# BIOLOGICAL AND ECOSYSTEM OBSERVATIONS WITHIN UNITED STATES WATERS I: A SURVEY OF FEDERAL AGENCIES

PRODUCT OF THE

National Ocean Council

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EXECUTIVE OFFICE OF THE PRESIDENT

**NATIONAL OCEAN COUNCIL**

WASHINGTON, D.C. 20502

December 19, 2016

Dear Colleagues:

We are pleased to transmit to you *Biological and Ecosystem Observations within United States Waters I: A Survey of Federal Agencies*, a summary report on a survey conducted by the Biological Integration and Observation Task Team of the Interagency Ocean Observation Committee, which is organized under the National Science and Technology Council, Committee on Environment, Natural Resources, and Sustainability's Subcommittee on Ocean Science and Technology (SOST). The SOST also functions as the Ocean Science and Technology Interagency Policy Committee under the National Ocean Council. This document is a companion to *Biological and Ecosystem Observations within United States Waters II: A Workshop Report to Inform Priorities for the U.S. Integrated Ocean Observing System®.*

This report responds to actions within the National Ocean Policy Implementation Plan to expand current ocean biological observations and extend current biological data standards to allow for increased interoperability with other biological, physical, and social data systems. This document also responds to recommendations developed by the ocean observing community during the 2012 United States Integrated Ocean Observing System Summit. The Summit participants identified the need to effectively integrate biological and ecosystem observations into ocean and coastal information systems.

Sincerely,

Tamara Dickinson

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Principal Assistant Director
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## About the National Ocean Council

The National Ocean Council (NOC) is charged with implementing the National Ocean Policy established in July 2010 under Executive Order 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes. The NOC released the National Ocean Policy Implementation Plan in April 2013 to translate the National Ocean Policy into specific actions Federal agencies will take to address key ocean challenges, streamline Federal operations, save taxpayer dollars, and promote economic growth. Federal agencies, states, tribes, and regional fishery management councils may choose to form regional planning bodies to provide communities greater collaborative input in these efforts. More information is available at www.WhiteHouse.gov/administration/eop/oceans.

## About the National Science and Technology Council

The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the Federal research and development (R&D) enterprise. One of the NSTC's primary objectives is establishing clear national goals for Federal science and technology investments. NSTC prepares R&D packages aimed at accomplishing multiple national goals. The NSTC's work is organized under five committees: Environment, Natural Resources, and Sustainability; Homeland and National Security; Science, Technology, Engineering, and Mathematics (STEM) Education; Science; and Technology. Each of these committees oversees subcommittees and working groups that are focused on different aspects of science and technology. More information is available at www.WhiteHouse.gov/ostp/nstc.

## About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on questions in which science and technology are important elements, articulating the President's science and technology policy and programs, and fostering strong partnerships among Federal, state, and local governments, and the scientific communities in industry and academia. The Director of OSTP also serves as Assistant to the President for Science and Technology and manages the NSTC. The Director of OSTP co-chairs the National Ocean Council, along with the Managing Director of the Council on Environmental Quality (CEQ). More information is available at www.WhiteHouse.gov/ostp.

## About the Council on Environmental Quality

The Council on Environmental Quality (CEQ) coordinates Federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. CEQ was established within the Executive Office of the President (EOP) by Congress as part of the National Environmental Policy Act of 1969 (NEPA), and additional responsibilities were provided by the Environmental Quality Improvement Act of 1970. Through interagency working groups and coordination with other EOP components, CEQ works to advance the President's agenda. It also balances competing positions, and encourages government-wide coordination, bringing Federal agencies, state and local governments, and other stakeholders together on matters relating to the environment, natural resources, and energy. The Managing Director of CEQ co-chairs the National Ocean Council, along with the Director of OSTP. More information is available at www.WhiteHouse.gov/ceq.

## About the Subcommittee on Ocean Science and Technology

The purpose of the Subcommittee on Ocean Science and Technology (SOST) is to advise and assist the NSTC on national issues of ocean science and technology. The SOST contributes to the goals for Federal ocean science and technology, including developing coordinated interagency strategies, and fosters national ocean science and technology priorities, including implementation of the National Ocean Policy. The SOST also serves as the Ocean Science and Technology Interagency Policy Committee under the NOC, and ensures the interagency implementation of the National Ocean Policy and other priorities for ocean science and technology objectives. More information is available at https://www.WhiteHouse.gov/administration/eop/ostp/nstc/oceans.

## About the Interagency Ocean Observation Committee

The purpose of the Interagency Ocean Observation Committee (IOOC) is to advise and assist the SOST on matters related to ocean observations, including coordination of Federal activities on ocean observations and other activities as described in the Integrated Coastal and Ocean Observation System Act of 2009 (P.L. No. 111-11, Subtitle C).

## About the IOOC Biological Integration and Observation Task Team

The IOOC established the Biological Integration and Observation Task Team (BIO-TT) to: (1) improve the availability of observations on the five currently identified United States Integrated Ocean Observing System (U.S. IOOS®) biological core variables; and (2) identify and prioritize additional cross-cutting Federal agency biological and ecosystem observation needs. To meet these goals, the IOOC BIO-TT collaborated with the U.S. IOOS Program Office, the U.S. IOOS Regional Associations, and other Federal interagency working groups as necessary.

## About this Document

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# Table of Contents

# Executive Summary

In 2013, the Interagency Ocean Observation Committee (IOOC), which is organized under the National Science and Technology Council, Committee on Environment, Natural Resources, and Sustainability's Subcommittee on Ocean Science and Technology, established the Biological Integration and Observation Task Team (BIO-TT). The primary goals of the BIO-TT were to: (1) improve the availability of observations on the existing United States Integrated Ocean Observing System (U.S. IOOS®) biological core variables;[1] and (2) identify and prioritize additional cross-cutting biological and ecosystem observational needs. To address these objectives the BIO-TT:

- Conducted a two-part survey of Federal agencies to identify (1) datasets on the existing biological core variables[2] and (2) prioritized needs for biological and ecosystem observations (this report);
- Prioritized cross-cutting biological and ecosystem variables that should be considered for addition to the list of U.S. IOOS core biological variables; and
- Conducted an expert workshop to analyze the survey findings, explore best available science of biological and ecosystem observing, and determine implementation strategies for biological and ecosystem observation needs identified from the survey (see companion report *Biological and Ecosystem Observations within United States Waters II: A Workshop Report to Inform Priorities for the U.S. Integrated Ocean Observing System*).

The BIO-TT distributed the survey to 14 agencies and received 86 responses over a two month period in 2014. Results from the first part of the survey indicate that many of the Federal agencies surveyed are not aware of, or are not using, existing metadata and biological data standards. Thus, there is an opportunity for the U.S. IOOS enterprise to facilitate the integration of more biological data into U.S. IOOS by increasing awareness of data standards through outreach and education efforts targeted at Federal agencies, including through the IOOC. The Federal agency responses to the survey can be queried to identify datasets that can be most readily incorporated into U.S. IOOS, such as those already using recognized metadata and U.S. IOOS biological data standards.

Results from the first part of the survey were used to generate several lists of variables that would meet the biological and ecosystem observational needs of the responding Federal agencies. Based on responses, benthic[3] species and abundance were the most frequently occurring observational need identified. Other frequently identified needs that are not currently U.S. IOOS core variables included marine mammal abundance and species, sound[4], sea bird abundance, phytoplankton abundance, primary production, and invertebrate species and abundance. These lists of variables were used as the basis for discussions at the expert workshop.

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[1] Defined by the BIO-TT as phytoplankton species, zooplankton species and abundance, and fish species and abundance. For completeness in Part I of the survey, the BIO-TT also included phytoplankton abundance as a core variable. Phytoplankton abundance, however, is not officially recognized by U.S. IOOS as a core variable.

[2] The terms biological core variables and core biological variables are both used in the report. Biological core variables refers to the subset of IOOS core variables which are biological (versus physical or chemical) while core biological variables refers to the set of variables among all biological variables that are considered to form the core of a sustained observing system.

[3] Benthic applies to anything of, relating to, or occurring in the depths of the ocean, on the sea floor.

[4] Sound is a fundamental ocean property, which that originates from biological (e.g., marine mammals, soniferous fish, snapping shrimp), physical (e.g., wind, surface waves, sea ice; geological (e.g., earthquakes), and anthropogenic (e.g., ships, air guns) sources, and affects many aquatic species. Analogous to ocean color, measurement of sound enables derivation of numerous variables, such as marine mammal and fish presence, wind speed estimates, and ambient noise. Sound provides a natural bridge between some of the physical and biological elements of an ocean ecosystem.

## Background

As articulated in *United States Integrated Ocean Observing System (U.S. IOOS®) Report to Congress (U.S. IOOS 2015)*, submitted to Congress in 2015, the core U.S. IOOS mission is to lead the integration of ocean, coastal, and Great Lakes observing capabilities, in collaboration with Federal and non-Federal partners, to maximize access to data and generation of information products, inform decision making, and promote economic, environmental, and social benefits to our Nation and the world. To further this mission, and in response to a call from the ocean observation community for wider inclusion of biological variables into U.S. IOOS at the 2012 U.S. IOOS Summit (IOOC 2012), the Interagency Ocean Observation Committee (IOOC), which is organized under the National Science and Technology Council, Committee on Environment, Natural Resources, and Sustainability's Subcommittee on Ocean Science and Technology (SOST), established a Biological Integration and Observation Task Team (BIO-TT) in 2013. In responding to the call for wider inclusion of biological variables into U.S. IOOS, the BIO-TT was also charged with addressing related actions in the National Ocean Policy Implementation Plan to expand current ocean biological observations and extend current biological data standards to allow for increased interoperability with other biological, physical, and social data systems. The IOOC BIO-TT collaborated with the U.S. IOOS Program Office, the U.S. IOOS Regional Associations, and other Federal interagency working groups as necessary.

The primary goals of the BIO-TT were to: (1) improve the availability of observations on the existing U.S. IOOS biological core variables[5]; and (2) identify and prioritize additional cross-cutting Federal agency biological and ecosystem observational needs. The approach to address these objectives was to:

- Conducted a two-part survey of Federal agencies to identify (1) datasets on the existing biological core variables[6] and (2) prioritized needs for biological and ecosystem observations (this report);
- Based on identified needs, prioritize cross-cutting biological and ecosystem variables that should be considered for addition to the list of U.S. IOOS core biological variables; and
- Conduct an expert workshop to analyze the survey findings, explore best available science of biological and ecosystem observing, and determine implementation strategies for biological and ecosystem observation needs identified from the survey.

This report focuses on the execution of and results from the survey of Federal agencies. Workshop discussions, analyses and outcomes, and recommendations for new and enhanced biological variables as part of U.S. IOOS can be found in the companion report *Biological and Ecosystem Observations within United States Waters II: A Workshop Report to Inform Priorities for the United States Integrated Ocean Observing System®.*

## Survey Objectives

The survey was divided into two parts, each focusing on one major objective. The first was to gather information on existing data sources for current U.S. IOOS biological core variables, including about their use within Federal agencies, the data and metadata formats used, and the agency relationship with those variables (e.g., whether the agency collected data on a particular core variable and/or used data it collected or data from another agency or outside source to meet agency missions). The second major objective was to ascertain from Federal agencies their current biological information needs, anticipated future needs, and recommended additional biological

[5] Defined by BIO-TT as phytoplankton species, zooplankton species and abundance, and fish species and abundance. For completeness in Part I of the survey, the BIO-TT also included phytoplankton abundance as a core variable. Phytoplankton abundance, however, is not officially recognized by U.S. IOOS as a core variable.

[6] The terms biological core variables and core biological variables are both used in the report. Biological core variables refers to the subset of IOOS core variables which are biological (versus physical or chemical) while core biological variables refers to the set of variables among all biological variables that are considered to form the core of a sustained observing system.

variables to define as "core" variables in the U.S. IOOS enterprise. The list of needs generated from the second part of the survey served as a starting point for the expert workshop convened by the BIO-TT in November 2014.

## Survey Methodology

The survey was conducted between March 7, 2014, and mid-April 2014. The survey was designed and issued using SurveyMonkey, and instructions and links to the survey were distributed via email directly to the survey participants. A full list of survey questions can be found in Appendix I.

Survey recipients were identified by the BIO-TT with additional input from the IOOC members. The BIO-TT targeted the survey at Federal recipients who have appropriate expertise and experience with biological and/or ecosystem observations and data and data management. As part of the survey, participants were asked to suggest additional experts within their agency who could provide valuable input through the survey; these individuals were then added to the participant list.

## Survey Participation and Response Rates

Eighty-six out of 219 survey recipients responded, representing 14 Federal agencies (Figure 1). Since the list of participants was not exhaustive, but a representative sample across all agencies, results should not be taken as indicative of entire agency practices. This report considers analysis of survey outcomes to reasonably represent a cross-agency perspective on biological and/or ecosystem observations, data, capabilities, and information needs and accordingly does not present results by individual agency. Additionally, the report does not provide summary analysis of all survey questions. It focuses on the subset of representative questions that most effectively articulate the state of biological and ecosystem observations and data within Federal agencies of most interest to U.S. IOOS.

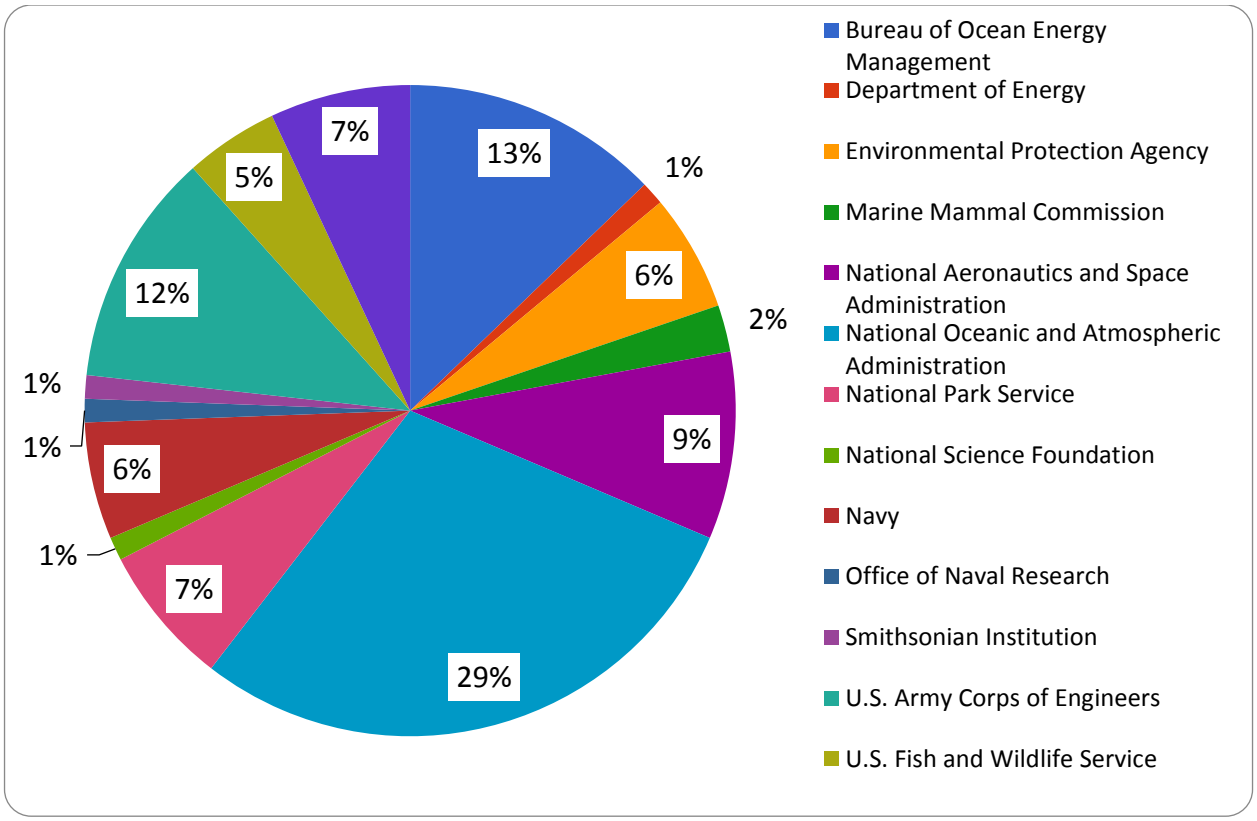


*Figure 1. Percent of overall response from the 14 Federal agencies to which the survey was distributed.*

# Survey Results

## Survey Part One: Existing Data Sources for Current U.S. IOOS Biological Core Variables

Survey questions 4 through 7 asked survey participants to provide information on whether their group within their agency collects, provides, and/or uses data on current U.S. IOOS biological core variables (Figure 2) and how they, as individuals, interact with the data (Figure 3).

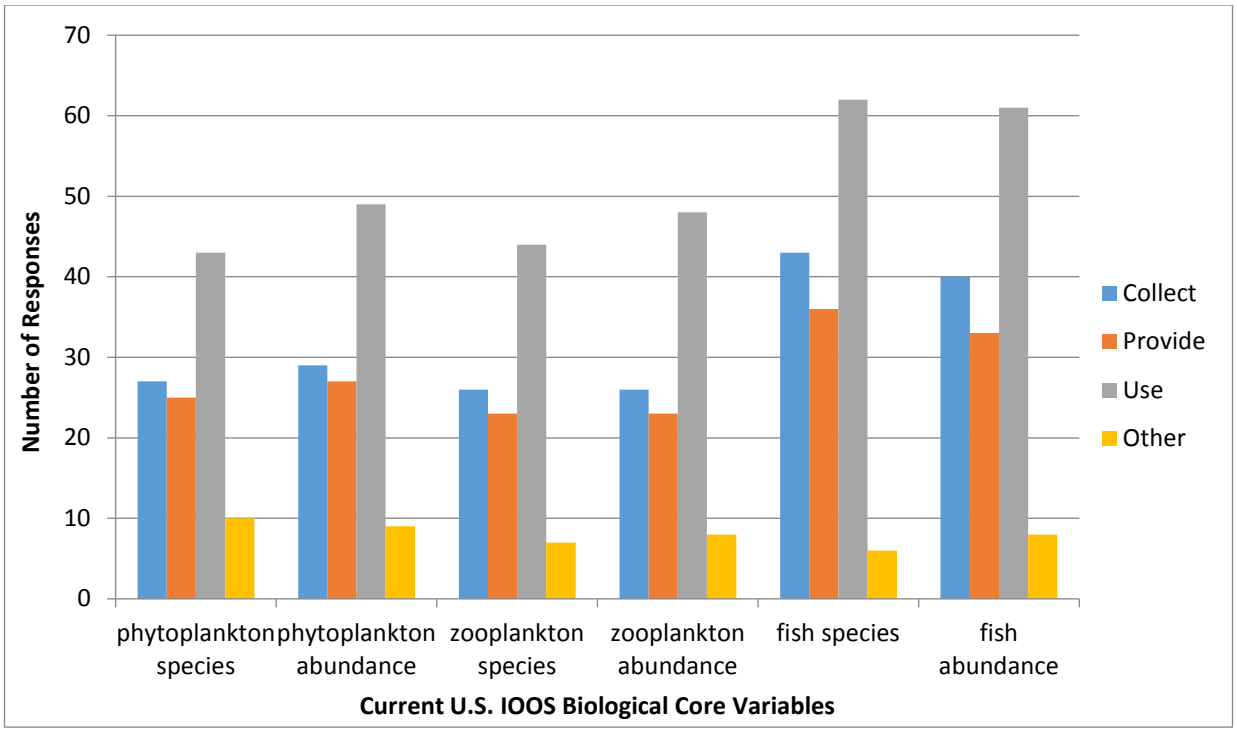


*Figure 2. Number of survey responses indicating that specific groups within Federal agencies collect, provide, use, or otherwise interact with data on current U.S. IOOS biological core variables (survey questions 4 and 5).*

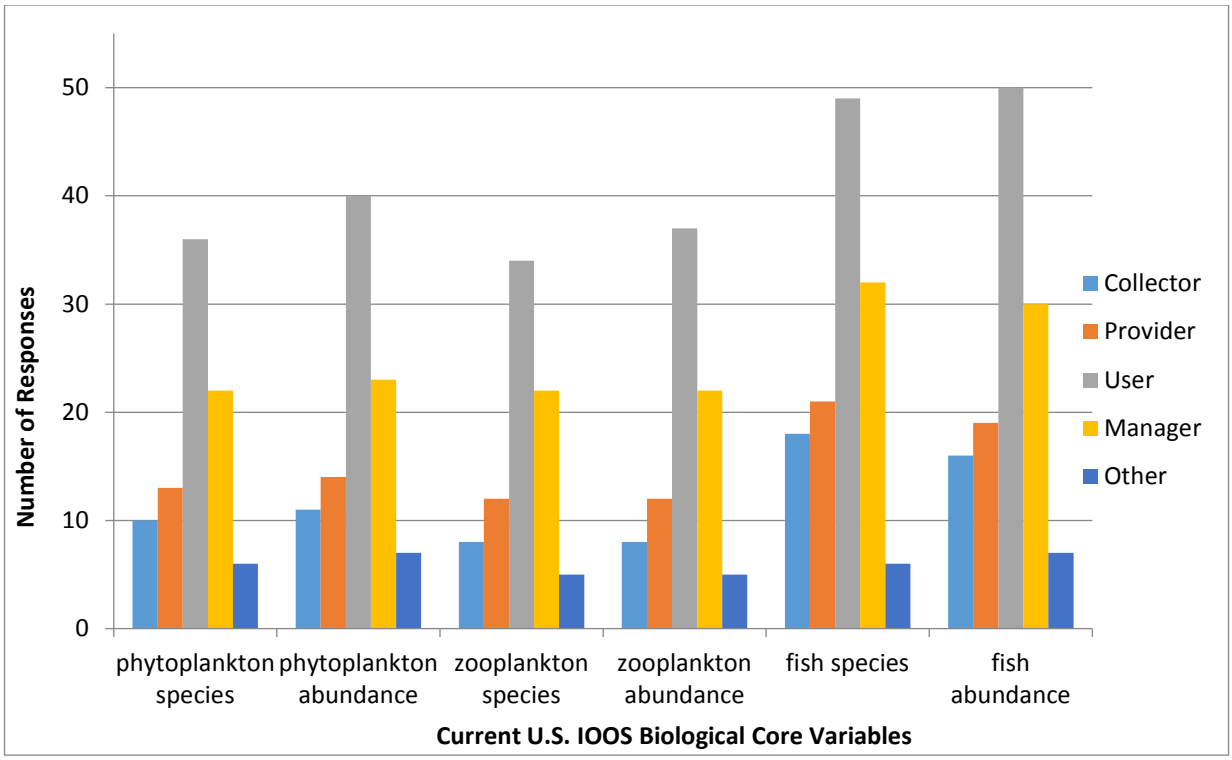


*Figure 3. Number of survey responses indicating that the individual respondent collects, provides, uses, manages, or otherwise interacts with data on current U.S. IOOS biological core variables (survey questions 6 and 7).*

For these questions, respondents were able to select more than one option, so a collector of data could also be a user of data. Survey responses indicate that across all current U.S. IOOS biological core variables many agencies, and to a lesser extent individual respondents, collect and provide data, but many more of the respondents consider themselves users and managers of the data. The results also suggest that while a specific group within an agency collects data, there are more individuals within that group that use the data collected. This result is not entirely surprising as data collected can be accessed by multiple users. Access to data by multiple users further implies the importance and value of those data collected for more broad use, especially in situations of limited observations. This result aligns with the suggestion from the results of part two of the survey that the greatest challenge faced by Federal agencies is limited availability of needed observations.

## Metadata

The U.S. IOOS Biological Observations Data Project addresses the Data Management and Communications requirements that pertain to biological observations standards and interoperability applicable to U.S. IOOS and various observing systems. U.S. IOOS BDP standards are based on multiple existing guidelines[7] for standardized data access services, data formats, metadata, controlled vocabularies, and other conventions.

[7] IOOS. Biological Observations Data Service, Biological Data Standards. http://ioos.github.io/biological-data-services/biological-observations/#biological-data-standards:08f52f911df72d9b94c5ed7d7d3e0541

Survey questions 8 and 9 asked survey participants to indicate how metadata are documented for each current U.S. IOOS biological core variable their agency collects, provides, or uses (Figure 4). The following are brief descriptions of the metadata schema that survey participants were asked to consider:

- International Organization for Standardization (ISO) 19115-1:2014 is a metadata schema used for describing geographic information and services. The schema provides information on the identification, extent, quality, spatial and temporal reference and aspects, distribution, and other geographic content of the data.[8]

- Federal Geographic Data Committee (FGDC) Standards aim to develop common terminology and definitions for geographic data, including biological data, through the creation of metadata schema and documentation.[9] FGDC was tasked by Executive Order 13286, amending Executive Order 12906, to develop and coordinate a National Spatial Data Infrastructure and Framework for data acquisition.[10]

- The National Aeronautics and Space Administration's (NASA) Global Change Master Directory (GCMD) holds Earth science data sets with appropriate keyword vocabularies that are used both to facilitate discoverability and to map data sets to the use in other applications used by the broader community. This standardization effort emerged as part of the National Space Science Data Center efforts to promote the exchange of data sets via Catalog Interoperability efforts.[11] Specific elements of the required metadata for the GCMD can be found in the Directory Interchange Format (DIF) Writer's Guide.[12]

- Ecological Metadata Language (EML) is a metadata scheme developed for ecology disciplines. It is based on work by the Ecological Society of America and is implemented as Extensible Markup Language modules that are designed to describe subsets of ecological datasets.[13]

The survey responses demonstrate that most Federal agency respondents are FGDC compliant, some are ISO 19115 compliant, and fewer are GCMD and EML compliant (Figure 4). A number of respondents stated they did not know which standards, if any, were applied to the current U.S. IOOS core biological variables, indicating that further outreach on the role and function of metadata in the context of biological data is needed. While such outreach has been one primary focus for the U.S. IOOS Program Office, the IOOC could play a role in education and outreach among its member agencies.

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[8] ISO. ISO 19115-1:3014, Geographic Information -- Metadata -- Part 1: Fundamentals, available at http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=53798.

[9] FGDC. Content Standard for Digital Geospatial Metadata Part 1: Biological Data Profile, Biological Data Working Group, Federal Geographic Data Committee and United States Geological Service Biological Resources Division. October 1999, FGDC-STD-001.1-1999, available at https://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/biometadata/biodatap.pdf.

[10] Executive Order 13286, 3 C.F.R. 2003, available at http://www.gpo.gov/fdsys/pkg/FR-2003-03-05/pdf/03-5343.pdf; See also, Executive Order, FGDC Website, at https://www.fgdc.gov/policyandplanning/executive_order.

[11] NASA. GCMD About Website, NASA, at http://gcmd.nasa.gov/learn/index.html.

[12] NASA. DIF Writer's Guide. GCMD, NASA, at http://gcmd.nasa.gov/add/difguide/index.html.

[13] KNB. Morpho User Guide, available at https://knb.ecoinformatics.org/#tools/eml.

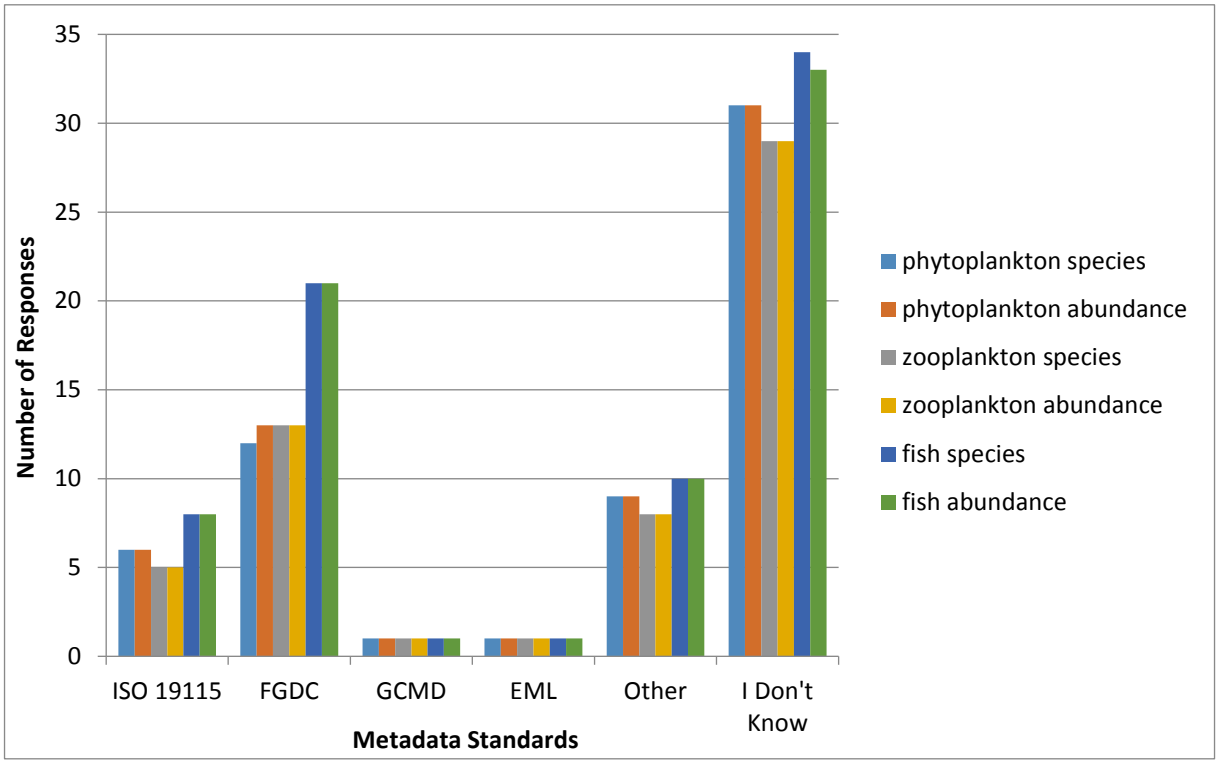


*Figure 4. Frequency of the use of metadata standards in documenting data on current U.S. IOOS core biological variables among Federal agencies that collect, provide, or use such data (survey question 8).*

## Biological Data Management

Question 10 asked respondents to indicate whether they were aware of U.S. IOOS biological data standards. There was a high frequency of "no" and non-responses and the fact that only the National Oceanic and Atmospheric Administration (NOAA) included "in progress" responses indicate that U.S. IOOS could derive some benefit by improving or increasing outreach and education efforts to Federal agencies with regard to U.S. IOOS biological data standards.

Many open-ended comments provided by respondents to Question 10 indicate that agencies are aware of U.S. IOOS biological data standards but require assistance updating their data to meet those standards or, alternatively, were not aware of the standards but would be interested in complying with those standards if provided assistance to do so. Some answers indicated that the respondent was aware of U.S. IOOS biological data standards but worked for an agency that had not yet required data managers to comply with U.S. IOOS the standards and therefore had not pursued compliance measures.

Survey questions 11 through 23 asked participants a series of questions about their internal database and data management practices both within and beyond their agencies. The BIO-TT worked with the U.S. IOOS Program Office to analyze these survey responses to identify general conclusions and suggest next steps to identify which datasets on existing U.S. IOOS core biological variables might be targeted for incorporation into U.S. IOOS in the near future.

Based on survey questions that asked respondents to provide information on data access and formats, the following general observations can be made:

- Many agencies surveyed used internal databases and were not inclined to use shared portals or databases if those tools are not currently part of established processes.
- Some agencies do not use data portals or databases because the data they utilize are contained in reports and documents produced by non-Federal sources, indicating there may be an opportunity to craft contract terms that would more clearly require data to be integrated into existing and cross-agency data storage tools.

Some agencies currently maintain some biological data in a restricted access location. A follow up activity for the U.S. IOOS Program Office will be to identify those agencies that are required to maintain certain types of data under restricted access so that efforts to integrate data can be prioritized, with an initial focus on agencies and datasets that can be shared more readily.

Many agency respondents use a mechanism for updating data and replacing flagged data. Some respondents, however, did not know and other respondents stated that there was no mechanism. This aspect of data management could benefit from the development of new or socialization of existing U.S. IOOS data management and communication practices. Currently, the U.S. IOOS Program Office works to provide online information and webinar series about specific Quality Assurance/Quality Control issues. Advertising these methods presents an opportunity for the U.S. IOOS Program Office to work closely with both the IOOC and the U.S. IOOS Advisory Committee to increase awareness of the tools already in place.

With regard to phytoplankton, and zooplankton, agencies either maintain that data at the National Oceanographic Data Center (NODC)[14] or maintain it in another data center (Figure 6). Fish data are also stored at NODC and other data centers, but one respondent also noted they maintain their data at National Geophysical Data Center (NGDC). Respondents were given the opportunity to identify other data centers they use. A summary table of these responses is provided in Appendix II. Beyond a national data center, the survey participants were asked if their biological data are stored in a public repository or are otherwise accessible to the public. These responses indicate that while phytoplankton and zooplankton data are generally accessible to the public, data on fish species and fish abundance are less available to the public. The respondents provided either a website or description of how the data could be accessed (Appendix III). The U.S. IOOS Program Office will review the information in Appendices II and III to determine if there are databases the U.S. IOOS Program Office was previously unaware of, and whether additional outreach is needed to make data on the existing U.S. IOOS core biological variables more available.

[14] Since the survey was conducted, NODC has become a part of the National Centers for Environmental Information.

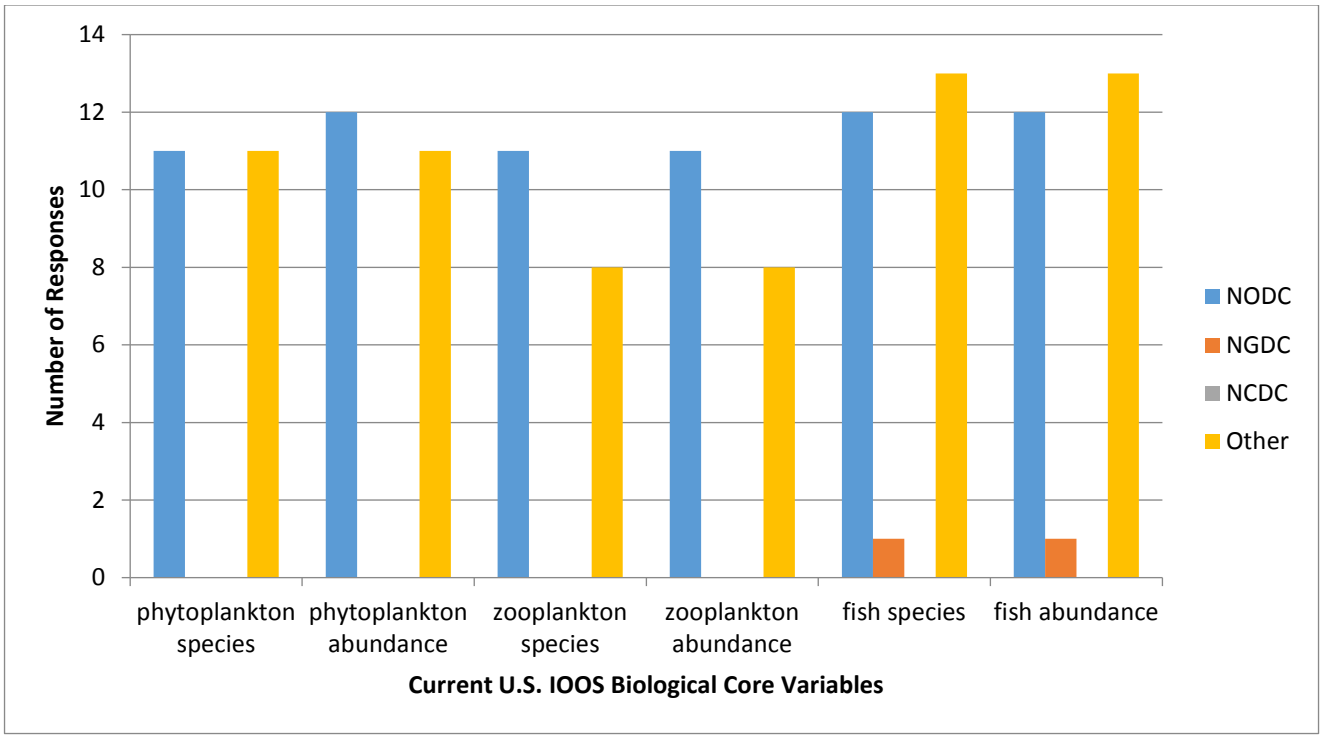


*Figure 6. Number of respondents that indicated their agency's phytoplankton, zooplankton, and fish data are maintained in a major national data center.*

## Survey Part Two: Biological Data Needs Assessment and Analysis Process

The second part of the survey on identifying and assessing Federal agency biological data needs used an open text field/narrative option for responses to all questions except question 29. This approach allowed the broadest capture of information from survey participants without restricting their responses to predefined terms. Open text field responses presented a challenge in grouping or binning responses to compare results across questions. A range of responses on biological data needs were received from generic terms to more complex and detailed information. To address this challenge the BIO-TT used a double-binning approach where the bins would be consistent across all questions. By looking at the frequency of responses that fall into particular bins, comparisons could be made across questions.

In the first round of binning, each response was taken as literally as possible with the goal of not interpreting the responses but categorizing them. In almost all cases, this binning process effectively "lumped at the character string level." For example, if the words "protected species" appeared in the response, the response was placed in the protected species category and not recorded under individual organism categories such as marine mammals, which could also include protected species. Complex responses were separated into different categories where appropriate. For example, if a response related to both marine mammal species and abundance, that response was recorded as both marine mammal species and marine mammal abundance. This first round of binning resulted in several major categories and subcategories (Table 1).

*Table 1. Major categories and subcategories of biological data needs as identified by Federal survey respondents and categorized using a double-binning approach (applied to survey questions 24 through 28 and 30 through 33).*

| Biological Data Need Category | Biological Data Need Subcategory | |
|---|---|---|
| Organism | Benthos<br>Birds<br>Corals<br>Endangered Species Act Listed<br>Fish<br>Marine Mammals | Invertebrates<br>Phytoplankton<br>Protected Species<br>Sea Turtles<br>Zooplankton |
| Non-Organism | Geography<br>Chemistry | Physical<br>Oceanography |
| Ecosystem | Habitat | Population Characteristics |
| Anthropogenic | Anthropogenic<br>Uses | Human Impacts |
| Other | Data<br>Optical | Sound |

While the initial binning analysis was constructive to identify major biological data categories and subcategories, much of the richness in the responses was not captured, impacting the value of comparisons between questions. Further, this categorization would not be useful for deriving variables that might be measured through U.S. IOOS or used to inform the expert workshop.

The BIO-TT undertook a second binning process to revisit the original responses, now grouped by the categories in Table 1, and derive additional categories that best represent the richness in the responses as well as more specific variables that could be measured to meet the need described in the response (See Box 1).

The second binning process resulted in the following biological data categories: Species; Abundance; Life History; Productivity/ Production; Diet; Sound; Derived Variables; Health/Condition; Habitat; Behavior; Anthropogenic; Taxonomic Grouping (without a qualifier); Techniques; Beyond our Scope; and Other Qualifiers (see Tables 3-6 for more detail).

**Box 1:** Example of the second binning process

Generic responses like "fish" or "corals" were counted under the category "taxonomic grouping without a qualifier."

While "Stable long term funding to allow us to continue collecting data on phytoplankton and zooplankton species abundance in the northern California Current" was captured as "Resources, phytoplankton species, zooplankton species, phytoplankton abundance, zooplankton abundance, and geography."

## Results by Question

For the purposes of this summary report a few detailed examples of the types of information that can be derived from the survey results are provided, including the information that was fed into the expert workshop.

Survey questions 24 through 28 asked respondents to indicate the top five biological or ecosystem observational needs, excluding the current U.S. IOOS biological core variables, which are currently not being met within the respondent's agency.

Species and abundance were the most commonly identified needs for biological data not currently being met (Figure 7). Beyond the existing U.S. IOOS core biological variables,[15] invertebrate and benthic, species and abundance were the most frequently identified needs that are not currently being met (Figure 8).

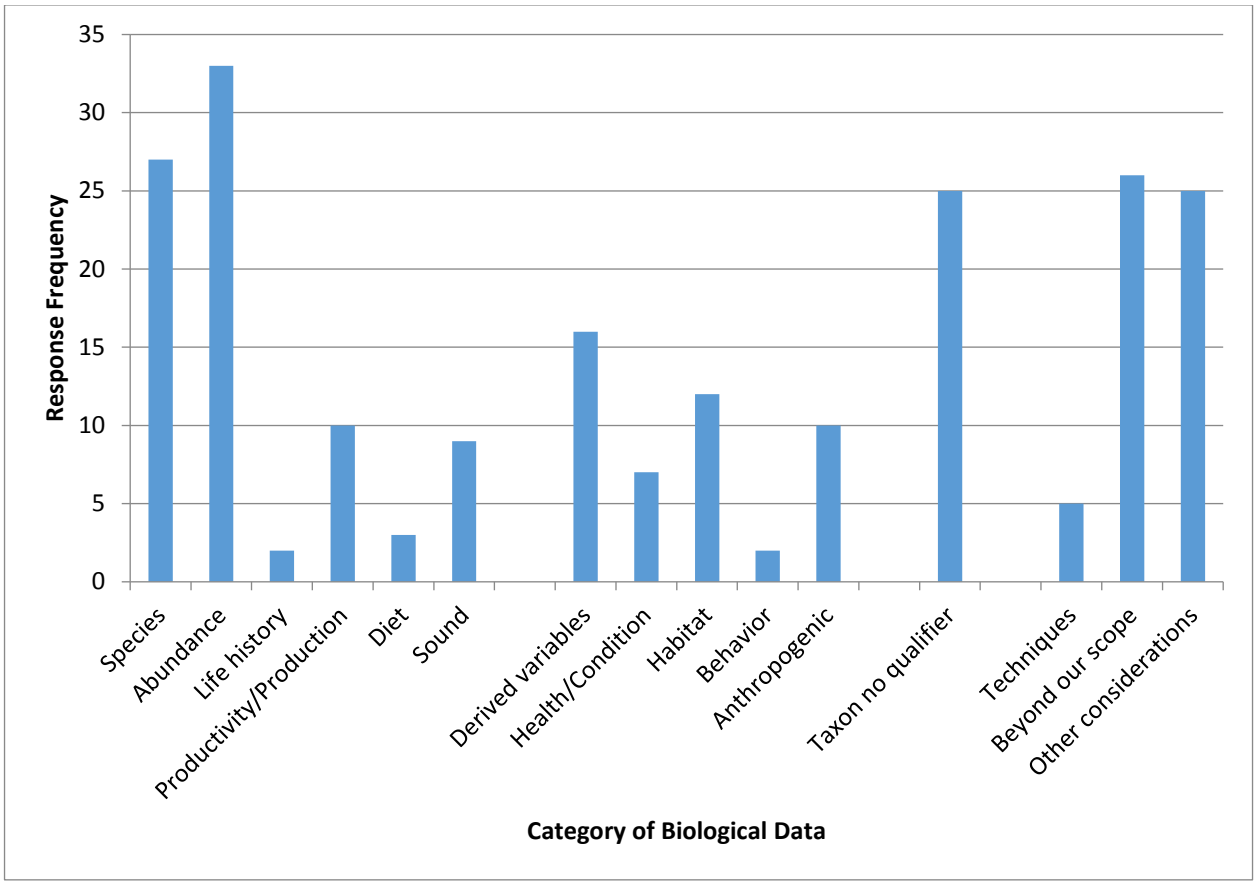


*Figure 7. Response frequency indicates where the need for different categories of biological data is currently not being met by responding agencies. The need for species and abundance data is most commonly not being met.*

[15] Defined by the BIO-TT as phytoplankton species, zooplankton species and abundance, and fish species and abundance. For completeness in Part I of the survey, the BIO-TT also included phytoplankton abundance as a core variable. Phytoplankton abundance, however, is not officially recognized by U.S. IOOS as a core variable.

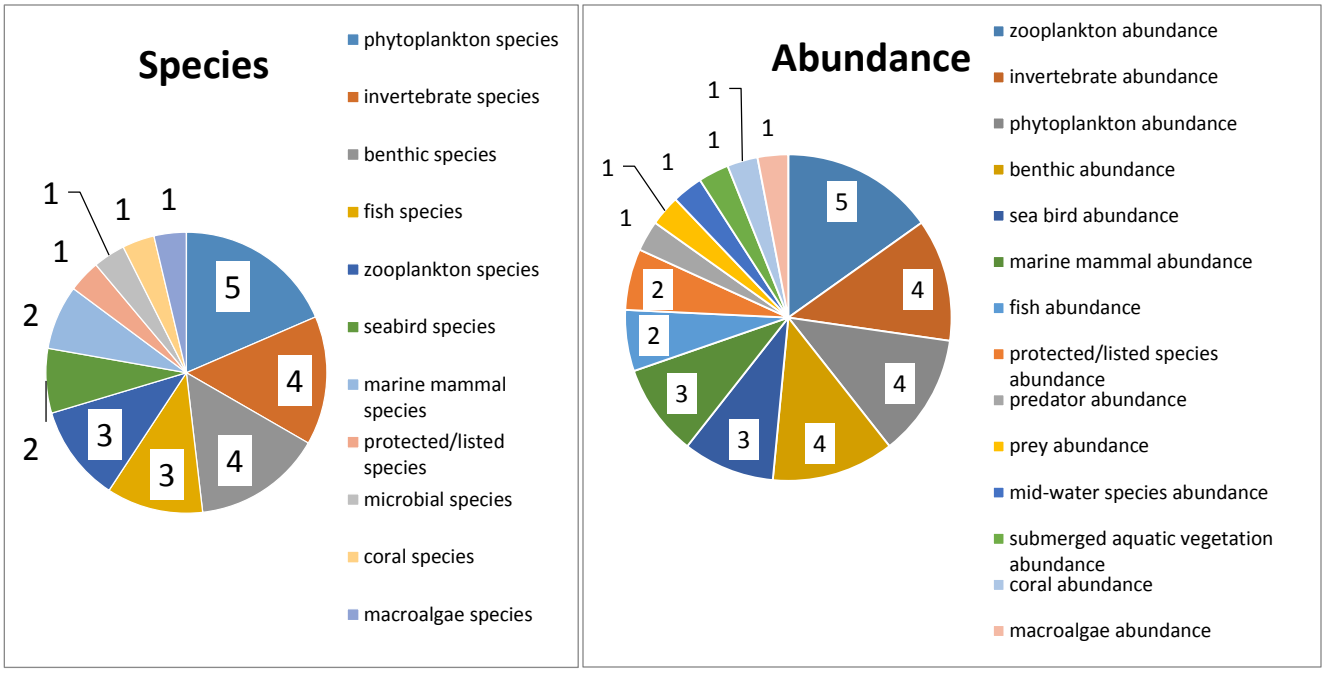


*Figure 8. Frequency with which survey respondents noted specific observational needs under the broader observational categories "species" and "abundance." The highest frequency corresponds to the first item in the legend and then progresses down the legend and around the pie in a clockwise direction.*

In survey question 29, survey respondents were asked to identify why the needs identified in questions 24 through 28 were not being met. Respondents selected from a drop down menu of options and the responses were grouped into challenge areas (Table 2). A lack of observations was the most commonly cited reason for needs not currently being met.

*Table 2. Survey responses indicating reasons needs are not currently being met for biological and ecosystem observations, grouped by major challenge area (survey question 29).*

| **Challenge Areas** | **Specific Survey Choices** | **Responses** |
|---|---|---|
| Too Few Observations | Geographic areas of interest contain too few observations | 104 |
| | Too few observations in general | 88 |
| | Repeated observations over time | 80 |
| Resources | Funding Limitations | 87 |
| | Infrastructure Limitations (e.g., ships, aircraft etc.) | 61 |
| Data | Timely data availability is inadequate | 45 |
| | Data quality | 39 |
| | Data precision | 32 |
| | Lack of data documentation | 28 |
| | Available in a limited format | 15 |

There were some similarities in the categories of biological variables that respondents identified as needs (questions 24 through 28) and those that they independently indicated should be considered for inclusion in U.S. IOOS (question 33) for example, species and abundance (Figure 9). Looking at the specific responses to each of these questions, however, revealed differences in the specific variables (Figure 10) and there were also some differences, for example a higher frequency of responses for productivity/production and sound in question 33 than questions 24 through 28 (Figure 9).

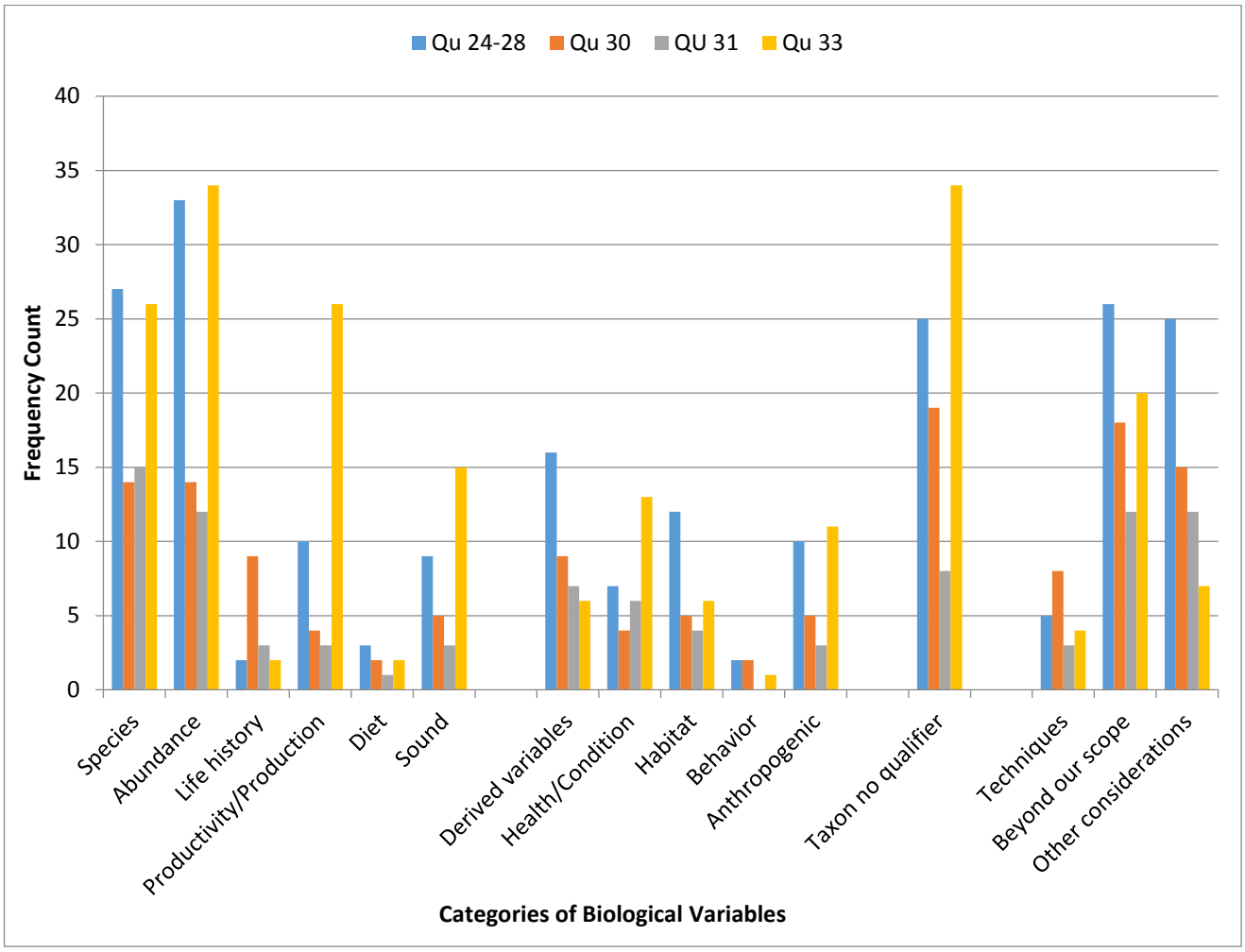


*Figure 9. Frequency histogram for all variable categories across all questions about biological and ecosystem needs as well as Question 33 ("Which variables should be considered for inclusion into U.S. IOOS next?"). The similarities in frequency counts between Questions 24-28 and Question 33 within categories, imply that many respondents identified needs in the same categories as they suggested be included next into U.S. IOOS.*

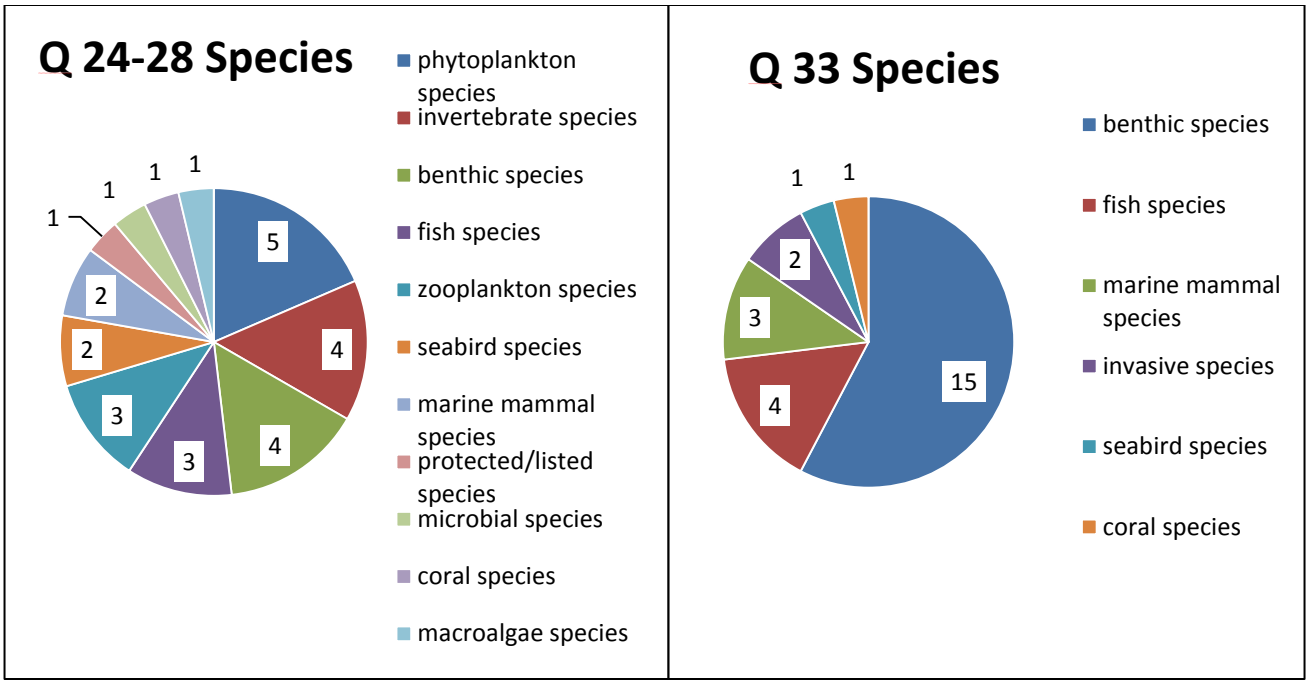


*Figure 10. Frequency pie charts for specific responses in the category "species" for Questions 24-28 and Question 33. This breakdown illustrates how different the responses were between the needs identified by the agencies and the variables they independently suggested be considered for inclusion in U.S. IOOS.*

While the broader categories identified were useful for comparing across question responses at a high level, examining the details of the responses revealed a different picture (Figure 10). As a result, the detailed responses across all questions were collated and considered together to inform the workshop discussions. Although the double-binning process retained the richness in the responses from the survey, it resulted in over 165 separately binned variables, which ultimately were grouped into the following categories:

- "Primary variables" represent key biological variables or those that would form the "core" of a biological observing system (Table 3);
- "Secondary variables" are important but require further discussion to identify key components necessary to monitor in order to deliver those variables as part of an observing system (Table 4);
- "Taxonomic information only" includes responses that contained only a taxonomic grouping (Table 5); and
- "Other topics of consideration" includes responses that were considered to be techniques as opposed to variables, beyond the biological scope of the survey (i.e., physical or chemical variables), or other qualifiers in relation to a variable such as timing, geographic location, or resources necessary) (Table 6).

The frequency counts of responses across all questions in section two of the survey are provided in Tables 3 through 6 and give some indication of the relative importance of the variables based on the survey results. For example, observations and data on benthic species and benthic abundance were the most frequently occurring need identified across all questions (Table 3). Other frequently identified needs that are not currently U.S. IOOS core biological variables included marine mammal abundance and species, sound, sea bird abundance, phytoplankton abundance, primary production, and invertebrate species and abundance.

*Table 3. Proposed Primary Variables with Qualifiers from the Survey. Numbers Indicate the Response Count from the Survey for each Variable.*

| Primary Variables | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | | **Abundance** | | **Life history** | | **Productivity/Production** | | **Diet** | | **Sound** | |
| Benthic species | 25 | Benthic abundance | 21 | Fish ages | 3 | Phytoplankton | 10 | Fish diet | 3 | Ambient/passive acoustic measurements | 12 |
| Fish species | 20 | Marine mammal abundance | 16 | Fish length | 3 | Primary | 9 | Diet and food chain/trophic linkages | 3 | Bioacoustics | 9 |
| Phytoplankton species | 8 | Fish abundance | 14 | Fish weight | 3 | Catch Per Unit Effort | 7 | Diet | 2 | Soundscape | 3 |
| Marine mammal species | 7 | Zooplankton abundance | 13 | Fish maturity | 2 | Zooplankton | 5 | | | Marine mammal acoustics | 2 |
| Zooplankton species | 6 | Sea bird abundance | 7 | Marine mammal | 1 | Grazing rates | 3 | | | Impacts of sound | 2 |
| Invertebrate species | 4 | Phytoplankton abundance | 5 | Marine mammal movements | 1 | Recruitment | 1 | | | Anthropogenic | 2 |
| Seabird species | 4 | Invertebrate abundance | 4 | Fish sex | 1 | Sea bird | 1 | | | Vocalizations | 1 |
| Invasive species | 2 | Protected/listed species abundance | 4 | Fish migration | 1 | Productivity rates | 1 | | | Fish acoustics | 1 |
| Protected/listed species | 2 | Coral abundance | 2 | Species migration | 1 | Surface | 1 | | | | |
| Coral species | 2 | Sea turtle abundance | 1 | | | Ecosystem | 1 | | | | |
| Microbial species | 1 | Microbe abundance | 1 | | | Coral spawning | 1 | | | | |
| Macroalgae species | 1 | Predator abundance | 1 | | | Coral recruitment | 1 | | | | |
| | | Prey abundance | 1 | | | | | | | | |
| | | Mid-water species abundance | 1 | | | | | | | | |
| | | Submerged aquatic vegetation abundance | 1 | | | | | | | | |
| | | Macroalgae abundance | 1 | | | | | | | | |

*Table 4. Proposed Secondary Variables with Qualifiers from the Survey. Numbers Indicate the Response Count from the Survey for each Variable.*

| Secondary Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Derived variables** | | **Health/Condition** | | **Habitat** | | **Behavior** | | **Anthropogenic** | |
| Fish distribution | 4 | Ecosystem | 6 | Habitat | 9 | Marine mammal behavior | 3 | Human use | 21 |
| Protected/listed species distributions | 4 | Marine mammal mortality events | 5 | Benthic habitat | 8 | Invertebrate life stage behavior | 1 | Human impacts | 8 |
| Marine mammal distribution | 4 | Pathogens | 3 | Wetland spatial extent | 3 | Fish life stage behavior | 1 | | |
| Marine mammal density | 4 | Benthos | 3 | Seafloor mapping | 1 | | | | |
| Sea bird distribution | 3 | Marine mammal | 3 | Seabird habitat use | 1 | | | | |
| Phytoplankton distribution | 3 | Contaminants | 2 | Fish habitat | 1 | | | | |
| Protected/listed species density | 3 | Health/condition monitoring | 2 | Seagrasses | 1 | | | | |
| Coral distribution | 2 | Habitat | 1 | Habitat use | 1 | | | | |
| Invertebrate distribution | 2 | Population | 1 | Fragmentation | 1 | | | | |
| Submerged aquatic vegetation distribution | 2 | Watershed | 1 | Migration corridors | 1 | | | | |
| Plankton diversity index | 1 | Wetland | 1 | | | | | | |
| Turtle density | 1 | Recovery | 1 | | | | | | |
| Zooplankton distribution | 1 | Health (human) | 1 | | | | | | |
| Fish demographics | 1 | | | | | | | | |
| Benthic trends | 1 | | | | | | | | |
| Invertebrate trends | 1 | | | | | | | | |
| Prey distribution | 1 | | | | | | | | |

*Table 5. Survey Responses with Taxonomic Information Only.*

| Taxon (no qualifier) | Response Count | Taxon (no qualifier) | Response Count |
|---|---|---|---|
| Phytoplankton | 18 | Benthic bivalves | 2 |
| Marine mammal | 13 | Benthic | 2 |
| Fish | 13 | Benthic epifauna | 1 |
| Sea birds | 5 | Benthic meiofauna | 1 |
| Coral | 4 | Non-plankton invertebrates | 1 |
| Protected/listed species | 3 | Zooplankton | 1 |
| Gelatinous zooplankton | 3 | Epibenthic invertebrates | 1 |
| Microbes | 3 | Benthic vertebrates | 1 |
| Benthic infauna | 2 | Ichthyoplankon | 1 |
| Sea turtles | 2 | Meroplankon | 1 |
| Seagrasses | 2 | Microzooplankton | 1 |
| Invertebrates | 2 | Macrozooplankton | 1 |

*Table 6. Other Topics of Consideration from Survey Results. Numbers Indicate the Response Count from the Survey for each Variable.*

| Other considerations | | | | | |
|---|---|---|---|---|---|
| **Techniques** | | **Beyond Task Team scope** | | **Other qualifiers** | |
| Optics | 13 | Hydrodynamic modelling /currents/hydrography | 17 | Timing | 27 |
| Genomics | 3 | Nutrient concentrations | 10 | Geography | 24 |
| Marine mammal passive acoustic detection | 2 | pH | 6 | Resources | 8 |
| Marine mammal passive acoustic classification | 2 | Temperature | 5 | | |
| Acoustic Doppler Current Profiler | 2 | Carbon stocks (Dissolved Organic Carbon, Particulate Organic Carbon, pCO2) | 4 | | |
| Video Plankton Recorder | 2 | Carbon fluxes | 4 | | |
| Fish finders/sonar | 2 | Dissolved Oxygen | 4 | | |
| Autonomous Underwater Vehicles | 1 | Colored Dissolved Organic Matter | 3 | | |
| Process studies | 1 | Salinity | 3 | | |
| High Pressure Liquid Chromatography | 1 | Turbidity | 3 | | |
| Marine mammal tracking | 1 | Ocean acidification | 3 | | |
| | | Marine sediment chemistry | 2 | | |
| | | Water quality | 2 | | |
| | | Total particles | 1 | | |
| | | Coastal erosion | 1 | | |
| | | Water chemistry | 1 | | |
| | | Carbon species | 1 | | |
| | | Sea ice | 1 | | |
| | | Air quality | 1 | | |
| | | Sand quality | 1 | | |
| | | Wave height | 1 | | |
| | | Subsurface data | 1 | | |
| | | Economic and societal impacts to human communities | 1 | | |

# Conclusion

Many of the respondents are not aware of, or are not using, existing metadata and biological data standards. There is an opportunity for the U.S. IOOS enterprise to move the ocean observation community forward and ultimately facilitate the integration of more biological data into U.S. IOOS by increasing awareness about data standards through outreach and education efforts targeted at the agencies, perhaps through the IOOC. As priorities for incorporating more biological data into U.S. IOOS are set, the Federal agency responses to the survey can be queried to identify tiers of data or datasets that can be most readily incorporated into U.S. IOOS, such as those already using recognized metadata and U.S. IOOS biological data standards.

Results from the second part of the survey were used to generate several lists of variables that would meet the biological and ecosystem observational needs of the responding Federal agencies. Benthic species and abundance were the most frequently occurring observational need identified across all questions. Other frequently identified needs that are not currently U.S. IOOS core variables included marine mammal abundance and species, sound, sea bird abundance, phytoplankton abundance, primary production, and invertebrate species and abundance. These lists of variables were used as the basis for discussions at the expert workshop as described in the companion report *Biological and Ecosystem Observations within United States Waters II: A Workshop Report to Inform Priorities for the United States Integrated Ocean Observing System®*.

# Appendix I

## *Text of Federal Survey Questions*

1. Contact Information.
2. Please check off all Departments/Agencies/Bureaus with which you are affiliated.
3. Please specify the office or offices within your Agencies that you are affiliated with.
    - Please try to be explicit and type the full name of the offices.
    - For Example, if you selected NOAA above, you might list "National Marine Fisheries Service" in line 1 and "Office of Protected Resources" in line 2.

SECTION ONE:

4. For each core biological variable, does YOUR GROUP WITHIN YOUR AGENCY collect, provide or use data?
5. If you answered "Other" for any of the core biological variables in the question above, please provide additional information.
6. For each core biological variable, please indicate how YOU interact with the data.
7. If you answered "Other" for any of the core biological variables in the question above, please provide additional information.
8. For each of the core biological variables that your agency collects, provides or uses, indicate how the metadata are documented.
9. If you are using another format for your metadata not listed above, please describe that format, including information about where to access details and/or a description of the format.
10. After reviewing information provided on IOOS biological data standards respondents were asked the following questions:
    - Were you aware, prior to this survey, of these IOOS biological data standards?
    - Are your data consistent with these IOOS biological data standards?
    - If you answered "No" to the second question, please describe the data standards you use (if any), or please use this space to provide any additional comments:
11. For each of the core biological variables that your agency collects or provides are the data stored on an internal system/database?
12. How do you access the data?
13. What format are the data available in?
14. If “Other” provide the data format(s).
15. If your database is accessible only internally what measures are used to restrict/allow access? (Please insert N/A below if this is not applicable).
16. Is there a mechanism for updating the data/replacing flagged data?
17. Do you track data versions?
18. For each of the core biological variables that your agency collects or provides are the data stored in a public repository/accessible to the public?
19. If you answered “Yes” above please provide a url or link to the data or a description of how the data can be accessed.
20. For each of the core biological variables that your agency collects or provides please indicate if the data are archived at a National Data Center
21. If “Other” please provide the name and a link to the National Data Center where the data are archived.
22. Are revisions to the data made internally also updated in the archived record?
23. Would you be interested in participating with IOOS and other partners in:
    - Making your data compatible with IOOS Standards?

- Helping define, refine, and enhance standards for biological data (to enable interoperability and integration with other like biological data and complementary physical/chemical ocean observational data)?
- Helping develop plans for integration of biological data into IOOS and IOOS standards?
- Comments:

SECTION TWO:
In questions 24 through 28, please indicate the top 5 biological or ecosystem observational needs, excluding the current IOOS core biological variables, which are CURRENTLY NOT BEING MET in YOUR GROUP WITHIN YOUR AGENCY.

24. Need 1
25. Need 2
26. Need 3
27. Need 4
28. Need 5
29. For each of the needs you just identified as not being met please indicate where the problem(s) lies. Check all that applies and please give a brief elaboration of the problem(s).
    - geographic areas of interest contain too few observations
    - too few observations in general
    - data quality
    - data precision
    - timely data availability is inadequate
    - repeated observations over time needed but unavailable
    - funding limitations
    - infrastructure limitations (e.g. not enough boats, aircraft, etc.)
    - lack of data documentation
    - data available in limited format

    Please elaborate on problems or describe additional problem(s) here:
30. For YOUR GROUP WITHIN YOUR AGENCY, excluding the current IOOS core biological variables, what are the top 5 biological or ecosystem observational needs to meet your mission that ARE MET by data collected WITHIN YOUR AGENCY? (i.e., needs that you meet internally).
31. For YOUR GROUP WITHIN YOUR AGENCY, excluding the current IOOS core biological variables, what are the top 5 biological or ecosystem observational needs that MAY NOT BE MET in the FUTURE?
32. If time and money was no obstacle what changes would you make in the data acquisition operations of your bureau?

    For example:
    - Would you conduct repeated surveys in a particular geographic area with particular spatial and temporal sampling over an indefinite period of time?
    - If you would conduct repeat surveys, how would these observations be conducted?
33. In your opinion, other than the current IOOS core biological variables, which biological variables should IOOS consider next for inclusion as a core variable? Please list up to five biological variables and include your reasoning for why they should be considered.
34. Would you recommend others in your agency who might be interested in completing this survey or who might be interested in improving integration of biological data into U.S. IOOS

# Appendix II

## *Question 21 Responses*

"Other" places agencies are archiving their data on the existing core biological variables.

| Answer Options | Database | Count | | |
|---|---|---|---|---|
| ALL core variables | NODC | 3 | | |
| phytoplankton species | NASA Goddard Space Flight Center Ocean Biology Processing Group | 1 | | |
| phytoplankton abundance | NASA Goddard Space Flight Center Ocean Biology Processing Group | 1 | | |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | National Marine Fisheries Service | 1 | | |
| fish abundance | National Marine Fisheries Service | 1 | | |
| | | | | |
| | **Database** | **Count** | **Database** | **Count** |
| ALL core variables | National Geophysical Data Center | 1 | British Oceanographic Data Centre | 1 |
| phytoplankton species | http://seabass.gsfc.nasa.gov/seabasscgi/news.cgi | 1 | | |
| phytoplankton abundance | http://seabass.gsfc.nasa.gov/seabasscgi/news.cgi | 1 | SeaWIFS | 1 |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | https://irma.nps.gov/App/Portal/Home | 3 | Ocean Biogeographic Information System (OBIS) USA | 1 |
| fish abundance | https://irma.nps.gov/App/Portal/Home | 3 | OBIS-USA | 1 |
| | | | | |

| | Database | Count | Database | Count |
|---|---|---|---|---|
| ALL core variables | http://www.epa.gov/storet/about.html | 2 | Environmental Mapping and Assessment Program | 1 |
| phytoplankton species | | | | |
| phytoplankton abundance | MODIS (http://modis.gsfc.nasa.gov) | 1 | | |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | | | | |
| fish abundance | | | | |
| | | | | |
| | **Database** | **Count** | **Database** | **Count** |
| ALL core variables | National Coastal Assessments | 1 | National Aquatic Resource Surveys | 1 |
| phytoplankton species | | | | |
| phytoplankton abundance | | | | |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | | | | |
| fish abundance | | | | |

# Appendix III

## *Public Access to Existing Federal Agency Data on the Core Biological Variables*

| | Database | # | Database | # |
|---|---|---|---|---|
| ALL core variables | http://seabass.gsfc.nasa.gov/ | | http://www.epa.gov/storet/web_services.html | 1 |
| phytoplankton species | http://www.st.nmfs.noaa.gov/plankton | 1 | http://seabass.gsfc.nasa.gov | 1 |
| phytoplankton abundance | http://www.st.nmfs.noaa.gov/plankton | 1 | http://modis.gsfc.nasa.gov | 1 |
| zooplankton species | http://www.st.nmfs.noaa.gov/plankton | 1 | http://www.sahfos.ac.uk/cpr-data.aspx | 1 |
| zooplankton abundance | http://www.st.nmfs.noaa.gov/plankton | 1 | http://www.sahfos.ac.uk/cpr-data.aspx | 1 |
| fish species | http://www.lovelab.id.ucsb.edu/platform_database.html | 1 | http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/data-downloads/index | 1 |
| fish abundance | http://www.lovelab.id.ucsb.edu/platform_database.html | 1 | http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/data-downloads/index | 1 |

| | Database | # | Database | # |
|---|---|---|---|---|
| ALL core variables | NODC | 4 | http://www.usgs.gov/obis-usa/index.html; http://waterdata.usgs.gov/nwis; http://alaska.usgs.gov/;https://www.pwrc.usgs.gov/; http://fl.biology.usgs.gov/; http://nas.er.usgs.gov/ | 1 |
| phytoplankton species | http://oceancolor.gsfc.nasa.gov | 1 | http://oceandatacenter.ucsc.edu/SCOOP/download.html | 1 |
| phytoplankton abundance | http://oceancolor.gsfc.nasa.gov | 2 | http://seabass.gsfc.nasa.gov | 1 |
| zooplankton species | ftp://ftp.nefsc.noaa.gov/pub/dropoff/jhare/EcoMon_Data/ | 1 | http://s3.nprb.org/datasets/e4e739aa-d9d0-4bd1-bf9a-e5845b2f9362/NPRB.2006.30.xml#idm3238880 | 1 |
| zooplankton abundance | ftp://ftp.nefsc.noaa.gov/pub/dropoff/jhare/EcoMon_Data/ | 1 | http://s3.nprb.org/datasets/e4e739aa-d9d0-4bd1-bf9a-e5845b2f9362/NPRB.2006.30.xml#idm3238880 | 1 |
| fish species | http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/queries/index | 1 | http://www.coris.noaa.gov/ | 1 |
| fish abundance | http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/queries/index | 1 | http://www.coris.noaa.gov/ | 1 |

| | Database | # | Database | # |
|---|---|---|---|---|
| ALL core variables | Smithsonian Archive | 1 | http://www.usap-data.org | 1 |
| phytoplankton species | http://www.sahfos.ac.uk/cpr-data.aspx | 1 | | |
| phytoplankton abundance | http://www.sahfos.ac.uk/cpr-data.aspx | 1 | http://oceandatacenter.ucsc.edu/SCOOP/download.html | 1 |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=468824&file=PACN_benthic_fish_metadata_20140225.zip | 2 | http://s3.nprb.org/datasets/e4e739aa-d9d0-4bd1-bf9a-e5845b2f9362/NPRB.2006.30.xml#idm3238880 | 1 |
| fish abundance | https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=468824&file=PACN_benthic_fish_metadata_20140225.zip | 2 | http://s3.nprb.org/datasets/e4e739aa-d9d0-4bd1-bf9a-e5845b2f9362/NPRB.2006.30.xml#idm3238880 | 1 |

| | Database | # | Database | # |
|---|---|---|---|---|
| ALL core variables | https://metacat.lternet.edu/das/lter/index.jsp | 1 | BODC | 1 |
| phytoplankton species | | | | |
| phytoplankton abundance | http://s3.nprb.org/datasets/e4e739aa-d9d0-4bd1-bf9a-e5845b2f9362/NPRB.2006.30.xml#idm3238880 | 1 | http://www.aoml.noaa.gov/phod/sfp/data/ship_obs.php | 1 |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | | | | |
| fish abundance | | | | |

| | Database | # | Database | # |
|---|---|---|---|---|
| ALL core variables | Pangea | 1 | WODselect | 1 |
| phytoplankton species | | | | |
| phytoplankton abundance | NODC | 1 | | |
| zooplankton species | | | | |
| zooplankton abundance | | | | |
| fish species | | | | |
| fish abundance | | | | |

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# Abbreviations

| | |
|---|---|
| BIO-TT | Interagency Ocean Observation Committee Biological Integration and Observation Task Team |
| BOEM | Bureau of Ocean Energy Management |
| CEQ | Center for Environmental Quality |
| DOE | Department of Energy |
| EML | Ecological Metadata Language |
| EOP | Executive Office of the President |
| EPA | Environmental Protection Agency |
| FGDC | Federal Geographic Data Committee |
| GCMD | Global Change Master Directory |
| IOOC | Interagency Ocean Observation Committee |
| ISO | International Organization for Standardization |
| MMC | Marine Mammal Commission |
| NASA | National Aeronautics and Space Administration |
| NCDC | National Climate Data Center |
| NDBC | National Data Buoy Center |
| NEPA | National Environmental Policy Act |
| NGDC | National Geophysical Data Center |
| NOAA | National Oceanic and Atmospheric Administration |
| NOC | National Ocean Council |
| NODC | National Ocean Data Center |
| NPS | National Park Service |
| NSF | National Science Foundation |
| NSTC | National Science and Technology Council |
| OBIS | Ocean Biogeographic Information System |
| ONR | Office of Naval Research |
| OSTP | Office of Science and Technology Policy |
| R&D | research and development |
| SI | Smithsonian Institution |
| SOST | Subcommittee on Ocean Science and Technology |
| USACE | United States Army Corps of Engineers |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| U.S. IOOS | United States Integrated Ocean Observing System |