

1 **Title**

2 FISHGLOB: a collaborative infrastructure for marine science and management

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45 **Key Words**

46 marine scientific survey, community-building, global change, biodiversity monitoring, dataset
47 integration, knowledge transfer

48 **Abbreviations**

49 ICES: International Center for the Exploration of the Sea

50 WoRMS: World Register of Marine Species

51 OBIS: Ocean Biodiversity Information System

52 GBIF: Global Biodiversity Information Facility

53 FishMIP: Fisheries and Marine Ecosystem Modelling Intercomparison Project

54 NOAA: National Oceanographic and Atmospheric Administration

55 FAIR: Findable, Accessible, Interoperable, Reusable

56 UN: United Nations

57 UNESCO: United Nations Educational, Scientific and Cultural Organization

58 **Standfirst Abstract**

59 Producers and users contributing to diverse scientific enterprises are often siloed.

60 FISHGLOB is a sociotechnical infrastructure supporting collaboration and data sharing

61 between experts in, and users of, fish bottom trawl surveys, a form of ocean monitoring.

62 **Main Text**

63 *Scientific surveys to monitor ocean biodiversity*

64 The UN Decade of Ocean Science for Sustainable Development seeks to mobilize existing
65 data to understand global change impacts on marine ecosystems and biodiversity [1].

66 Scientific surveys are vital to this effort and to inform resource managers because they use
67 consistent and well-documented sampling methods through time [2]. However, few
68 coordinated initiatives exist to compile and harmonize the data collected by multiple marine
69 scientific surveys around the world. Added to this is the disparity in capacity across regions.
70 FISHGLOB fills these gaps with a consortium of scientists whose goal is to build a social
71 infrastructure by enhancing cross-regional collaborations, and a technical infrastructure by
72 developing analytical tools for integrating datasets.

73 FISHGLOB identifies and integrates monitoring datasets from scientific bottom trawl surveys
74 (SBTS) to support research on regional and global ocean biodiversity. FISHGLOB has
75 already established a unique set of survey metadata, data, and applications via its global
76 network. Through this network, researchers and managers connect to each other to share
77 knowledge and use data for science and resource management. To date, FISHGLOB has led
78 to multiple projects and peer-reviewed publications, counts more than 100 contributors from
79 36 countries, and was recently endorsed by the [UN Decade of Ocean Science SUPREME](#)
80 [Programme](#). FISHGLOB's goal is to support knowledge to action and enhance decision-
81 making in an era of profound change, by facilitating effective use and exchange of scientific
82 information across regions. Here, we present progress, lessons learned, and opportunities to
83 engage with FISHGLOB.

84 *Mobilizing surveys*

85 In 2019 three early career scientists organized a meeting at the ICES Annual Scientific
86 Conference to discuss collaborations around SBTS performed along continental shelves (Fig
87 1), some of the most diverse and productive marine ecosystems. SBTS started in the 1900s to
88 collect demersal marine species (living over and on the sea bottom) and provide data for
89 fisheries management and ecosystem monitoring independently from the fishing industry.

90 This initiative led to the first global inventory of SBTS, revealing 95 ongoing surveys across
91 all continents and covering more than 283,000 sampling events across 2.5 million km² of
92 seafloor since 2000 [3]. Over 40% of the survey data were publicly available. Other surveys
93 were not publicly available, and either required requests for data access, or only metadata

94 were accessible (detailing both survey and event information), or only the survey metadata
95 were accessible (Fig 1F). Focusing initially on an inventory of metadata allowed us to both
96 build a catalog of existing surveys and expand our consortium. Other types of marine
97 scientific monitoring surveys could benefit from developing similar catalogs (Fig 1F). Sharing
98 our experience in consortium-building and inventorying is thus broadly valuable.

99 Survey data accessed via public repositories or collaborations have been integrated into a
100 technical infrastructure by the FISHGLOB biodiversity synthesis working group. We
101 developed procedures for data quality control and standardization that allow for cross-
102 continental integration of SBTS data [4]. The public data products are version-controlled with
103 openly available code to facilitate re-use of surveys (accessible via
104 <https://fishglob.sites.ucsc.edu>). FISHGLOB's technical infrastructure includes several levels
105 of information, from survey metadata to event-based metadata to species occurrence and
106 abundance data, and optimizes transparency under different levels of accessibility (Fig 2).

107 *Linking the data infrastructure*

108 The data integration and infrastructure development led to new questions about data standards
109 for scientific surveys and links to other biodiversity databases. FISHGLOB currently
110 reconciles taxonomic names and can import species' traits from [WoRMS](#), [FishBase](#), and
111 [FishLife](#) (Fig 2). This enables connecting SBTS to other initiatives such as biogeography data
112 repositories (e.g., [OBIS](#), [GBIF](#), [Aquamaps](#)), ecosystem modeling platforms (e.g., [FishMIP](#)),
113 fisheries data platforms (e.g., [RAM legacy database](#), [Sea Around Us](#)), and institutional data
114 servers (e.g., [ICES](#) and [NOAA](#) data portals). However, further development of metadata and
115 data standards is needed to better connect these community initiatives. For example, Darwin
116 Core [5] is a well-used data and metadata format for species occurrences, but cannot fully
117 capture needed information that are central in monitoring scientific surveys. Linking to
118 nascent inventory metadata standards, such as the Humboldt Extension to the Darwin Core
119 [6], may provide an elegant solution.

120 *Values to bring people together*

121 FISHGLOB quickly identified people, relationships, and trust among partners as fundamental
122 for the project. Maintaining long-term participation requires shared values, ethos and concepts
123 for data sharing and tangible benefits for participants. In 2022, FISHGLOB hosted a series of
124 webinars to better understand the needs and goals of participants. This effort identified
125 interests in data and knowledge exchange, but also substantial diversity in goals (e.g.,

126 providing, using, or coordinating technical and social infrastructures) and capacity among
127 consortium members.

128 FISHGLOB brings together perspectives from diverse career stages and all continents and can
129 therefore serve as a foundation for capacity building and knowledge transfer. Growing
130 capacity is essential because sharing data and knowledge can paradoxically perpetuate rather
131 than overcome inequities, as data sharing may mostly benefit users from countries that
132 already have the most capacity [7,8]. These recognitions led us to identify key values in
133 FISHGLOB (Fig 2), aligned with the [UNESCO's recommendations on open science](#),
134 including:

- 135 ● Open data and open science as guiding principles to enable wide societal benefits.
- 136 ● Data sovereignty and a recognition that data originators may place limits on what can
137 be made available and on how data are used, such as through Creative Commons
138 licensing, data use agreements, and prior and informed consent approaches, all of
139 which follow the FAIR principles [9].
- 140 ● Capacity building to grow an international community that addresses historical,
141 linguistic [10], cultural, financial, political, technical, and structural barriers to
142 participation.
- 143 ● Credit and visibility for consortium members, including documented methods for
144 citing data products and inclusive models for authorship.

145 These values can serve as a foundation towards more equitable infrastructures for long-term
146 partnerships.

147 *Opportunities for engagement and ways forward*

148 Infrastructure building relies on a social process of identifying needs and solutions that
149 maximize community coordination and participation. In FISHGLOB, community consultation
150 was and remains essential to developing the infrastructure. For example, a survey distributed
151 to data providers, regional experts, and users identified that standardized sets of visual
152 summaries, including biodiversity change indicators and maps of species distributions, would
153 be a useful, value-added product. A future FISHGLOB initiative may share these deliverables
154 on an online platform to lower the barrier to using SBTS data, much as similar maps from
155 [OceanAdapt](#) enabled dissemination and adaptation by [journalists](#), [students and teachers](#),
156 textbook authors [11], [fisheries management councils](#), [environmental agencies](#), and

157 [conservation non-profits](#). Enhanced relationships with regional and global initiatives will
158 strengthen efforts to co-develop products responding to the needs of the consortium and larger
159 audiences. A longer-term priority is the development of opportunities for collaborations with
160 regions from the Global South and/or regions that do not operate under open infrastructures,
161 which need to be supported by initiatives such as the UN Ocean Decade and similar funding
162 agencies. Moving forward, opportunities to contribute to these different activities will be
163 facilitated (to join FISHGLOB, visit <https://fishglob.sites.ucsc.edu>).

164 **Conclusion**

165 In four years of work, we identified community needs and opportunities that are supported by
166 a social and technical infrastructure. FISHGLOB facilitates innovation thanks to its diverse
167 community and novel SBTS integration in a time when scientific evidence is needed to tackle
168 unprecedented ocean change across jurisdictional borders. FISHGLOB seeks to value the
169 representation of a diversity of perspectives from many regions of the world by connecting
170 communities who generate and use ocean datasets, and by doing so, contributes to the Ocean
171 Decade and UNESCO's Open Science initiative. FISHGLOB creates an opportunity for all
172 those who wish to be involved to collectively provide evidence of the ocean we changed, and
173 act for the ocean we want.

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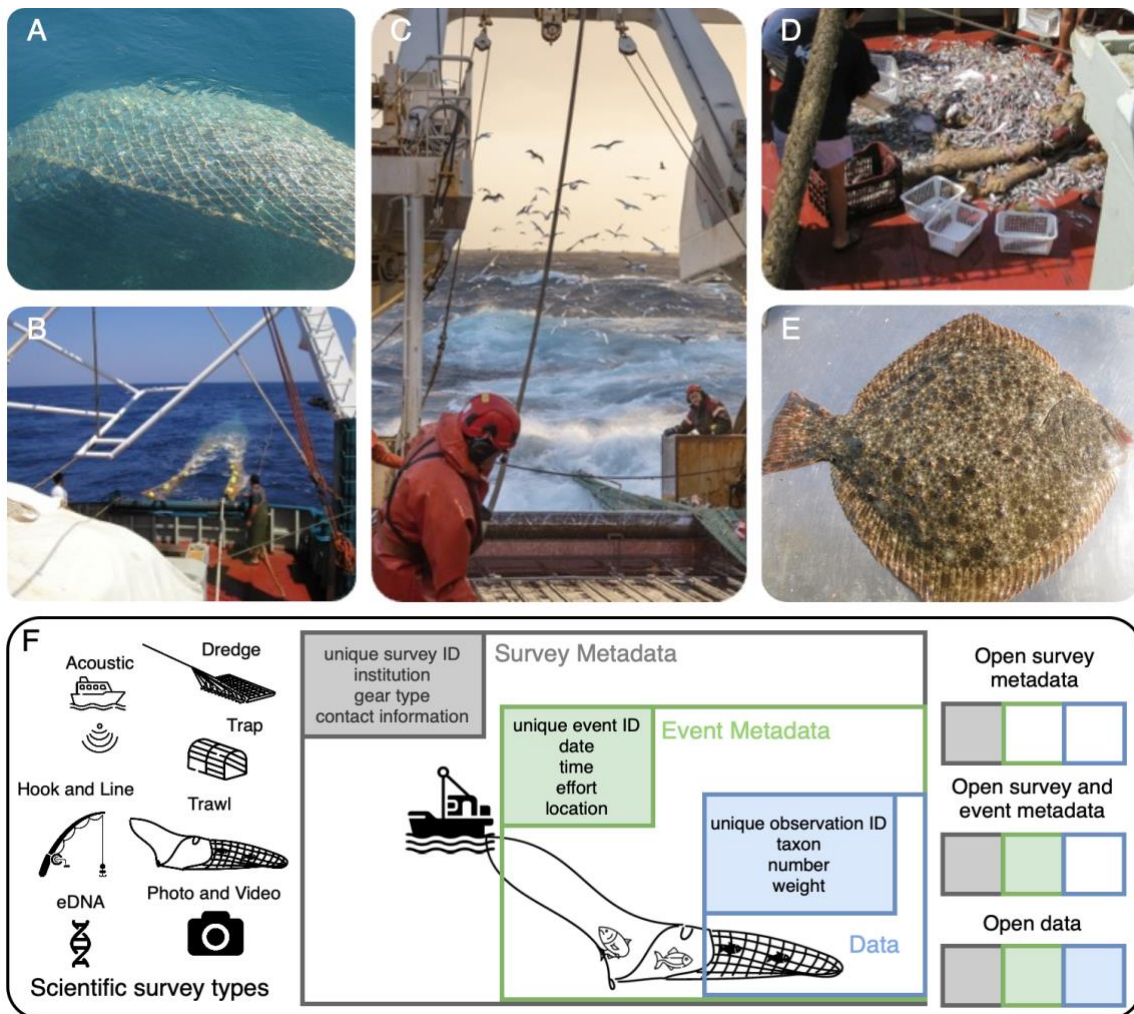
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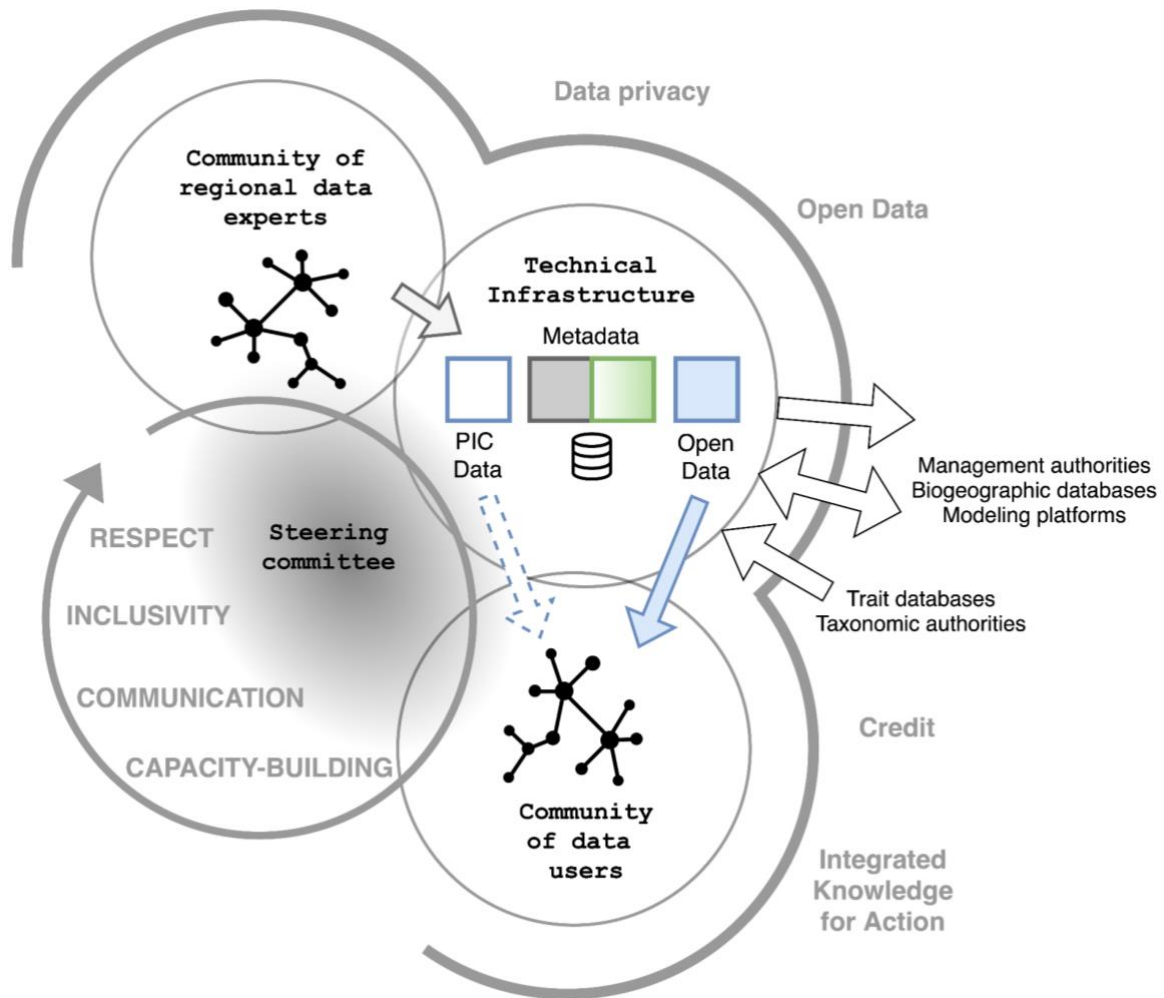
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228

229 **Fig 1. Sampling demersal communities with scientific bottom-trawl surveys (SBTS).**

230 Sampling steps with SBTS: trawling operation (A) and (B), bringing the trawl back onboard
 231 (B) and (C), catches from the haul (D), individual specimen identification and measurements
 232 (E). Scientific survey datasets in the oceans can be performed under a wide range of designs
 233 and sampling methods resulting in diverse survey types ((F) on the left). Within scientific
 234 surveys, SBTS in FISHGLOB ((F) on the right) are structured around the integration of the
 235 survey metadata (gray) with individual sampling event metadata (green) and biological
 236 observations (blue). The FISHGLOB technical infrastructure supports a range of data privacy,
 237 from fully open survey data to surveys with only survey-level metadata that are public.
 238 Survey photo credits: Svanhildur Egilsdóttir from the Marine and Freshwater Research
 239 Institute in Iceland (Icelandic survey in (C)), Elitsa Petrova from the Institute of Fish
 240 Resources in Bulgaria (Western Black Sea survey in (A) and (E)), George Tserpes from the
 241 Hellenic Center for Marine Research in Greece (Mediterranean Survey via the MEDITS
 242 program in (B) and (D)). Icon credits in F: <https://www.flaticon.com>.



243
 244 **Fig 2. The FISHGLOB socio-technical infrastructure.**

245 The FISHGLOB infrastructure is centered around shared values, two primary communities,
 246 and a technical data integration process and datastore, all linked to the steering committee.
 247 One of the specificities of the FISHGLOB infrastructure is its recognition and inclusion of a
 248 range of data privacy of the metadata and survey data [3]. This means FISHGLOB recognizes
 249 and builds its infrastructure following both open science and FAIR principles [9]. FISHGLOB
 250 needs to further develop its connections within the landscape of other data platforms to ensure
 251 interoperability in the way SBTS are accessed and linked. The philosophy behind the
 252 infrastructure supports both credit to experts and contributors, as well as the use of integrated
 253 knowledge for action in an era of global change.