectives are achieved by 2020. The EU Strategy sets out actions and horizontal measures needed to reverse loss of biodiversity,



and includes built-in measures such as the Natura 2000 network to improve the implementation of the Birds and Habitats Directives. Measuring the success of these strategies is essential and one vital step in this process is effective monitoring of biodiversity to which BioBlitzes can contribute (*BOX 6*).

### **Added Value and Outcomes of BioBlitz: Public Engagement with Science and Policy**

A BioBlitz is a process whereby the knowledge gained by the participants and the scientists create sustained awareness and commitment to address environmental issues.

#### **1) Individual and Community Outcomes**

BioBlitzes empower individuals and communities to take action to protect the environment. They can help address issues of concern for communities such as biological invasions or air quality by using bioindicators. Participation in BioBlitzes can also improve the sense of being part of a local area and develop community cohesion.

#### **2) Scientific and Environmental Outcomes**

Data collected during a BioBlitz can be used for research such as updating species lists and documenting the occurrence of rare species (*BOX 7, 8*). It is not a replacement for a professional ecological survey as the outcome depends on the methods used and the expertise available on the day. Nevertheless, a BioBlitz attended by professional experts offers opportunities for skills development in surveying and identification; fosters collaboration and networking; strengthens connections between professionals; whilst contributing data towards more long-term surveying efforts.

#### **3) Policy and Management Outcomes**

BioBlitzes have the potential to inform policymaking, but these links can be enhanced. When a BioBlitz is able to give answers to community concerns, the policy outcomes of these events become even stronger. A BioBlitz can launch campaigns on environmental issues relevant at local scale or contribute knowledge addressing larger-scale challenges. For instance, the detection of IAS helps track their occurrence and distribution and reduces time of action with real-time notification to government agencies (*BOX 3*). In many cases BioBlitz events are held in protected areas (*BOX 6*), contributing data to inform management interventions and to support monitoring and reporting of environmental legislation.

### **How to increase BioBlitz Impact: Fostering Networking and Capacity Building**

Many BioBlitz events are held within Europe with little cross-boundary exchange of experience, resulting in a missed opportunity to maximise the impacts and outcomes of this approach. With BioBlitzes becoming more and more popular, research is needed to identify

good practices that take into account citizens', researchers' and policymakers' priorities. Establishing a BioBlitz multi-actor framework would make it possible to better align priorities and needs of stakeholder groups. The European Citizen Science Association (ECSA) was established in 2013 to foster the potential of Citizen Science with regard to environmental sustainability and policy making. One of its goals is to support such a movement by providing opportunities for networking and exchange of knowledge, aiming to consolidate the European network and making it sustainable in the long-term.

## Recommendations

We recommend the establishment of a Europe-wide network of BioBlitz stakeholders for the following objectives:

- To facilitate the sharing of best practices and to build capacity for this approach.
- To facilitate cross-border research and cooperation and to promote the implementation of BioBlitzes to achieve a wide range of desirable outcomes.
- To further develop the potential of BioBlitz to be temporally repeated monitoring events.
- To enhance the potential of this approach to support the implementation of local, national and international biodiversity strategies and to inform decision-making processes.
- To advocate and provide support for taxonomists to attend, develop their own skills and to support post-event follow up.
- To encourage the growing interest in schoolyard BioBlitzes and other outdoor educational curricula to increase social commitment to the study and conservation of nature.

## Colophon

This policy brief was facilitated by the lead authors (ECSA) through open interaction and discussion with the ECSA BioBlitz working group. While this was carried out as part of H2020 'Doing It Together Science' (DITOs) Coordination and Support Action project, the views expressed in it do not reflect the consensus opinion of DITOs partners.

## BOX 1 - UK National Network and Defra

The UK Department for the Environment, Food and Rural Affairs (Defra) is a member of Bristol Natural History Consortium (BNHC), the charitable partnership that coordinates the National BioBlitz Network for the UK ([www.bioblitzuk.org.uk](http://www.bioblitzuk.org.uk)). Since 2010, Defra has supported a number of research and development activities around BioBlitz, recognising the potential of the format to deliver priorities for the UK Government Biodiversity 2020 Strategy<sup>vi</sup>. Outcome 4 of the strategy states that: *“By 2020, significantly more people will be*

*engaged in biodiversity issues, aware of its value and taking positive action*". BioBlitz offers specific opportunities to support two of the key themes:

Theme 2: Putting people at the heart of policy

Theme 4: Improving our knowledge

### **BOX 2 - Bioblitz in marine and coastal habitats**

In 2009, the Marine Biological Association (MBA) and the Natural History Museum London led the first UK marine and coastal BioBlitz. Combining marine, land and freshwater surveys shows the connection between systems often considered in isolation and brings together people from a range of disciplines. Work in the marine environment presents a number of unique challenges, but with the help of experienced partners and appropriate planning these can be overcome. Activities such as shore surveys, ocean vigils, and strandline walks can be safely undertaken by most people. Marine BioBlitzes provide important biodiversity data, helping to fill the 'major knowledge gap in the marine environment' identified by the European Biodiversity Strategy mid-term review<sup>vii</sup>. Many events occur at Natura 2000 sites and fill distribution points for common, but under-recorded species, non-natives and protected species and features.



Marine and coastal BioBlitz events organised by the MBA with several partners. Credit: Marine Biological Association

### **BOX 3 - Bioblitz and Invasive Alien Species**

The EU Regulation on the prevention and management of invasive alien species (IAS) requires 'Member States to determine the presence and distribution of new as well as already established IAS of Union concern'. By the nature of the BioBlitz format, new distribution records of IAS are often made, making a valuable contribution to science as well as environmental management as required by the Marine Strategy Framework Directive and Water Framework Directive. Globally, there are cases of BioBlitz events that have been

successful in specifically targeting only IAS<sup>viii</sup>. The Marine Biological Association encourages participants to survey IAS by scheduling IAS surveys during events. Data can then be analysed against IAS registers to identify the proportion of IAS vs. non-IAS for a site, to indicate the level of ecosystem alteration. Records can be passed quickly to relevant authorities for action using systems such as the Great Britain Rapid Response Protocol operated in the UK<sup>ix</sup>.



The invasive alien seaweed *Undaria pinatifida* found during a BioBlitz organised by the MBA with several partners. Credit: Marine Biological Association

#### BOX 4 - BioBlitz Barcelona (BioBlitzBcn)

The BioBlitzBcn started as an initiative of the University of Barcelona and the Barcelona City Council in 2010 with the aim of increasing awareness of urban biodiversity. The City Hall of Barcelona has partially funded the first five editions in agreement with the Natural History Museum of Barcelona and the resulting datasets are submitted to the local agency of environmental affairs. The selection of locations for the BioBlitzBcn has focused on big urban parks to create a biodiversity inventory according to the needs of the Barcelona environmental agency. Data collected from 2010 to 2014 have been compiled and published in the Global Biodiversity Information Facility (GBIF), which is a free and open access database for biodiversity data<sup>x</sup>.



BioBlitzBcn - Spain

Credits Dacha Atienza  
Aizoverte

#### BOX 5 - Island BioBlitz: celebrating Ireland's island biodiversity

The National Biodiversity Data Centre organised a week-long Island BioBlitz in 2016 to engage the local community in the celebration of Ireland's natural heritage and to generate inventories of the biodiversity of each island. Teams of experts, citizen scientists and locals documented the biodiversity of the 5 offshore islands <https://bioblitz.ie>. A unique feature of the event was that teams competed against each other to see which island could document

the most species (see Table below). To support the event, the Data Centre developed a state of the art online and mobile phone app to enable the data to be captured in real time and results streamed live. All data collected as part of Island BioBlitz have been validated and are freely available for download <http://maps.biodiversityireland.ie> and through GBIF <http://www.gbif.org>. The island communities have taken ownership of the results to promote the unique natural heritage of their areas.



### Island BioBlitz 2016 - Final Results

	Total Species	Most Marine Species	Most Conservation Species	Species Richness	Most Productive Team
1st	Bere Island - 1,178	Inis Mór - 190	Inis Mór - 73	Tory Island - 209	Bere Island - 34.8
2nd	Inis Mór - 1,096	Clare Island - 181	Tory Island - 64	Cape Clear - 130	Clare Island - 33.6
3rd	Cape Clear - 870	Tory Island - 170	Cape Clear - 62	Bere Island - 67	Tory Island 30.9
4th	Clare Island - 836	Bere Island - 152	Bere Island - 54	Clare Island - 52	Inis Mór - 29.7
5th	Tory Island - 710	Cape Clear - 88	Clare Island - 42	Inis Mór - 35	Cape Clear 26.5

The table presents the results from the competition between the 5 islands based on the 5 categories of recording effort (i.e. 'Total species' indicates the island where the higher number of species have been recorded). Credits: Liam Lysaght.

### BOX 6 - BioBlitz in Natura 2000 sites in Italy

The Maremma Natural History Museum (Tuscany, Italy) has organised 24-hour BioBlitzes since 2013 to raise awareness of biodiversity and generate species inventories for the selected areas<sup>xi</sup>. The events are held in Natura 2000 sites to allow the promotion of the network of protected areas at the local scale while contributing to updates of knowledge useful for Bird and Habitats Directives' reporting. More than 1000 citizens actively took part in the events between 2013 and 2016 and about 30 sessions of data collection were carried out in each BioBlitz. The first two Bioblitzes were organised in the 'Oasi di San Felice' (a large Mediterranean pinewood, with sandy dunes and riparian vegetation) in agreement with Allianz Insurance, owner of the reserve, who funded the event and provided visibility at the national and international levels.



Accesa Lake BioBlitz 2016 - Maremma Natural History Museum.

### BOX 7 - Rare Species Discovered at Bristol BioBlitz (extract from a press release<sup>xii</sup>)

The rare bark beetle *Xyleborus monographus* was spotted at the 2015 Bristol Bioblitz and confirmed by experts to be previously recorded only four times in England and never before in the South West. Scientists reported that likely the beetle had only been in England since 2003, when it was first recorded, having travelled from Europe. The discovery showed a

potential new location indicating the need for further research at the site. As reported by a scientist involved at the event: “*BioBlitz shines a spotlight on sites of interest, enabling an intense, quick study which tells us whether more work should be done to establish their importance. It shows people that even on your own doorstep you can find an incredible amount of wildlife and how wildlife populations are changing very rapidly in response to threats like climate change*”.



Rare species *Xyleborus monographus* found during a BioBlitz in Bristol (UK). Credits: Mark Telfer.

### **BOX 8 - Alexandra Palace Park BioBlitz, London**

The Natural History Museum in London has led a series of 24-hour Bioblitzes across southern England. The Alexandra Palace Park Bioblitz was held in 2010 in partnership with the British Broadcasting Company, local council and site managers. It attracted over 8000 members of the public and recorded over 700 species including a regionally important area of acid grassland, the fourth UK record of a rare variety of a *Bolbitius* fungus, and the rarely recorded red data book beetle *Amphotis marginata* - only the second reported occurrence in the UK since 1969. There was also a discovery of male and female stag beetles, *Lucanus cervus*, the first time this Biodiversity Action Plan species had been recorded in the park. The event contributed to both site management and conservation<sup>xiii</sup>. The local Council and Friends of Alexandra Palace Park used the data to begin the process of applying for the park to be designated as a local nature reserve (granted in 2013).

### **BOX 9 - Local Data, National Impact**

In the UK, there are two principal routes by which biological records are collated and verified: via Local Environmental Records Centres (LERCs), and the National Recording Schemes and Societies (NSS). Depending on the event, data collected during a BioBlitz are submitted through these channels directly or via online tools. Many NSS and LERCs also exchange data with each other on a regular basis. Most data from both LERCs and NSS are made available in the National Biodiversity Network (NBN), via the NBN Atlas, which is used by government agencies, members of the public, researchers and many others. BioBlitz events contribute to local and national bodies of knowledge by: contributing records to these platforms, showcasing the value of biological recording, providing opportunities for training and introducing new biological recorders to these schemes.

## 8.2 Appendix 2 – Biodesign Policy Brief

### ***‘Do It Yourself Biotechnology’ (DIYBio) for open, inclusive, responsible Biotechnology***

This policy brief assesses the potential and challenges of “Do-It-Yourself Biotechnology” (DIYBio) for the progression of open science and responsible research and innovation (RRI). It makes recommendations to the European Commission as to how it can integrate DIYBio into existing science funding mechanisms and regulatory directives, thereby maximising benefits for European stakeholders.

DIYBio activities are conducted in various private and public laboratories outside of traditional academic or corporate institutions and are therefore outside the scope of current policy. The full spectrum of DIYBio activities is also much broader than what is currently understood as Citizen Science.

The re-evaluation of funding mechanisms and regulations for DIYBio should:

- promote inclusiveness and openness in science,
- clarify ethical dilemmas,
- promote social and business innovation,
- transform education,
- enable public dialogue on responsible research in the field of biotechnology demonstrated by grassroots groups from civil society.

### **Understanding the Potential of DIYBio**

Although the informal network of biotechnology enthusiasts labelled as DIYBio is frequently described as a collective movement with shared values and goals<sup>xiv</sup>, there are significant differences between participating individuals and organizations. Often DIYBio is understood as citizens involved in biotechnology<sup>xv</sup>, whereas DIYBio activities span open science activism<sup>xvi xvii</sup>, art-science<sup>xviii</sup>, pre-competitive business incubation<sup>xix</sup>, (speculative) design<sup>xx</sup>, hobbyism<sup>xxi</sup>, science communication and more<sup>xxii</sup>. In an attempt to capture this diversity, roundtables were held (Göbel et al., forthcoming<sup>xxiii</sup>, European Citizen Science Forum<sup>xxiv</sup>) and a video series on DIYBio was published<sup>xxv</sup> in anticipation of this policy brief. These activities highlighted four dimensions of DIYBio that will be addressed here because of their potential value and relevance to policy making.

### **1) Potential for Inclusivity and Openness in Science**

Practitioners of DIYBio, also known as biohackers or DIYBiologists, aim to ultimately make biotechnology accessible to anyone. This rapidly growing culture of inclusivity, which emerged in the United States in the early 2000s, challenges more conventional academic and industry structures, by promoting complete access to scientific resources such as instruments, laboratories and publications.

The aim for a more inclusive and transparent science is also a key component of the Responsible Research and Innovation (Stilgoe et al. 2013) and Open Science<sup>xxvi</sup> policy agendas promoted by the European Commission. As a community built around these values from its inception, the DIYBio movement can be a valuable model for academia as it undergoes a transition to a more open practice. Case Study 1 (below) describes how the DIYBio space “Open Wetlab” of Waag Society operationalised openness and inclusiveness.

The full use of the potential of DIYBio spaces is currently limited due to insufficient financial resources. The informal nature of the DIYBio movement, which is vital to its innovative capacity and agility, are unfit for many funding mechanisms. The lack of funding often results in DIYBiologists working during their free time and with their own resources<sup>xxvii</sup>. In an attempt to resolve this issue many DIYBio community labs already have relationships with local research universities and academics, for example allowing them to recycle equipment that is retired from institutions<sup>xxviii</sup>.

Recent discussions of DIY science by established international academies have suggested a central role in assessment and support of DIY research for the Global Young Academy<sup>xxix</sup>. Such connections could bring support for DIYBio through funding opportunities, access to facilities, equipment and training. However they are critically discussed within DIYBio communities for their tendency to institutionalisation and neglecting the grassroots character of the movement.

## 2) Potential for Ethics

The DIYBio movement has developed an alternative practice-based ethics, which complements the ethics procedures within traditional academia. This approach could enrich the discussions of the Ethics dimensions of the RRI and Open Science agendas as they develop. The ethical discussion about the regulation of the revolutionary gene-editing CRISPR-Cas9 technology is a case in point. Todd Kuiken, senior program associate and principal investigator of the Wilson Center’s Synthetic Biology Project in Washington DC, explains this in *Nature*. He describes how the academic community could “learn from DIY biologists”, who have adopted a responsible and proactive attitude towards the regulation of this technology, instead of the “post hoc scrambling that often occurs within the scientific



establishment". The DIY biologist approach seems well suited at producing a robust public dialogue, resulting in safe and responsible research<sup>xxx</sup>, for three reasons:

1. DIYBio practitioners explore ethical issues in a broader perspective, signal ethical issues earlier, and signal different issues. It is notable that the DIYBio community has been progressive in developing a Codes of Ethics to guide the activity of the movement<sup>xxxi</sup> and promote experimentation based on shared principles of transparency, safety, open and access<sup>xxxii</sup>.
2. DIYBio projects have the ability to organise moral deliberation, indirectly and directly, and not just as a means to restore trust in science or communicate science. We connect here to Wynne (2006)<sup>xxxiii</sup> who makes the case against various deficit understandings of the public. Discussing ethics, parallel to other DIYBio efforts, is empowering in the sense that it enhances the collective and individual capacity to morally assess biotechnological developments and issues. For example the recent CRISPR Kitchen event<sup>xxxiv</sup> and the series described in Case Study 3 below.
3. DIYBio includes art-science practices, which are noteworthy for their examination of the ethical challenges of contemporary biotechnology research. The works of bioartists can signal potential complexities of new technology and challenge existing notions of living systems, by laying bare the politics of biology, and shedding light on dominant anthropocentric accounts in current research. They also increasingly bring these wider issues to a different audience, moving beyond the research context to confront biotechnology<sup>xxxv</sup>. Some initiatives explicitly aim to open up moral reflection and examine societal values, and should be valued for their ability to seek 'tangible encounters' with the many issues concerning developments in the field (Zwijnenberg, 2014). Projects such as Oestrofem (Marry 'Maggic' Tsang) involving reproductive hormones, DeepWoodsPCR (Paul Vanouse) exposing the historical context of discovery, and Mutate-or-die (Adam Zaretsky) or CTCAG (Špela Petrič) questioning genetics are just some of the artistic works that involve DIYBio methods and help further societal understanding of biotechnological futures. Case study 2 describes how a DIYBio space is supporting such work.

### 3) Potential for Innovation

The transdisciplinary nature of DIYBio often results in new methods of applied problem-solving that reflect co-production of knowledge and technologies<sup>xxxvi</sup>. Projects such as Epidemium<sup>xxxvii</sup>, where members of the DIYBio space 'La Paillasse' worked with Hoffmann-la-Roche on cancer research, demonstrate that grassroots organizations can productively interface with corporations. Other examples of innovation already resulting in market-value originating from DIYBio activities are the emergence of companies offering hardware for DIY experiments<sup>xxxviii</sup> and DIY educational kits<sup>xxxix</sup>. Case study 4 on "Open Insulin" describes

another grassroots initiative with an even higher level of ambition aimed at developing affordable drugs for diabetes.

The EU Responsible Research and Innovation approach encourages actors in the research and innovation ecosystem to adopt large-scale institutional change to result in a more responsible, ethical and socially beneficial practice by engaging societal actors throughout their research process<sup>xi</sup>. This new emphasis may open up a platform for contribution by DIYBio practitioners through collaborations. In particular DIYBio projects could complement academic research projects that focus on excellence, with a more frugal and direct approach towards a contribution to societal needs<sup>xli xlii</sup>, such as defined in the UN Sustainable Development Goals<sup>xliii</sup>.

As the DIYBio community started as a counter culture to academic science, it might hold the key to accelerate culture change in such institutions, by leading the way through open access, open source and inclusiveness towards innovation.

#### **4) Potential for Education: project and practice based learning**

Numerous DIYBio initiatives focus on education<sup>xliv xlv xlvi xlvii xlviii</sup> and some community labs are established with the explicit goal of public engagement<sup>xlix</sup>. The open sharing of methods and skills through online platforms ensures course materials are widely disseminated and accessible to the education sector as well as self-motivated learners. Some DIYBio organisations even offer dedicated programmes to train teachers and educators in DIYBio methodology and equipment building. While some initiatives take place in the confinement of a classroom and school system, many take an open-ended, self-organized approach. Typically, DIYBio education programmes are project based and offer explicit room for improvisation and experimentation outside of the pre-set instructions and predetermined endpoints. Case Study 5 describes that it is not just the outcomes, but also the process of Do-It-Yourself Bio that is of interest to the educational community.

#### **Considerations when adjusting funding Mechanisms and Regulation**

This policy brief describes that DIYBio, often perceived as merely life science done by citizens, is much more than low-cost gathering and processing of data and also goes beyond mere education and public engagement. As shown above, DIYBio offers many examples and interesting proposals for implementing the principles of RRI and Open Science. Also, although a very young field, practices are not at a purely conceptual and experimental stage anymore, but vibrant groups, projects or start-up companies have been established. The

movement now needs additional support from the European Commission to grow deeper and wider through the availability of more funding and adjustment of particular regulations. In particular, the Science with and for Society (SwafS) program seems a suitable source.

The current system is inadequate because in funding mechanisms based on cooperation between grassroots communities and research institutions, structural tension arise from different needs and working conditions of paid and unpaid contributors to science and their different form of organization. For example, EU funding schemes usually do not permit a cooperative framing of research questions before a given citizen science project starts. Furthermore, funding structures such as H2020 and Creative Europe are unfit for small community projects. In addition, indicators for quality of research as well as eligibility criteria that focus on excellence favour established institutions over a collective of individual DIYBiologists. CSA projects such as KIICS, SPARKS and SYNENERGENE have presented methodologies to partly resolve this. A more dedicated funding call for the strengthening of informal DIY networks would be a logical next step.

While not able to outweigh such structural barriers to DIYBio in particular, and bottom-up citizen science in general, intermediary organisations and community labs, such as Waag Society, La Paillasse, BiologiGaragen or Hackuarium, fulfil an important support function for DIY communities. Beyond access to equipment and biological material, they act as catalysts for joint projects, offer space for meetings and deliberation, provide training, in some cases funding support and personnel resources, and can work as brokers to mediate between stakeholders and DIY community members. Creating a special funding mechanism focussed on such intermediary organisations could provide a partial solution.

A different recurring subject in interviews with DIYBio practitioners is their experience with restrictive legislation on biotechnology, especially in regards to genetic engineering. As signalled in EU evaluations, there are significant differences<sup>i li</sup> in the national implementation of Directive 2009/41/EC<sup>lii</sup> regulating the contained use of genetically modified micro-organisms. However, these evaluations are mostly performed top-down, not taking the notion of grassroots biotechnologists into account. For example in Germany, permits are only awarded to academically qualified individuals<sup>liii</sup>, while in The Netherlands permits are awarded to legal entities. Some DIYBio practitioners have indicated that the scope of their projects is limited due to these regulations and have called for the resolution of the heterogeneous distribution of regulations across Europe.

## Recommendations

Based on the points discussed above, the following recommendations are made:

1. Recognition of complementary roles for DIYBio and traditional academia in the scientific endeavour through dedicated indicators. Funding schemes adapted to enable access by community stakeholders or even dedicated support.
2. Increase the level of understanding of DIYBio by providing networking opportunities among key players, including different Citizen Science and DIY Science communities as well as stakeholders.
3. Inclusion of DIYBio methods in Responsible Research and Innovation approaches to bring the public in close encounter with biotechnology.
4. Include DIYBio practitioners and non-institutional actors in the evaluation of biotechnology regulations across Europe and permit application processes for DIYBio.

## Colophon

This policy brief was facilitated by the lead authors (Waag Society) through open interaction and discussion with the European DIYbio community, which is partly documented as a vlogging series known as #OPENBIOTECH on YouTube. While this was carried out as part of H2020 'Doing It Together Science' (DITOs) Coordination and Support Action project, the views expressed in this policy brief do not reflect the consensus opinion of DITOs partners.

## Case Study 1: Open Projects at Waag Society's Open Wetlab

Example of Potential of DIYBio for Openness



One of the best ways to become more acquainted with the DIYBio movement is to visit a community biolab. The Open Wetlab in Amsterdam is such a space. It welcomes anyone to work on biotechnology related projects under two conditions: the work has to be safe, and it has to be openly shared. The space has an infrastructure that supports work that spans a broad spectrum of biological sciences, such as genetic engineering, microbiological (tissue) culturing and brain computer interfacing.

Weekly public evenings were held for the community to meet and present ongoing work. These evening sessions were highly social oriented in support of informal knowledge exchange and were the primary opportunity for new members to join existing projects or start a new concept. Basic lab consumables and chemicals are available free of charge, but special materials have to be paid for by the users themselves. The users also work in the lab unpaid, in their own free time. Therefore the main aim of most participants is to experience the creative and free tinkering spirit while working with people from completely different backgrounds, rather than completing the actual project. The projects are typically focused on personal interests (health, food or expanding one's understanding of biology), societal challenges (antibiotics resistance, affordability of medicine, malnutrition) or business (creating prototypes).

Living proof of this is Xandra van der Eijk<sup>liv</sup>, who never even had touched a microscope before entering the Open Wetlab and now calls herself a "biology pro". She has developed an impressive project in a short period, called Genesis, in which she studied microorganisms and their pigment changes. It even became part of the exhibition Fluid Matter.

## Case Study 2: Art+Science at Kersnikova Institution, Ljubljana

Example of Potential of DIYBio for Openness

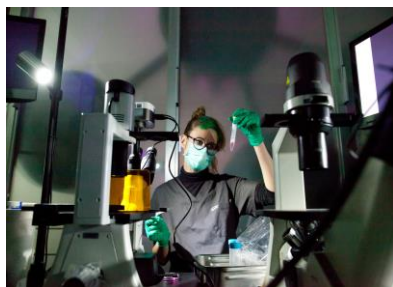


At Kersnikova, DIYBio is practiced at the BioTehna Lab - a physical laboratory with extra class instrumentation. The lab was incepted with the help of Hackteria in 2012 and has been upgraded many times until its present shape. The lab offers space, equipment, materials, and experts as a supportive environment to artists and art projects produced by Kapelica Gallery - another department at KI that focuses on production of hybrid (bio)art projects. In so-called 'incubation' processes, artists are put in contact with (DIYBio) scientists and experts that help implement the art project by offering assistance with complex scientific protocols outside institutional frameworks - mostly because access to physical spaces and high-end equipment inside mainstream scientific & research institutions are off-limits to 'general public' - in this case, artists. The nature of contemporary hybrid (bio)art projects is the implementation of biotechnological processes and protocols in the artwork itself, which can lead to specific demands regarding the equipment and knowledge needed, but it may also provoke reflections of values and ethical restrictions.

The most notable examples would be hybrid art projects by artists Špela Petrič (a former biology phd scientist turned (bio)artist) and Maja Smrekar (a fine-art artist turned (bio)artist) who utilized the knowledge and expertise of DIYBio individuals, the equipment and materials provided by BioTehna in the development stages of their project.

Špela Petrič developed the Strange Encounters phase of her "Confronting Vegetal

Otherness”. The DIYBio part of the project was focussed on facilitating in-vitro confrontations of human bladder carcinoma cells and *Chlorella* algae cells and custom-designing smaller and larger incubators where the cells will grow.

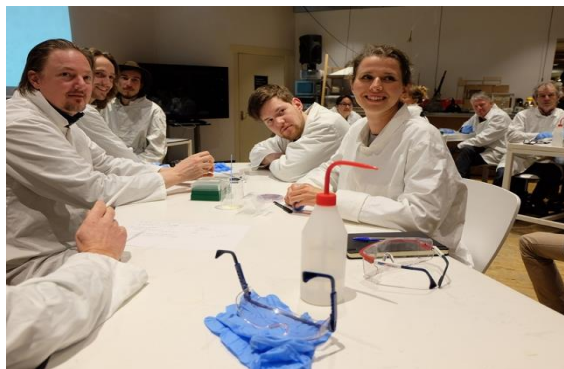


BioTehna also facilitated various phases of Maja Smrekar’s “K-9\_topology” project. One of the phases (Ecce Cannis) was to investigate the coevolution of humans and wolves, and investigating metabolic pathway processes that trigger emotional motif which connects two species: humans and dogs to successfully coexist together. The other phase (ARTE\_mis) was focusing more on biotechnological potential of fusing the artist’s molecular material with the domesticated dog.

### Case Study 3: Het Praktikum

#### Example of the Potential of DIYBio for Ethics

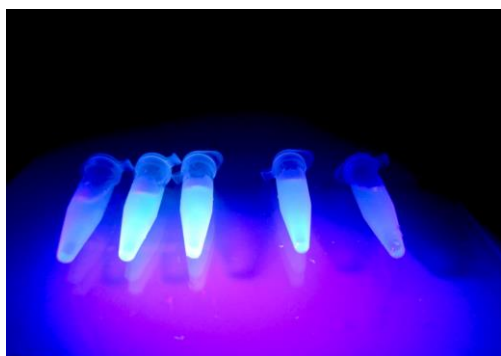
In order to facilitate a meaningful discussion about scientific and technological discoveries, Waag Society organised ‘Het Praktikum’ - a series of themed evening discussions and practicals during which the participants unravel the complex threads of cutting-edge technology and decide where they stand on the issues. The first two evenings in the series focussed on CRISPR DNA editing technology. During the first evening participants played a statement game in which the questions and answers revolved around the positive or negative effects of CRISPR technology on society. One question was, for example, “once it becomes possible to get an early diagnosis for certain genetic diseases, how will this affect how we define sickness and health?” The six possible responses to this question were defended by the participants at each table. When the evening came to an end they formulated what they would want CRISPR to achieve under ideal circumstances. During the second evening, the participants revisited to their ideals, but this time a practical demonstration took centre stage. They unboxed the CRISPR kit<sup>IV</sup> and got to work. Surprisingly, no-one decided to finish the experiment and subsequent discussion examined how and why this consensus was reached.



### Case Study 4: Open Insulin

Example of Potential of DIYBio for Innovation

The global insulin market is dominated by just a few companies, a quasi-monopoly resulting in high prices for patients. In order to make insulin more affordable, and thus accessible, biohackers are attempting to develop a generic drug. Ryan Bethencourt, a biohacker, entrepreneur, and co-founder of IndieBio, a biotech accelerator program in San Francisco, explained the broader goal of the Open Insulin project: “demonstrate that we can achieve usable levels of purity in a DIY setting, and to document how we do and share the knowledge”. Together with a computer hacker, Anthony Di Franco, they pushed the project until, in 2015, Counter Culture Labs, a “Community Lab for biohacking and citizen science” in Oakland, California, successfully launched a crowdfunding campaign (for \$16,000) and began exploring new ways to produce insulin by genetically engineering bacteria. The project received a wide media coverage, focusing on the innovative potential of DIYBio, but also drawing attention to the broader problem of drug access for disadvantaged communities and to DIYBio as a potential solution to the crisis of drug innovation. Critics, on the other hand, have pointed out that the real difficulty lies not in the production of small quantities of insulin, but in the cost of the clinical trials and of getting approval by regulatory agencies. Whether or not the Open Insulin project will ultimately succeed in offering ways for patients to produce insulin, as simple as “brewing beer at home”, it will have stimulated a critical discussion among laypeople and experts alike about the current challenges of drug innovation.

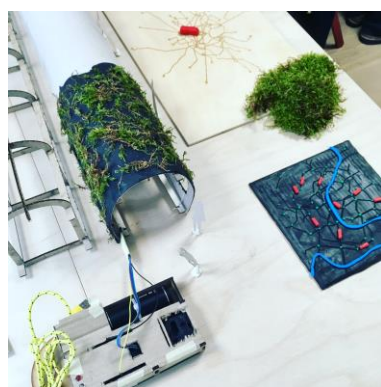


Eppendorfs containing recombinant bacteria expressing green fluorescent protein and proinsulin at Counter Culture Labs, Oakland, California, March 2017. Credit: Gabriela Sanchez.

### Case Study 5: UPD’s Co-lab Workshops

Example of Potential of DIYBio for Education

DIYBio educational projects foster the creation of truly interdisciplinary projects around life sciences. For example, the three-day Co-Lab BioArch workshop delivered by the Centre for Interdisciplinary Research at University Paris Descartes in April 2017 gave rise to a group project centred on treating air pollution in the Paris Métro. The interdisciplinary group gathered two architects, a photographer, a designer, a project manager, a Masters student in education and technology, a biologist and an artist. The key to finding solutions was a collective research process. Public data confirmed their initial hypothesis of an important air pollution within the underground system. Through a process of iteration central to the DIYBio approach, they determined three possible solutions to use the train as a mobile anti-pollution tool. Depolluting the air evolved over successive phases, but led to creating a “second skin” around the train wagons to absorb the particles, considering the trains as a mobile cleaning system. After attempting to gather data with a DIY particle capture tool, the team used laser-cut models and drawings, as well as hand-written posters, to illustrate their project.



<sup>i</sup> Science Communication Unit, University of the West of England, Bristol (2013). *Science for Environment Policy In-depth Report: Environmental Citizen Science*. Report produced for the European Commission DG Environment, December 2013.

<sup>ii</sup> Chandler et al., 2017. Involving Citizen Scientists in Biodiversity Observation. In *The GEO Handbook on Biodiversity Observation Networks* (pp. 211-237). Springer International Publishing.

<sup>iii</sup> Robinson et al., (2013) Guide to running a BioBlitz. Natural History Museum, Bristol Natural History Consortium, Stockholm Environment Institute York and Marine Biological Association.

<sup>iv</sup> Hepburn et al., (2015) The Australian Guide to Running a BioBlitz.

<sup>v</sup> EU Commission, 2011. Our life insurance, our natural capital: an EU biodiversity strategy to 2020. *COM (2011), 244*.

<sup>vi</sup> Defra. (2011). *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*. London: Department for the Environment, Food and Rural Affairs.

<sup>vii</sup> <http://biodiversity.europa.eu/mtr/biodiversity-strategy-plan/eu-mid-term-review-for-horizontal-measures>

<sup>viii</sup> [https://scholarworks.alaska.edu/bitstream/handle/11122/3919/2012\\_07-InvasiveSpecies.pdf?sequence=1](https://scholarworks.alaska.edu/bitstream/handle/11122/3919/2012_07-InvasiveSpecies.pdf?sequence=1)

<sup>ix</sup> <http://www.nonnativespecies.org/alerts/>

<sup>x</sup> Atienza, D. et al., (2015) Volunteers prospecting the biodiversity of Barcelona: a summary of the first five editions of BioBlitz BCN (2010-2014)

<sup>xi</sup> Sforzi et al., 2013 Report:

<https://docs.google.com/uc?export=download&id=0B7V6NZEjbcnYS1zOGJJMUFqYTQ>

<sup>xii</sup> Link to full press release: <http://www.bnhc.org.uk/rare-beetle-discovered-bristol-bioblitz/>

<sup>xiii</sup> Alexandra Palace Park Board (2012). Alexandra Park Management Plan 2008-2018.

<http://www.alexandrapalace.com/content/uploads/2012/05/Alexandra-Palace-Park-Management-Plan-Summary-2012.pdf>



- <sup>xiv</sup> <https://diybio.org/codes/>
- <sup>xv</sup> “Empowering Citizen Scientists.” *Nature Methods* 12, no. 9 (September 2015): 795–795. doi:10.1038/nmeth.3577.
- <sup>xvi</sup> Seyfried, Günter, Lei Pei, and Markus Schmidt. “European Do-It-Yourself (DIY) Biology: Beyond the Hope, Hype and Horror.” *BioEssays* 36, no. 6 (June 1, 2014): 548–51. doi:10.1002/bies.201300149.
- <sup>xvii</sup> Landrain, Thomas, Morgan Meyer, Ariel Martin Perez, and Remi Sussan. “Do-It-Yourself Biology: Challenges and Promises for an Open Science and Technology Movement.” *Systems and Synthetic Biology* 7, no. 3 (September 1, 2013): 115–26. doi:10.1007/s11693-013-9116-4.
- <sup>xviii</sup> <http://hackteria.org>
- <sup>xix</sup> Lorenzo, Víctor de, and Markus Schmidt. “The Do-It-Yourself Movement as a Source of Innovation in Biotechnology – and Much More.” *Microbial Biotechnology* 10, no. 3 (May 1, 2017): 517–19. doi:10.1111/1751-7915.12715.
- <sup>xx</sup> [http://2015.igem.org/Tracks/Community\\_Labs](http://2015.igem.org/Tracks/Community_Labs)
- <sup>xxi</sup> Meyer, Morgan. “Domesticating and Democratizing Science: A Geography of Do-It-Yourself Biology.” *Journal of Material Culture* 18, no. 2 (June 1, 2013): 117–34. doi:10.1177/1359183513483912.
- <sup>xxii</sup> <http://www.economist.com/news/technology-quarterly/21615064-following-example-maker-communities-worldwide-hobbyists-keen-biology-have>
- <sup>xxiii</sup> Göbel, C., Agnello, G., Vohland, K. (Eds.) (forthcoming): European Stakeholder Round Table on Citizen and DIY Science and Responsible Research and Innovation. Doing-it-Together Science Report.
- <sup>xxiv</sup> <https://cri-paris.org/the-european-citizen-science-forum/>
- <sup>xxv</sup> <https://www.youtube.com/watch?v=dYJvDfUjrc&list=PLB6IBD9OG9pC1i7VkZIWZg9hE3puKX7Ep>
- <sup>xxvi</sup> <https://ec.europa.eu/digital-single-market/en/citizen-science>
- <sup>xxvii</sup> deLorenzo V. and Schmidt M. 2017. The do-it-yourself movement as a source of innovation in biotechnology – and much more. *Microbial Biotechnology* DOI: 10.1111/1751-7915.12715
- <sup>xxviii</sup> [http://wiki.hackuarium.ch/w/Main\\_Page#Hackuarium](http://wiki.hackuarium.ch/w/Main_Page#Hackuarium)
- <sup>xxix</sup> EASAC report ‘Genome editing: scientific opportunities, public interests and policy options in the European Union’.  
([http://www.easac.eu/fileadmin/PDF\\_s/reports\\_statements/Genome\\_Editing/EASAC\\_Report\\_31\\_on\\_Genome\\_Editing.pdf](http://www.easac.eu/fileadmin/PDF_s/reports_statements/Genome_Editing/EASAC_Report_31_on_Genome_Editing.pdf))
- <sup>xxx</sup> Kuiken, Todd. “Governance: Learn from DIY Biologists.” *Nature News* 531, no. 7593 (March 10, 2016): 167. doi:10.1038/531167a.
- <sup>xxxi</sup> <https://diybio.org/codes/>
- <sup>xxxii</sup> <https://bioartsociety.fi/projects/making-life/pages/bio-commons-workshop>
- <sup>xxxiii</sup> Wynne, B. (2006). Public engagement as a means of restoring public trust in science—hitting the notes, but missing the music?. *Public Health Genomics*, 9(3), 211-220.
- <sup>xxxiv</sup> <http://www.crispr.kitchen>
- <sup>xxxv</sup> Zylinska, Joanna. *Minimal Ethics for the Anthropocene*: Open Humanities Press, 2014. <http://www.openhumanitiespress.org/books/titles/minimal-ethics-for-the-anthropocene/>.
- <sup>xxxvi</sup> Nowotny, H., Scott, P., & Gibbons, M. (2003). Introduction: Mode 2 revisited: The new production of knowledge. *Minerva*, 41(3), 179-194; Jasanoff, S. (2010). A new climate for society. *Theory, Culture & Society*, 27(2-3), 233-253.
- <sup>xxxvii</sup> <http://www.epidemium.cc>
- <sup>xxxviii</sup> <http://www.openpcr.org>
- <sup>xxxix</sup> <https://www.bento.bio>
- <sup>xl</sup> <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>
- <sup>xli</sup> <http://trendinafrica.org>
- <sup>xlii</sup> <http://openhardware.science/about/why-gosh/>
- <sup>xliiii</sup> <https://sustainabledevelopment.un.org/?menu=1300>
- <sup>xliiv</sup> <http://www.ekoli.be>
- <sup>xli v</sup> <http://biohackacademy.github.io>
- <sup>xli vi</sup> <http://biologigaragen.org/portfolio/group-experiment-nights/>
- <sup>xli vii</sup> <http://www.diybcn.org/actividades-activities/talleres-workshops/>
- <sup>xli viii</sup> <http://magmanova.com/education/>
- <sup>xli x</sup> Scheifele, L. Z., & Burkett, T. (2016). The First Three Years of a Community Lab: Lessons Learned and Ways Forward. *Journal of Microbiology & Biology Education*, 17(1), 81-85. doi:10.1128/jmbe.v17i1.1013
- <sup>i</sup> <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2016:808:FIN>
- <sup>ii</sup> Survey on the implementation of Directive 2009/41/EC - COGEM
- <sup>iii</sup> [http://ec.europa.eu/health/sites/health/files/files/eudralex/vol-1/dir\\_2009\\_41/dir\\_2009\\_41\\_en.pdf](http://ec.europa.eu/health/sites/health/files/files/eudralex/vol-1/dir_2009_41/dir_2009_41_en.pdf)
- <sup>iiii</sup> <http://www.gesetze-im-internet.de/gentg/index.html>
- <sup>liv</sup> <http://xandravandereijk.nl>
- <sup>lv</sup> <http://www.the-odin.com/diy-crispr-kit/>