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Towards a Best Practice for Developing Best Practices in Ocean Observation (BP4BP): Supporting Methodological Evolution through Actionable Documentation

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Abstract

Ever-increasing complexity and multi-dimensionality of ocean investigations present a challenge for the ocean community as we collaboratively (co-)develop methods to research, monitor, and use our oceans. To support transparent sharing of methods, and ultimately agree on best practices in ocean research, operations, and application, the IOC Ocean Best Practices System (OBPS) was initially developed as an Ocean Data Standards project deliverable of the International Oceanographic Data Exchange (IODE) who in 2017 joined with the AtlantOS/ODIP/RCN Best Practices Working Group (BPWG) to develop it into a System. In 2019 the IOC Ocean Best Practices System was approved as a UNESCO/Intergovernmental Oceanographic Commission (IOC) Project, jointly funded by the IODE and GOOS Programmes. In this document, we provide guidance on how to best use the OBPS templates, allowing greater discovery, machine readability, sharing, and understandability of methods and best practices. We clarify how to optimally populate the different sections of an OBPS template, and describe how those sections support the evolution of each OBPS submission, towards a global best practice. Further, we discuss some general challenges in developing methods into community-accepted best practices. While this document focuses on the OBPS, it also offers a perspective on the general challenge of structuring and harmonising method documentation. We invite the community to provide feedback on this document (link to Community review), to contribute towards a generalised best practice for advanced methodological management across the ocean community.

1. Introduction

1.1 What is a best practice, and how do we get there?

Across disciplines and domains, all researchers seek the confidence that the methods they use are 1) of highest possible and consistent quality, 2) relevant and applicable to their system of interest, and 3) comply with conventions and standards that make outcomes reusable through some degree of interoperability. If a method has been shown to consistently produce superior results than others, and has been adopted by more than one organization or group of practitioners, it usually starts to be accepted as a Standard Operating Procedure (SOP) and may even evolve into a community-agreed community best practice (BP; Simpson et al. 2018; Pearlman et al. 2019). Typically, this does not happen instantly – methods are usually refined over multiple iterations and through community feedback (**Figure 1**). Naturally, a best practice does not remain so forever, and serves as a catalyst to the "next best practice". Thus, easy accessibility and interoperability along with community engagement, adoption, feedback, and refinement, is required to turn a high-quality methodological document into a de facto BP.

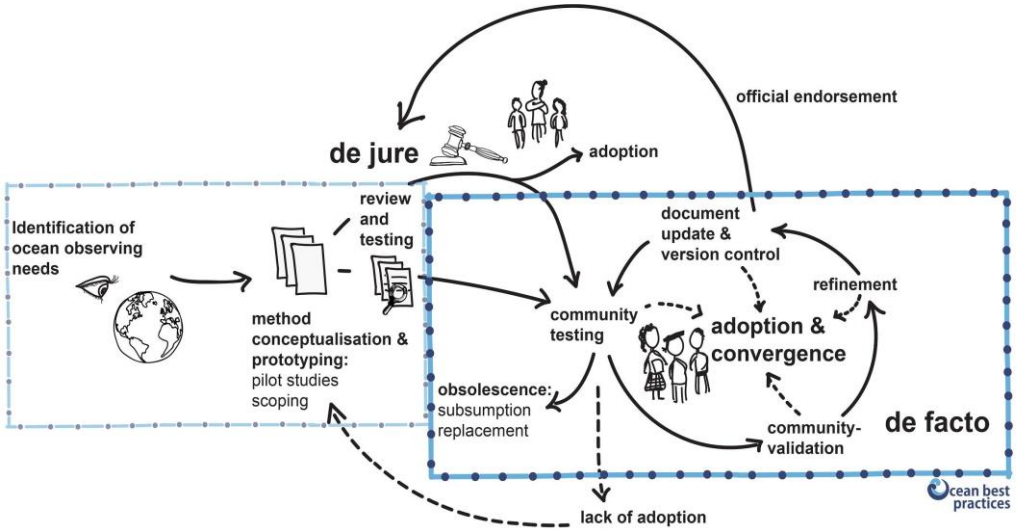

Figure 1. Common (de jure and de facto) developmental paths of a best practice (BP). Methods (shown), standards, guidelines, and other methodological records are developed in response to ocean observing needs, often closely tied to societal goals. The advancement of a method into a BP can occur through 1) endorsement by a legally empowered authority (in some contexts, this role may be filled by standards organizations), thus creating a "de jure" best practice, and/or 2) through successive rounds of method testing, refinement, and validation which – together with broad adoption and review – evolve the method into a "de facto" best practice. Communities can also seek official recognition and endorsement of a specific version of a de facto BP, integrating these two pathways. The adoption of a method can happen at any stage once a method is shared with the community. As methods reach the end of their lifetime, they are either being subsumed into other methods or become obsolete and are replaced. The same is true for both de jure and de facto best practices: they cannot remain the "best" in perpetuity, and so are also subject to cycles of renewal and replacement. The Ocean Best Practices System (OBPS) provides services and capacities to support the community in advancing their methods (heavy blue box). To a lesser extent (light blue box), the OBPS also supports its users in identifying gaps and conceptualising methods through search and discovery of existing approaches used by the ocean community. By facilitating these processes in an integrated system, the OBPS is extending its ability to catalyse convergence of methodological documents submitted by widely distributed communities. For traceability and transparency reasons, both current and obsolete methods are findable in the OBPS repository; obsolete methods are denoted as "SUPERSEDED", and work is being done to provide finer-grained version control (see section 2.4). Some methods might lack adoption within the community and need method revision or better user engagement (see section 1.4).

1.2 Why create best practices?

All types of operations and processes rely on well-documented methods and guidelines. To create trust in such methodological documents, a document review and approval process through method testing is required. With time and adoption, a best practice (BP) usually leads to more standardised, quality-controlled, and harmonized activities across communities and

geographical regions. The advantages are clear and include the generation of consistent data and information products, compatible expertise, and communities of practitioners more able to develop and sustain collaborations. Because of these qualities, some BPs may even be declared as standards by their user communities[1] (see Pearlman et al. 2019 for a detailed description of how BPs and Standards relate to each other). This leads to greater opportunities for long-term observations, large-scale intercomparison as well as stable, sustainable, and ultimately multidisciplinary analyses. The more we stabilise and connect our observations, the more collaborative opportunities we create across the ocean value chain[2], including opportunities for scientific initiatives to collectively approach global questions, cross-validate each other's findings, and increase confidence in the outcome.

Ocean best practices and societal goals

Exploring, using, and living with the ocean has always been deeply connected with societal well-being from local to global scales. How societies secure that well-being can be complex, and many challenges exist in ensuring that the practices used are mutually beneficial. Activities in this space are intensifying as the UN Decade of Ocean Science for Sustainable Development (2021-2030) begins (Ryabinin et al. 2019). The intersection of science, technology, and other disciplines with societal factors is a very complex space. Thus, those submitting documents to the IOC Ocean Best Practices System (OBPS) are strongly encouraged to dedicate some prose explaining how their content relates to societal goals and targets, and how they can be used to accelerate actions across the ocean value chain. A clear statement about which stakeholders (e.g. public, policymakers, industry, local or indigenous communities, conservation, etc.) can directly or indirectly benefit from the method will increase the discoverability of the content as well as interdisciplinary cooperation and support better decision making (see also Socialisation of a best practice, section 3).

Better decision making across multiple ocean sectors requires the engagement of different stakeholders. For example, the OBPS should further engage and support industrial or commercial actors to develop more reliable products while interfacing with emerging community standards. The OBPS can help policy analysts, and makers to focus attention on communities that are converging on more global and endorsed methods.

This is especially relevant in regions that are under-observed. Targeting these regions is essential to pursuing societal goals at a global scale, but is a process that needs to be sensitive to local development objectives, methodological needs, and levels of financial and human resources. Thus, methods – even those developed by well-resourced nations – should ideally be implementable in under-resourced communities without sacrificing the level of quality and trust embodied in the method (further discussed in section 2.3.2). This would aid global capacity exchange while simultaneously increasing global reach and the impact of high-quality methods.

Ocean observations and applications rarely - if ever - happen in a societal vacuum. Indeed, in some cases, the implementation of an ocean method for one sector has a negative effect on another. Therefore, any ocean methodology whose execution and outcomes may impact local communities should take special care to consult with and reach agreements on co-design, access, knowledge ownership, and sharing. Further, where guidelines on such interactions exist (e.g. https://www.csiro.au/en/Research/LWF/Areas/Pathways/Sustainable-Indigenous/Our-Knowledge-Our-Way, https://snappartnership.net/), they should be clearly and completely integrated with any method. Any deviations should be explained and contextualised. Capacity exchange and development flourish from building trust among

[1] We note that the use of de jure BPs is typically mandated, and while other methods may produce superior results, they will not supersede the de jure BP (as an official, standard method) unless evaluated and accepted by the mandating authority.
[2] The ocean value chain describes key steps in ocean practices from societal requirements to societal benefits (Pearlman et al. 2019, Figure 1)

knowledge holders and practitioners, especially with local and indigenous communities who have historical and deep connections with their environment.

To help accomplish societal goals, the OBPS documents can be linked to the Sustainable Development Goals (SDGs), their targets and their indicators. Users are thus able to reference the goal(s), target(s), and/or indicator(s) that their document can address through fields in its metadata section (see section 2.2). This makes the document collection searchable by societal goals. This is the first example of a capacity, which we plan to extend to address other frameworks relevant to the OBPS users, such as the Aichi Biodiversity targets, or the EU Marine Strategy Framework Directive (MSFD).

Last, but by no means least, ocean practitioners are facing challenges at a larger scale and with greater interdisciplinarity than ever before. We need to make our methods and best practices easily discoverable, understandable, reusable, and able to help new waves of young professionals – as well as the current generation – advance and innovate in the face of ever-greater complexity.

1.3 Where are our ocean best practices?

Although documentation related to best practices has been generated for centuries, only a fraction of it is easily findable and accessible. Some are present in the scientific literature, others are archived (in an unconsolidated and uncoordinated form) by professional organizations or project websites, and still others are not digitized and are kept as hard copies in filing cabinets, lab books, or compendia of field notes.

Increasing the discoverability of documentation that is related to best practices on the Web would significantly reduce the time needed for researchers and practitioners to find methods that match their needs (Pearlman et al. 2019). The IODE of UNESCO/IOC has established the Ocean Best Practices System (OBPS; https://www.oceanbestpractices.org/), which includes an open, sustained, and digital repository to archive methods and help them evolve into BPs which offers a user-friendly search interface to increase discoverability. This resource specifically aims to serve the global needs for BPs and methodology documents.

1.4 User engagement

With the motivation to create BPs in place, and a centralized and sustained repository to place them in, the need to create methods that connect with needs, interests, and capacities of a global readership takes centre stage. Here, the documentation of the method is the key to effective practitioner engagement.

When an author starts writing a methodological document, it is helpful to empathise with the practitioner, and assess how one can engage the interest of users. Following general guidelines can significantly increase user satisfaction and successful method implementation:

- A precise, clear, concise language using community conventions and terminologies for effective communication.
- Predictability of format and content of documents help readers quickly find the content of interest. Reoccurring standard formats simplify intercomparison of documents.
- Complex content supported by the use of (professional) images (Khoury et al. 2019), sketches, and multimedia (e.g. videos).
- Different backgrounds and educational levels must be considered within the interdisciplinary, international community.

With the sometimes overwhelming amount of available information, we need to be proactive in how we engage potential users of a method and how that method is socialised. While user

engagement occurs when the reader effectively interacts with the document, promoting the apparent value of the document can happen earlier and via different (e.g. social media) sources. Appropriate socialization of methods requires individual consideration and is discussed in the socialisation of a best practice section (section 3).

While a well-crafted document will go far to engage readers, the technologies that the OBPS uses, facilitates interactions with its users, allowing discovery and interlinkage of documents and their related resources (e.g. data sets, multimedia, and calibration sheets), which contributes to a much stronger user engagement. The OBPS will continually develop these capacities around new structures and innovations; however, users submitting methods need not be passive here: as outlined below, well-formatted and metadata-rich documents will allow technologies underpinning the OBPS to augment system-wide user engagement by leveraging (and thus exposing) well-crafted documents. From the user engagement perspective, we, therefore, emphasise the critical importance of what may initially seem as "dry" tasks of formatting and metadata population.

To support authors' documentation, the OBPS provides document templates that help the system parse and link documents and communities. These templates are provided to support authors with formatting and increase the document machine readability.

2. Anatomy of a best practice

This section describes how to structure a document for submission to the OBPS so that three things can occur: 1) consistency 2) key concerns of the community (which we have learned over the existence of the OBPS) are addressed, and 3) the technologies inside the OBPS can better parse and expose the submission's content[3]. To address these three points, the current OBPS document template consists of a metadata section, a main body outline, and a supplement section with additional figures and references[4]. Examples of the templates used are available in the system (e.g. http://dx.doi.org/10.25607/OBP-13). The more that submitters adhere to the template structure and suggested conventions, the more that the OBPS can leverage its technology to provide automated services and user convenience. Here, we propose an approach to populate these templates with well-structured and easily parsable information (**Figure 2**).

The different best practices have the following templates:

- Sensors version 6 (DOI: http://dx.doi.org/10.25607/OBP-758)
- Ocean Applications version 6 (DOI: http://dx.doi.org/10.25607/OBP-758)
- Data Management version 6 (DOI: http://dx.doi.org/10.25607/OBP-760)

Naturally, the subjects of these templates will also be updated over time as well as new ones being created to extend the subjects to other areas of ocean observation. Thus, we will update this document when the changes to one or more templates are sufficiently large to require new guidance.

[3] We acknowledge that institutional or other templates for methodological documents exist and authors are sometimes required to use them. Authors can upload their documents following any template to the OBPS, however, only part of the system's capabilities will be available and content-level consistency with other submissions will be diminished. We therefore encourage authors to reformat their submission along our quite flexible template suggestion.

[4] The current versions of these templates comprise what the OBPS community believes to be a good but general set of sections. We welcome input from expert communities to refine these templates and make them more fit for purpose.

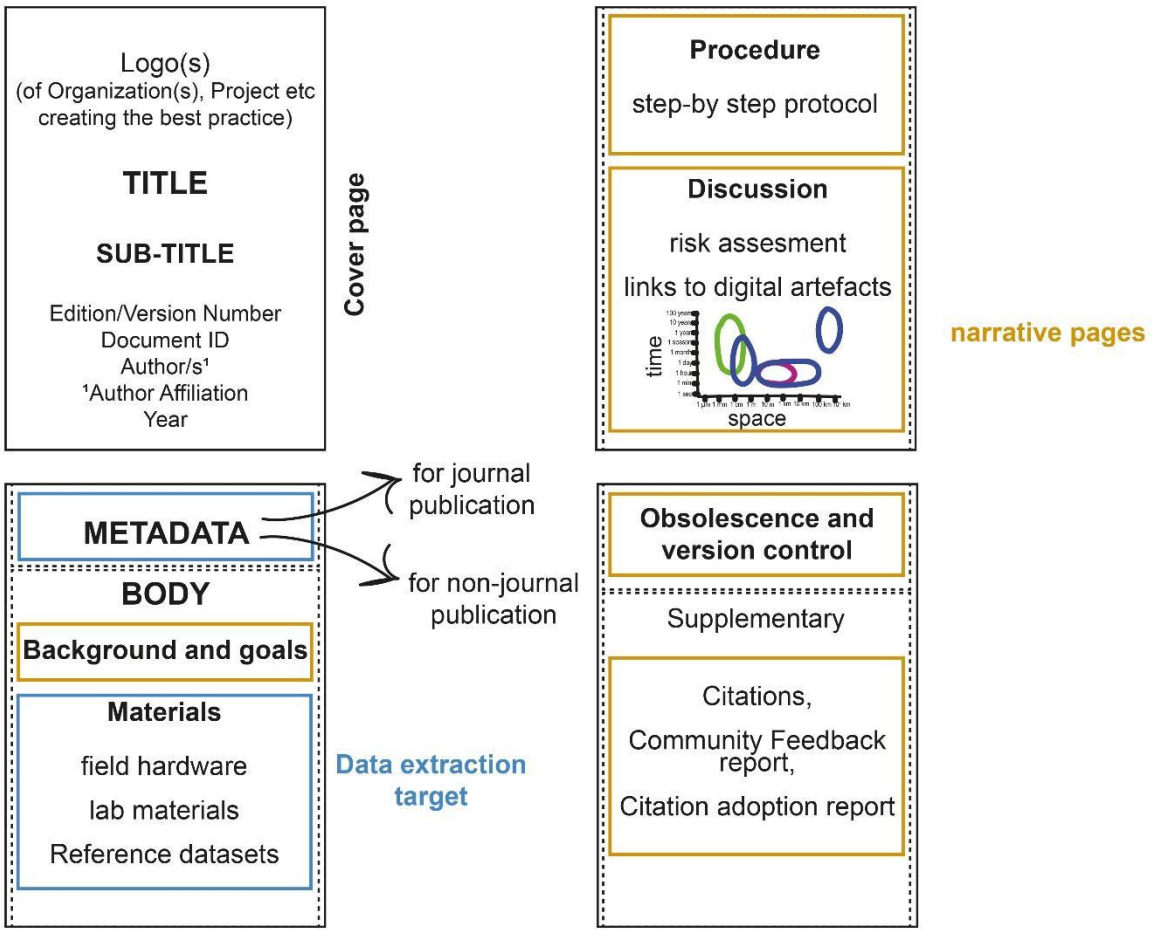

Figure 2. Schematic of OBPS template Version 3 with proposed modifications. The template supports both better user uptake and machine readability. Blue boxes highlight fields where data get extracted. Structured metadata, which uses standards and common vocabularies, are needed for machine readability and automated population of metadata fields. Yellow boxes highlight narrative pages. These pages can be text mined. Narrative pages should provide details for successful method replication including workflows, drawbacks and errors, comparison with other methods and potential extended future applications.

2.1 Cover page

The cover page is a visual representation of the document and should contain the title, subtitles, the document ID, author, and their institution. Further, the cover page should display the licence associated with the document (e.g. Creative Commons) to ensure the correct acknowledgment of intellectual property and its appropriate dissemination. Any logos or images the submitters wish to include can also be added to the cover page. We emphasise the authoritative source for any information displayed on the cover page is the document metadata table (see section below), as this is machine readable.

Many word processors include a facility to add a cover page to a document. We encourage the authors of documents intended for the OBPS to use these functions, as they will clearly identify the nature of this page in the code underlying the document seen on screen. This is essential to improving machine-readability and actionability.

2.2 Document Metadata table

The metadata section captures essential information about the nature, content, and provenance of the document (see **Annexes: III and IV**) in a machine-readable form. A well-filled metadata table greatly enhances findability and machine-actionability of the document by making it more understandable to the technologies behind the OBPS. Further, it helps practitioners by presenting them with a summary of the method's objectives and reproducibility. In a very practical sense, the content of the metadata table allows the OBPS to make a

document “FAIR” (findable, accessible, interoperable, reproducible; (Wilkinson et al. 2016; Buttigieg et al. 2019).
Note: At the time of publication, metadata tables used by the OBPS were being enhanced. Below, we use the pre-update version to be consistent with the system as it stood during publication of this document. The new metadata profiles will be used in the next revision of this document.

The fields inside the metadata table can be grouped thematically:

One set of fields provides **basic bibliographic information**. Online, a beginning “document type” field offers the author to choose a certain type between a journal contribution and a report, book section, or similar, which then presents the appropriate (and sometimes mandatory) metadata fields. Basic bibliographic information includes creator contact details to enable users to open a dialogue with the creator concerning the methodology. A short abstract and keywords provide key findings to practitioners and highlight the goal of the proposed method.

The next group of fields links the document to the **global frameworks**, to which the authors believe their method is relevant. The link to such frameworks potentially strengthens collaboration around data acquisition, access, and usage of methods, and impacts other societal efforts. For instance, the link to SDGs increases the likelihood that a given document might be pertinent for political and economic progress and decision. Submitters also have the opportunity to link their document to the Essential Ocean Variables (EOV) (Lindstrom et al. 2012), Essential Climate Variables (ECV), (Stephan et al. 2014), and Essential Biodiversity Variables (EBV) (Pereira et al. 2013). This promotes the submission’s discoverability by communities rallying around more globally coherent observational models. Further, it allows the developers of those frameworks to access and endorse documents that become De facto standards for these frameworks.

Current levels of **quality and review** process are covered in fields such as maturity level (TRL) and fields providing information about the publisher. This information helps the user to create a risk assessment prior to adopting the proposed method. An additional system function for version control is planned in the next software update.
Practical **execution** of the method is ensured by providing associated datasets and specification resource links. Original data does not need to be provided in the document in its entirety, but links (URI, DOI, etc.) to original datasets should be provided. Smart sub-datasets are discussed in the materials section below. Authors should ensure they provide rights for (free) distribution and adaptation (Creative Common licence). For easy access, cost estimates of technical and human resources should be named in the metadata. However, this metadata field is not about the individual materials needed (e.g. CTD, floats, etc.) but more about the financial and other resources required to acquire and operate them. A detailed breakdown of the required resources and materials will be covered in the materials section.

2.3 Body

The main body of the text provides the method description and includes (1) the background and goals of the method, (2) materials required to execute the method, (3) the procedure itself expressed in clear steps, (4) a discussion section about procedure or the materials highlighting risks and caveats of the method and any limitations, which the user will encounter. The discussion should include an indication of other organizations known to be using the same procedure.

2.3.1 Background and goals

All methods develop from pre-existing methods or principles. In this section, authors should briefly connect their work to material that inspired their methods and submission to the OBPS.

Key steps on how to arrive at such an exemplary submission is shown in Supplementary Figure 1. The body section of the submission should include the novelty or particular strength of the method by stating its core goals and objectives and improvement relative to pre-existing methods or principles.

The background should address the following questions:

- Why was the method created?
- What is the scope of the method?
- Who was involved in the development of this method, and how were these collaborators decided?
- Where / in which environment has the method been tested? What is its range of application? For example, a Stommel diagram as in the EOVs specification sheets. (Figure 3, adapted from EOV specification sheet; e.g. https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=17468). Authors are invited to provide a similar diagram if applicable.
- Are there any deviations in data quality and accuracies expected between different local implementations?
- What makes it different from existing methods?
- Where are the limitations of the method?
- Where has it been applied/tested?
- Does the method belong within a series of other methods or depend on any other specific methods?
- Is the method part of a major campaign?
- Are there any alternative methods the reader should consider?
- Are there plans to update the method, track its use, or solicit feedback for future versions?

Conciseness is valuable here; this section provides the reader with the motivation behind the creation of the document and its scope of application. If subtler or more expansive points need to be made about the submission, it may be wise to submit a commentary article in the open access peer-reviewed literature as an accompaniment (e.g. Przeslawski et al. 2019).
While such commentaries can be submitted anywhere in the peer-reviewed literature, a companion Research Topic has been created in *Frontiers in Marine Science* to support authors contributing in the OBPS[5].

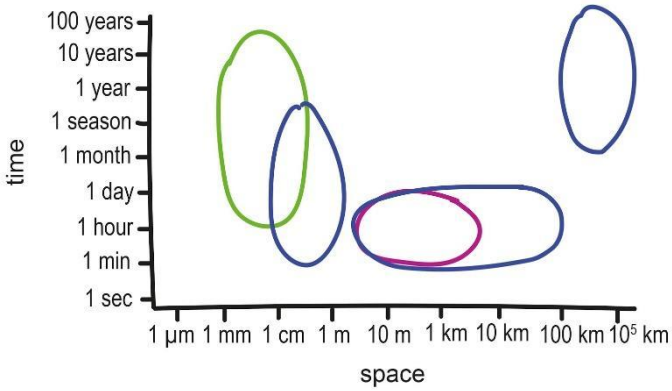

Figure 3. Scope of method application in the field on a temporal and spatial scale (Stommel diagram; Stommel 1963). Spatial scale can vary between 10^{-6} m and 10^{5} km; a temporal scale can be short-term within seconds, or long-term observations up to 100 years. Blue circles indicate different spatio-temporal scopes of the method. Other comparable methods are shown in green and purple.

[5] https://www.frontiersin.org/research-topics/7173/best-practices-in-ocean-observing

2.3.2 Materials & Resources

Ensuring the technical reproducibility of the method is important across variations in time, costs, and environment. The material section should preferably include information about “estimated costs”, “needed personnel” (in person-hours), “field hardware” such as sensors and platforms, and “lab materials” including consumables, reagents and kits, and “software and reference datasets”. Further, it is essential to provide datasets that practitioners can compare and benchmark data.

Before we discuss the content of the Materials section, we emphasise that the costing (estimated if needed) of all materials and resources should be included, if possible, to help potential adopters gauge the feasibility of deploying the method in their environment. As costs are often a limiting factor for method adoption, costs and resources should be transparently described. If supporting capacity development is an objective, discussion of lower cost alternatives to equipment, techniques, and so forth should also be included. We propose that along with the submission of the methods should be an estimate of the cost of performing the methods (in USD); either in absolute amounts, or split into person hours (qualified by the employee type), instrument costs, computing costs, etc. We note that this might not always be feasible as products arise from institutional workshops or similar but will also provide practitioners with an idea of reproducibility. This would both show where the expenses lie (potential cost reduction steps as method refinement) or helps planning experiments, potentially even linking to less expensive methods with minor compromises. By no means should expensive methods be completely excluded from the field, but expenses of equipment and consumables are essential for method adoption. Naturally, costs change over time and this change can be both captured and monitored in the OBPS version control system (see section 2.4)

Successful and content method implementation relies on well-managed personnel time and appropriate qualification. BP developers should briefly provide estimates about required capabilities and personnel time. Ideally, authors should also account for the need of additional time and material for method training.

Hardware and lab materials are essential components of proposed methods and should be easily findable in the document. A tabular style might be appropriate. It is important to correctly name brands and versions of products. Minimal differences between products might drastically impact experiment outcomes. Developers are invited to be as transparent as possible and cross-reference literature supporting their decision on certain products. Hardware and software should at least be mentioned once using their full name, and ideally including identifiers to support term-mining of methods

Software procedures are available in online code repositories such as GitHub (github.com). These websites are already well established, so it should be possible to use these platforms and crosslink the code in the BP document. However, notably, the storage of the code on these platforms is not ensured for eternity, and a copy of the code needs to be accessible directly via the OBPS repository website.

Reference datasets and information are needed for a transparent workflow and to validate results within the community refinement process of a method. Calibration datasets and benchmark datasets should be presented showing well-documented, expected data output. Furthermore, links to digital artifacts (e.g. data sets, code, multimedia files) should be provided to avoid confusion and error. The document should have an accompanying data demonstration with validation checks or procedures, identifying common errors. The data should — where applicable — be usable for machine learning tasks.

Many community standards have been developed that support cross-comparisons of data and methods (e.g. the ISO 19115:2003 Geographic Information Metadata (NOAA 2012) or

minimum information about a marker gene sequence (MIxS) (Yilmaz et al. 2011)). These are not just information standards, but could be engineering standards, organisational standards, or even personnel management standards (if needed). The use of standards in creating a methodology increases reproducibility and eventually facilitates the transition of a method into a BP.

2.3.3 Procedure

Interdisciplinary collaboration requires users more than ever to engage methods outside their field. Clear, precise guidance is required for successful implementation.

Steps to increase the engagement of readers with the contents of a given procedure should be taken (see section 1.4); however, the core focus is to create step-by-step guidance to increase the understandability and reproducibility of the method. Following essential and desirable criteria should be considered when writing procedure protocols:

- **Essential**
  - Structured formatting by following templates identified in this document
  - Logical order of required steps in form of a “cookbook”
  - Clear identification of required versus recommended steps
  - Easy and clear vocabulary (preferably in English)
- **Desirable**
  - Abridged protocols based on detailed and extended protocols to ease repeated application. Trade-offs between a detailed listing of required steps and brief hands-on protocols should be carefully considered, and potentially split into a quick guide for repetitive usage and a longer manual, which can be used during initial deployment/testing and in cases where issues arise.
  - Consideration of common errors. Application of unknown procedures bears risks of error, which can be counteracted by the usage of standard formatting (potentially supported by smart placement of annotation symbols). Highlighting risks upfront in the protocol prevent practitioners from overlooking pitfalls.
  - Handover protocols. For methods used in long-term activities, sub-procedures for changing/replacing equipment and personnel, such that the effect on the signal/data can be characterised and corrected for, should be included.
  - A contact point (email and/or ORCID) for addressing user questions.
  - Documentation of issues and challenges by adopters.

Naturally, not all documentations have procedures as such; however, user engagement at this level is always recommended and can be applied throughout documentation.

2.3.4 Discussion

A method, even if comfortably established in a niche among other methods, has its challenges, differences and overlaps with other methods. Often, opportunities remain for the broader application of methods beyond their core community. In this section, authors should provide background information so practitioners are able to assess the risk of a particular method, and better transform methods to their specific needs. The discussion of a methodological document should be application-oriented and should include cross-references to other similar methods. Vitally, it should also discuss drawbacks and risks, frankly and exhaustively.

As practitioners adopt new methods in their field, appropriate risk assessment is an essential step to reduce the possibility of application failure. Thus, authors should provide detailed

material about potential risks and uncertainties of their method. Such uncertainties are often connected to (sometimes unmeasured) environmental factors. Any detail beyond the metadata is thus extremely welcome. To clarify, in ocean science, short-term events might cause apparent errors or unknown outliers, which can only be detected based on sufficient metadata information. For accurate analyses, authors should cross-reference related resources such as cruise reports, studies from the same expedition to create a wealth of background knowledge about the environment.

Even if the risks of a method are well characterized, not all methods are applicable within the same spatio-temporal or environmental range within the oceans. Each method is likely to have an optimal scope of application (see section 2.3.1) and, therefore, authors should discuss where the boundaries of that scope exist. Other very comparable or relevant methods can be indicated in the spatio-temporal plot (**Figure 3**) to highlight overlaps with the new method or to indicate extensions of the new method in comparison to previous ones. When the community is aware of these boundaries, it is better able to know where a method should be applied with confidence and where it should be applied with caution. Further, where limitations exist, the community is challenged to develop new approaches to co-develop the next generation of methods and best practices for ocean observation.

Finally, as generations of methods come and go, discussing how to manage the obsolescence of any method in a structured way is of great importance[6]. This discussion would, for example, emphasise which parts of existing methods should be preserved in subsequent methods, and which weaknesses should be addressed. This is important to ensure developers of new methods can preserve a chain of provenance to avoid prematurely replacing existing methods or their parts. It is this section of the discussion that will be the basis of community refinement and the roots of the next generation of BPs.

2.3.5 Review process

Rigorous content review by a diverse group of experts is an essential element in the evolution of a method into a best practice (see section 4). As the OBPS contains records from very different kinds of practitioners, we expect equally wide-ranging processes of internal, external, and peer-based review to be possible. As such, the process of review should either be described in the document itself or - if documented elsewhere - references provided to the review guidelines[7]. This is essential to help readers understand the document's history and previous evaluation by experts. The dedicated section should also include a description of the reviewers or the reviewer community themselves. It should also include a summary of the outcomes of the review process and/or the reviews themselves.

For example, this document has been internally and externally reviewed and was open for community review online [link]. The review was sought by the authors from the internal OBPS Steering Group for input of the different dimensions within the OBPS. We further reached out to several experts and institutions via email for experience with method documentations and endorsement processes. The experts were also invited to distribute the link to the review document within their networks, and, in addition, we invited the broader community to review and comment on this document during the annual Evolving and Sustaining Ocean Best Practices Workshop IV. With the help of the community through continuous feedback and review opportunities, and the evolution of the system, we plan a regular update of this document (next version planned: 2022-01-01).

[6] Methods may become obsolete for a number of reasons such as the natural replacement through advancements of techniques or simply the obsolescence of hardware or software used in the method.

[7] Exceptions include articles from peer-reviewed journals cross-archived in the OBPS, where the review process is documented by the journal publisher. A peer-review process is indicated in the [Refereed Status**] metadata field.

2.4 Version control

While a method is being refined through community input and expert revisions, it is essential that the version history of that document is recorded and recoverable. Currently, the OBPS treats new versions of documents as separate submissions. Superseded documents are identified by a "Superseded" value in the "Status" metadata field through manual curation. Authors thus have the opportunity to submit updated versions to the system for secure archiving (e.g. Ocean Glider delayed mode QA/QC best practice manual, Version 2.0. (Woo, 2019) superseded by Ocean Glider delayed mode QA/QC best practice manual, Version 2.1. (Woo, 2019)). However, the current system requires human curation and links to the succeeding document are included but will be replaced by automated version control.

More automated and consistent version control technology is available and – following the update of the OBPS repository software to DSpace 6.3 – readily implementable in the repository through item-level versioning modules. With such solutions, all revisions of a document will be consistently linked to one another and more easily parsable by machine agents. This is especially true if the document and its revisions follow a consistent and machine-readable template (see above), as changes between versions then become more easily identifiable by automated systems.

A hybrid of a manual and automated version control is what is probably most likely to support the community needs and the need for fine-grained auditing of document changes. We recommend that user-declared versions follow the logic of semantic versioning typically used for software (e.g. https://semver.org/). In our context, the MAJOR.MINOR.PATCH (e.g. 3.2.1) system would be interpreted as follows:

- **Major:** This number increments when components of the method (e.g. the workflow, equipment, experimental set-up) has changed such that it is either incompatible with the previous workflow or would deliver incomparable or different results.
- **Minor:** This number increments when one revises the previous document such that any changes are "backwards compatible" with previous versions (e.g. adding a section specifying how to apply the method in a new environmental setting, replacing a section due to a sensor update from a manufacturer, which has no meaningful impact on the results of the method).
- **Patch:** This number increments when one makes minor changes that are backwards compatible with previous versions and which have no meaningful impact on the results of the method (e.g. making corrections/modifications to a reagent concentration value or the settings of a sensor that, if not performed, would not meaningfully change the output of the method).

In this scheme, methods that have yet to be fully tested or completed can be released under a "v0.x.x". This is often desirable, as it attracts early adopters and potential collaborators/ co-developers.

Version control also offers us several opportunities for engagement. For example, inclusion in the document of a detailed version history will make it easier for users to track the evolution of a method. Further, our metadata sheets allow authors to indicate when they will review the document and update if needed (in the field "Recommended Next Content Review Date (yyyy-mm-dd)"). In doing so authors can reassure their readers that the record is maintained.

Upgrading the version control system and guidelines in the OBPS has been identified as a priority in the system's development plan, and will be coupled with the issuing of version-linked identifiers. The version control system can also be used to synchronise document versions with controlled versions of other digital artifacts, including computer code (in systems such as git and Subversion), images, and videos. Naturally, version integrity will be testable through the calculation and storage of checksums.

3. Socialisation of a best practice

Authors create methods that they want other practitioners (i.e. their social/ research/ working group) to adopt. However, most methods need feedback and review from one or more communities of practice to be better integrated in the field. The processes of 1) interacting with a community and 2) responding to their input (Figure 1) allow the *socialisation* of a method within that community. Socialisation, especially when sensitive to the needs of students or practitioners new to the field, helps to enhance a community's confidence in a method, which may help it evolve into a best practice.

Different degrees of socialisation may be required depending on whether an entirely new method is introduced, or whether version changes were made to existing methods. Assuming a method is already well-socialised, minor changes or small developments will often be well received by the community. More far-reaching changes or the introduction of novel methods need more intense efforts. This includes a strong focus on raising community awareness and training, in order for a community to know and care about a method "external" to their common practices.

Naturally, conferences, workshops and similar in-person scenarios are the typical environments in which methods are socialised. However, since from a global perspective attendance at workshops and conferences is not sufficiently widespread, there is a growing need to provide free, online socialisation approaches to contend with, for example, uneven resourcing across stakeholders and a desire to reduce travel impacts. Thus, the OBPS provides a supporting infrastructure to socialise submitted methods on several levels:

- Newsletter[8] to inform community and advertise new methods
- Social media outreach to disseminate new submissions
- Search functionality to increase findability under multiple search terms
- Endorsement to enhance community trust/ standardisation (see section 4.2)
- The OBPS can help submitters create a portfolio of modules and training courses, which will become an integral part of the OBPS user experience. Capacity Development and Training component created in collaboration with the IOC/IODE OceanTeacher Global Academy (OTGA)[9]. Dissemination is strengthened through collaborations with other training organizations such as POGO (the Partnership for Observation of the Global Ocean; https://www.ocean-partners.org/) and the IOCCP (International Ocean Carbon Coordination Project; http://www.ioccp.org/).
- Version control: (see section 2.4) can be used to show links between trusted methods and new revisions.

A central challenge in socialising a method is that any given set of socialisation approaches can easily fail to engage communities they do not explicitly target. For example, the realities of operating in lower capacity settings are often overlooked during the development of methods by well-resourced parties. Additionally, socialisation that is overspecialised to one discipline is unlikely to reach all parties needed to solve today's interdisciplinary challenges. Therefore, efforts to create more inclusive socialisation campaigns are urgently needed to prevent leaving highly relevant stakeholders behind. While many method developers are able to accomplish this, at least to a degree, maximising the socialisation of their valuable work is likely to require services from professional communicators and/or digital platforms (such as the OBPS) which are able to survey resources, demands and detect potential conflicts. Here, we identify two main forms of these services and note how the OBPS can support them: **1)** a **broker,** or

[8] https://obpsystem.org/community-engagement/newsletter/
[9] Training materials and educational content can be distributed through the OceanTeacher e-Learning Platform (OT e-LP) as well as its network of Regional Training Centers and Specialised Training Centers.

matchmaker, service and **2)** a **mediator** service when there are significant obstacles to socialisation.

> A **broker** arranges the contact between parties within a community that have complementary needs and resources. The OBPS supports such matchmaking by interlinking documents with similar metadata or content, using semantic and advanced indexing technologies (Buttigieg et al. 2019).
>
> A **mediator** is often required when parties or interests within groups interfere or compete with one another, leading to degrees of conflict. This neutral, third party can provide perspective and paths to compromise over, e.g., shared resources and a common mission. While approaches to mediation are not yet formally implemented in the OBPS, the system includes the *Frontiers Research Topic, Best Practices in Ocean Observing*[10], where it can support mediators in publishing commentaries to bridge communities for our collective benefit.

We emphasise that the OBPS has growing capacity to enhance community-wide deployment and refinement of methods. We invite the community to help us co-design and co-develop this capacity as needs arise. Simultaneously, we highlight that socialisation is not a single-lane, straightforward approach and often requires bespoke strategies, supported by professional communicators. We anticipate that dedicated documents will be created and stored in the OBPS, elaborating on this diversity of issues and perspectives. As socialisation advances, the ocean community will draw closer together, and will be able to better address its collective goals for improved ocean observation and action.

4. Review and Endorsement

4.1 Review and evolution of a best practice

As described above, the archive at the core of the OBPS hosts a wide range of documents, which submitters believe can elevate the quality of observation across the ocean value chain; however, a review process is necessary to validate such belief. Community review should not be confused with the curation process that for example takes place when a document is submitted to the OBPS repository. The OBPS considers facilitating the processes that are linked to both bottom-up community review and top-down review by expert panels. Interactive software solutions such as online forums and issue trackers are being trialled as mechanisms to facilitate these processes in addition to a recommended section about the steps taken in the review process of a document (see section 2.3.6). Several metadata fields in the recommended templates (see section 2.2.) theoretically allow users to quickly identify submissions that have been through one or more reviews.

Ideally, reviews should be based on practical evaluations of the method by an independent expert or group of experts in the same field/ discipline. Even when submissions have previously passed a review process (for example, through publication in an academic journal), hosting by the OBPS encourages further community review and feedback based on actual experience in the field, lab, or computational environment.

Of course, no process of review is perfect, and there are always some hurdles to overcome. For example, the current state of knowledge in ocean science is very far-reaching and interdisciplinary. Thus, an increase in the diversity of reviewers during the review process can help cover a wider range of current theoretical and practical knowledge. We hope that more descriptions of review processes will inspire increasingly effective approaches across communities in the years to come.

[10] https://www.frontiersin.org/research-topics/7173/best-practices-in-ocean-observing

4.2 Endorsement of a method or best practice

Endorsement of a document by a recognised authority or community can elevate a document to a formal best practice. The endorsement serves as a mark of confidence; the group granting the endorsement declares that the method is a best practice fit for their purposes and operational context. Formal endorsement is one route to distinguish de jure from de facto best practices (see **Figure 1** for context); however, it also offers a way for communities of practitioners, without a strictly defined legal status, to declare that a method is a de facto best practice to other communities. The role of endorsement is essential to qualifying any collection of methods, but no system currently exists to effectively manage the endorsement process by multiple groups across scales. For the OBPS to acknowledge an endorsement, it is required that the "endorsement strategy" is documented. Although the OBPS will and can not interfere with criteria of the endorsing entity, the documented endorsement strategy is needed and served to the users of the OBPS repository.

One emerging process to manage endorsements is being developed by the OBPS and the GOOS Biology and Ecosystems (BioEco) Panel. As with the other GOOS Panels, the BioEco Panel is charged with identifying methods to recommend in their EOV Specification Sheets[11]. Some of these are de jure while others, especially for emerging variables like microbial biomass and diversity, are more de facto and identified through consultations with the networks engaged by the Panel. The OBPS is developing mechanisms where GOOS panels can annotate archived documents with an official endorsement, comprising a metadata flag and a supplementary document describing the endorsement. This mechanism will be linked to the OBPS's search functionality, allowing users to rapidly discover endorsed practices by a panel of experts. Naturally, any recognized community can request the role of an endorser in the OBPS to allow greater inclusivity and comprehensiveness.

Another path to increase inclusivity and help endorsement bodies become aware of promising new methods involves the direct intervention of document submitters. The OBPS currently supports this through its metadata fields dedicated to the EOVs (see section 2.2): Any group or consortium working on methods relevant to the EOVs can declare which EOVs their method pertains to. The respective panels then have a mechanism to discover new methods that they can input into their endorsement process. In future, the OBPS will include a more formal request mechanism (i.e. allowing the authors to explicitly notify and request review from a participating endorsement body). These capacities will allow the OBPS to better link and help align methods to global frameworks such as those set forth by GOOS.

5. Conclusion

Good documentation is the base of successful method implementation and exchange within the community. Well-documented methods can evolve into community-wide best practices through continuous method refinement and broad adoption. By definition, this means current practices will be critiqued and superseded. As with any other document in the OBPS, these guidelines will be updated in time as community co-development proceeds. We look forward to the evolution of this document and welcome community input in the process.

[11] Essential Ocean Variables (with link to disciplinary panels), https://www.goosocean.org/index.php?option=com_content&view=article&id=14&Itemid=114; e.g. EOV Specification Sheet: Ocean Colour version 1: https://goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=19959

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Document Metadata Table

Practice type ** Choose up to 2 entries from the list (delete the rest) to indicate what BP type you consider your document is. Separate two entries with a semicolon (;) · **Best Practice**: a best practice is defined as a methodology that has repeatedly produced superior results relative to other methodologies with the same objective; to be fully elevated to a best practice, a promising method will have been adopted and employed by multiple organizations · **Manual (incl. handbook; guide, cookbook)**: a document giving instructions or information · **Standard**: something set up or established by a recognized standards authority as a rule for the measure of quantity, weight, extent, value, or quality. · **Standard Operating Procedure:** established or prescribed methods to be followed routinely for the performance of designated operations or in designated situations · **Training and educational material**: an item, document, video etc intended to be used for instruction or training purposes	Best Practice; Manual (incl. handbook; guide, cookbook)
English-language document title ** Entries should be in English. End title with a full stop If applicable, include a sub-title after a colon (:) and version number after the title text (e.g. Version 3.2).	Towards a Best Practice for Developing Best Practices in Ocean Observation (BP4BP): Supporting Methodological Evolution through Actionable Documentation.
Non-English document title If the title was not originally in English, please include it in its original form here. If applicable, include a sub-title after a colon (:) and version number after the title/subtitle text (e.g. Version 3.2).	NULL
Author Last, First Name(s) ** Separate multiple entries with a semicolon (;) e.g.: Smith, Joseph; **Jones, H.**; (enter the name/s as it appears in the document)	Hoerstmann, Cora; Buttigieg, Pier Luigi; Simpson, Pauline; Pearlman, Jay; Karstensen, Johannes; Waite, Anya
Author ORCID(s) e.g. 0000-0002-4366-3088. Visit https://orcid.org/ to register Separate multiple entries with a semicolon (;) The order of these entries should correspond to that of the names above	https://orcid.org/0000-0002-0097-2454; https://orcid.org/0000-0002-4366-3088; https://orcid.org/0000-0003-2551-5740;
Editor Last, First Name(s) ** Separate multiple entries with a semicolon (;) (enter the name/s as it appears in the document) eg: Buttigieg, Pier Luigi; Simpson, P.	NULL

Editor ORCID(s) e.g.: 0000-0002-4366-3088 The order of these entries should correspond to that of the names above. Separate multiple entries with a semicolon (;)	NULL
Corporate Author ** Where there is no personal author or editor enter the organization, project or team name responsible for creating the best practice, eg. CleanSea Project	NULL
Contact person - Last, First names e.g. Smith, Joseph	Hoerstmann, Cora
Contact person - Email **	cora.hoerstmann@awi.de
Date of Issue (yyyy-mm-dd) **	2020-12-30
Recommended Next Content Review Date (yyyy-mm-dd) Please indicate the date which you believe the document should be revised and updated	2022-01-01
Pages or Extent e.g.: 57pp. Use straight through pagination of document e.g. 39pp. & Annexes Use pagination of the document body e.g. 12 mins (for video)	34pp.
Publisher Name(s) ** e.g.: Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) Please state the Institute's (Issuing Organization) name as it is specified in official communications. Separate multiple publisher entries with a semicolon (;)	UNESCO
Place of Publication e.g.: Plouzane, France This should correspond to the publisher name(s) provided above.	Paris, France

Series Name and/or Document Number(s) If applicable, list creator document identifiers, e.g.: SIP Protocol Series 6; e.g. JERICO-NEXT-W2-D2.1.-24112016-V2.0 Separate multiple entries with a semicolon (;)	Intergovernmental Oceanographic Commission Manuals and Guides 84
External identifiers e.g. DOI:xxxxxx ; ISBN: xxxxxx Separate multiple entries with a semicolon (;)	DOI: http://dx.doi.org/10.25607/OBP-781
Resource URL: Enter the URL: Organization/Publisher Official URL	https://repository.oceanbestpractices.org/handle/11329/1266
Abstract/Summary ** Please provide a brief summary of your method/best practice including, as appropriate, a brief descriptions of what techniques your best practice is about, which ocean environments or regions it targets, the primary sensors covered, what type of data/measurements/observing platform it covers, limits to its applicability and note which community of practice developed the best practice.	Ever-increasing complexity and multi-dimensionality of ocean systems presents a challenge for the ocean community as we collaboratively (co-)develop methods to research and monitor our oceans. To support transparent sharing of methods, and ultimately agree on best practices in ocean research, operations and application, the IOC Ocean Best Practices System (OBPS) was developed. In this document, we provide guidance on how to best use the OBPS templates, allowing greater discovery, machine readability, sharing and understandability of methods and best practices (Buttigieg et al. 2019). We clarify how to optimally populate the different sections of an OBPS template, and describe how those sections support the evolution of each OBPS submission, towards a global best practice. Further, we discuss some general challenges in developing methods into community-wide best practices. While this document focuses on the OBPS, it also offers a position on the general challenge of structuring and harmonising method documentation. We invite the community to provide feedback on this document (link to Community review), to contribute towards a generalised best practice for advanced methodological management across the ocean community.
Abstract (Other language)	NULL

Maturity Level If applicable, note one of the maturity levels of the methodology in the document · **N/A** where maturity level not applicable · **Mature**: Methodologies are well demonstrated for a given objective,documented and peer reviewed; methods are commonly used by more than one organization (TRL 7-9) · **Pilot or Demonstrated:** Methodologies are being demonstrated and validated; limited consensus exists on widespread use or in any given situation (TRL 4-6) · **Concept:** A methodology is being developed at one institution(s) but has not been agreed to by the community; requirements and form for a methodology are understood (TRL 1-3)	N/A
Spatial Coverage If applicable, please specify the region where the best practice is applied. For regional term guidance link: https://www.nodc.noaa.gov/worlddatacenter/regions.html. e.g. SW Pacific Ocean Enter NULL if none	NULL
Sustainable Development Goals, Targets, and Indicators ** If applicable, please specify if the best practice has application for a sustainable development goal. Target number is required and should be entered e.g 14.3 Add Indicator if applicable eg. 14.3.1 Refer to this page for more information: https://sustainabledevelopment.un.org/ Separate multiple entries with a semicolon (;) **Enter NULL if none**	14.A
Essential Ocean Variables (EOV)** Copy and paste standard variable names from the list on this link. Separate multiple entries with a semicolon (;) Enter NULL if none	NULL
Subject: Other Add any other key words, e.g. Melt pond; Diatoms; Absorption coefficient Separate multiple entries with a semicolon (;)	Best practice creation; Document template
Additional Information	

Refereed Status** Has this document been peer reviewed/refereed? Please enter YES, NO or UNKNOWN	YES
Bibliographic Citation ** Enter the form in which you would like your article cited. For example, consider this report citation format: Author/Editor (Year) Title. Place of Publication, Publisher, xxpp. (Series Name, Document ID). DOI:	Hörstmann, C., Buttigieg, P.L., Simpson, P, Pearlman, J., Karstensen, J. and Waite, A.M. (2020) Towards a Best Practice for Developing Best Practices in Ocean Observation (BP4BP): Supporting Methodological Evolution through Actionable Documentation. Paris, France, UNESCO, 34pp (Intergovernmental Oceanographic Commission Manuals and Guides No.84). (IOC/2020/MG/84). DOI: 10.25607/OBP-781
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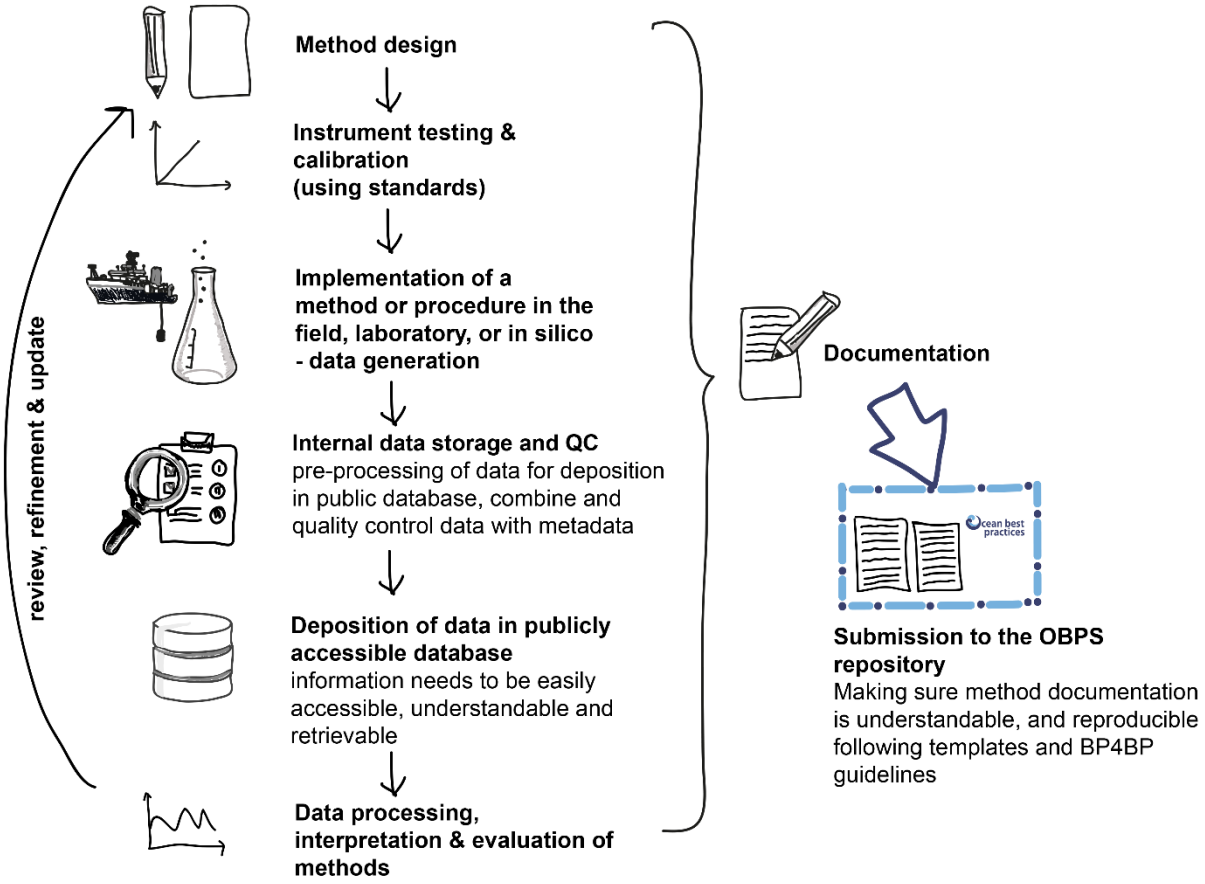
ANNEX I: Supplementary Figures



Supplementary Figure 1. Illustration reflecting the steps or categories required to realize a best practice process, applicable to most ocean observing systems or activity; from 1. the design and preparation of the activity, through 2. the calibration and testing of the required/used instrumentation, 3. the executive phase (whether in the field, in a laboratory setup, in silico, or a combination of any) that leads to data generation, 4. the data handling and quality control, allowing for 5. Deposition of all data and information generated by the method into publicly accessible, sustained, and community-endorsed repositories, and, (6) the subsequent use of this data through further processing, analysis and interpretation along with an evaluation of the methodology. The submission to the OBPS can happen at any stage of the categories (e.g. a field manual, calibration standards). Figure concept courtesy of Virginie van Dongen-Vogels; Illustration by Cora Hörstmann.

ANNEX II: Acronyms

BP	Best Practice
EBV	Essential Biodiversity Variables
ECV	Essential Climate Variables
EOV	Essential Ocean Variables
GOOS	Global Ocean Observation System
IOC	Intergovernmental Oceanographic Commission
ISO	International Standards Organization
OBPS	Ocean Best Practice System
SDG	Sustainable Development Goals

ANNEX III: OBPS Metadata table (non-journal contribution)

Document Data Sheet v6 (for submissions to https://www.oceanbestpractices.org). We recommend including this document data sheet into your submission to the OBPS. Please do not change any formatting, entries in the left column, or the table structure. The format below will allow automatic ingest of the data in this table into the Ocean Best Practice Repository. Enter data only in the right-hand column.

Mandatory fields are indicated with ** but we strongly recommend that you provide data (if applicable) for all the metadata fields requested; this will allow you to unambiguously declare what your best practice is about and help our indexing technology make it more visible.

Practice type ** Choose up to 2 entries from the list (delete the rest) to indicate what BP type you consider your document is. Separate two entries with a semicolon (;) **Best Practice**: a best practice is defined as a methodology that has repeatedly produced superior results relative to other methodologies with the same objective; to be fully elevated to a best practice, a promising method will have been adopted and employed by multiple organizations **Manual (incl. handbook; guide, cookbook)**: a document giving instructions or information **Standard**: something set up or established by a recognized standards authority as a rule for the measure of quantity, weight, extent, value, or quality. **Standard Operating Procedure**: established or prescribed methods to be followed routinely for the performance of designated operations or in designated situations **Training and educational material**: an item, document, video etc intended to be used for instruction or training purposes	
English-language document title ** Entries should be in English. End title with a full stop If applicable, include a sub-title after a colon (:) and version number after the title text (e.g. Version 3.2).	
Non-English document title If the title was not originally in English, please include it in its original form here. If applicable, include a sub-title after a colon (:) and version number after the title/subtitle text (e.g. Version 3.2).	
Author Last, First Name(s) ** Separate multiple entries with a semicolon (;) e.g.: Smith, Joseph; Jones, H.; (enter the name/s as it appears in the document)	
Author ORCID(s) e.g. 0000-0002-4366-3088. Visit https://orcid.org/ to register Separate multiple entries with a semicolon (;) The order of these entries should correspond to that of the names above	

Editor Last, First Name(s) ** Separate multiple entries with a semicolon (;) (enter the name/s as it appears in the document) e.g.: Buttigieg, Pier Luigi; Simpson, P.	
Editor ORCID(s) e.g.: 0000-0002-4366-3088 The order of these entries should correspond to that of the names above. Separate multiple entries with a semicolon (;)	
Corporate Author ** Where there is no personal author or editor enter the organization, project or team name responsible for creating the best practice, e.g. CleanSea Project	
Contact person - Last, First names e.g. Smith, Joseph	
Contact person - Email **	
Date of Issue (yyyy-mm-dd) ** e.g. 2018-05-21	
Recommended Next Content Review Date (yyyy-mm-dd) Please indicate the date which you believe the document should be revised and updated	
Pages or Extent Use straight through pagination of document e.g.: 57pp. Pagination of the document body e.g. 39pp. & Annexes Video, e.g.12 mins	
Publisher Name(s) ** e.g.: Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) Please state the Institute's (Issuing Organization) name as it is specified in official communications. Separate multiple publisher entries with a semicolon (;)	
Place of Publication e.g.: Plouzane, France This should correspond to the publisher name(s) provided above.	

Series Name and/or Document Number(s) If applicable, list creator document identifiers, e.g.: SIP Protocol Series 6; e.g. JERICO-NEXT-W2-D2.1.-24112016-V2.0 Separate multiple entries with a semicolon (;)	
External identifiers e.g. DOI:xxxxxx ; ISBN: xxxxxx Separate multiple entries with a semicolon (;)	
Resource URL: Enter the URL: Organization/Publisher Official URL	
Abstract/Summary ** Please provide a brief summary of your method/best practice including, as appropriate, a brief descriptions of what techniques your best practice is about, which ocean environments or regions it targets, the primary sensors covered, what type of data/measurements/observing platform it covers, limits to its applicability and note which community of practice developed the best practice.	
Maturity Level If applicable, note one of the maturity levels of the methodology in the document · **N/A** where maturity level not applicable · **Mature**: Methodologies are well demonstrated for a given objective, documented and peer reviewed; methods are commonly used by more than one organization (TRL 7-9) · **Pilot** or Demonstrated: Methodologies are being demonstrated and validated; limited consensus exists on widespread use or in any given situation (TRL 4-6) · **Concept**: A methodology is being developed at one institution(s) but has not been agreed to by the community; requirements and form for a methodology are understood (TRL 1-3)	
Spatial Coverage If applicable, please specify the region where the best practice is applied. For regional term guidance use the following link: https://www.nodc.noaa.gov/worlddatacenter/regions.html e.g. SW Pacific Ocean Enter NULL if none	

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IOC Manuals and Guides

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2	International Catalogue of Ocean Data Station. 1976. *(Out of stock)*
3 rev. 3	Guide to Operational Procedures for the Collection and Exchange of JCOMM Oceanographic Data. Third Revised Edition, 1999. 38 pp. (English, French, Spanish, Russian)
4	Guide to Oceanographic and Marine Meteorological Instruments and Observing Practices. 1975. 54 pp. (English)
5 rev. 2	Guide for Establishing a National Oceanographic Data Centre. Second Revised Edition, 2008. 27 pp. (English) *(Electronic only)*
6 rev.	Wave Reporting Procedures for Tide Observers in the Tsunami Warning System. 1968. 30 pp. (English)
7	Guide to Operational Procedures for the IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring. 1976. 50 pp. (French, Spanish)
8	*(Superseded by IOC Manuals and Guides No. 16)*
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9 Annex I	*(Superseded by IOC Manuals and Guides No. 17)*
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20	Guide to Drifting Data Buoys. 1988. 71 pp. (English, French, Spanish, Russian)
21	*(Superseded by IOC Manuals and Guides No. 25)*
22 rev.	GTSPP Real-time Quality Control Manual, First revised edition. 2010. 145 pp. (English)
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63	The IHO-IOC General Bathymetric Chart of the Oceans (GEBCO) Cook Book. 2012. 221 pp. (English). *Also IHO Publication B-11*
64	Ocean Data Publication Cookbook. 2013. 41 pp. (English)
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66	IOC Strategic Plan for Oceanographic data and Information Management (2013-2016). 2013. 54 pp. (English/French/Spanish/Russian)
67	IODE Quality Management Framework for National Oceanographic Data Centres. 2014; revised edition 2019 (English)
68	An Inventory of Toxic and Harmful Microalgae of the World Ocean (in preparation)
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83	Quality Control of in situ Sea Level Observations: A Review and Progress towards Automated Quality Control, Vol. 1. (English only), 2020
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85	Vol1.: Workbook: How to Reduce Coastal Hazard Risk in your Community – A step-by-step approach. English only (2021)

No.	Title
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