

# Developing an Online Spatial Bibliography Featuring an Alaska Deepwater Marine Science Case Study

U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
NOAA Research  
NOAA Ocean Exploration

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# Developing an Online Spatial Bibliography

## Featuring Alaska Deepwater Marine Science

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## Executive Summary

This technical memorandum details the process and outcomes of constructing an interactive spatial bibliography and related products, which can help inform baselines for potential ocean exploration work by assessing the biological, chemical, and physical marine science knowledge gaps. By placing literature in a geospatial context and incorporating tools to search, sort, and filter for pertinent information, the interactive spatial bibliography can help researchers understand the state of science in an area.

The case study presented here represents a partnership between NOAA Ocean Exploration (part of NOAA Research), NOAA's National Centers for Coastal Ocean Science (NCCOS, part of NOAA's National Ocean Service), and the NOAA Central Library to support the planning of NOAA Ocean Exploration activities in deep waters (200 meters and deeper) of the Alaska region. This workflow can be applied to other regions and projects to assist in analyzing potential science gaps, project planning, and decision making.

This project resulted in the following products:

- An [annotated bibliography](#).
- Shapefiles for [regional delineations for the annotated bibliography](#), [refined regional delineations for the spatial bibliography](#), and [deepwater delineations for Alaska](#).
- A [spatial bibliography](#) based on the annotated bibliography that uses a web-based interface that aligns sources with the refined regional delineations.
- This technical memorandum, which describes the entire body of work.

The annotated bibliography contains 451 peer-reviewed publications and technical reports from six academic disciplines and seven geographic regions in Alaska as well as institutions from a variety of sectors. This project identified themes of interest to the marine science community as well as key regional data generators and users. Each source was annotated with the following information: academic discipline, geographic region, sampling site (including latitude, longitude, and depth, if available), sample collection method, and sample type (see **Appendix A**).

The spatial bibliography is an online, publicly accessible tool that geographically aligns select sources from the annotated bibliography with their respective region. It allows users to filter sources based on the bibliographic categories in **Appendix A** and provides full citations and links to sources, when available. This tool increases accessibility of the annotated bibliography while also providing a geospatially explicit query platform that can be used to help develop priorities for deepwater ocean exploration and support other decision-making. The interactive spatial

bibliography will support future NOAA Ocean Exploration efforts, such as determining funding priorities and conducting gap analyses.

## Introduction

NOAA Ocean Exploration is leading national efforts to explore the ocean and works closely with partners across public, private, and academic sectors to fill gaps in our basic understanding of the marine environment. This allows us, collectively, to protect ocean health, sustainably manage our marine resources, accelerate our national economy, better understand our changing environment, and enhance appreciation of the importance of the ocean in our everyday lives.

A first step in identifying exploration priorities is a detailed review of existing data, research, and published literature (sources). While existing search tools (such as Google Scholar and Web of Science) enable compilation and review, they do not provide a geospatial context for published sources. Geographically representing the distribution of existing published research efforts in a spatial bibliography enables users to see the work already done in an area and should hopefully eliminate future redundant efforts (Taylor and Nelson 2006; Nelson et al. 2009; Howell et al. 2019).

In this technical memorandum, the authors describe the process of creating an interactive spatial bibliography using a project to identify marine science knowledge gaps in the Alaska region as a case study. The resulting spatial bibliography summarizes research efforts in the region, provides a geospatial context to these research efforts, and allows users to more easily search and sort through sources using the interactive web platform. By making this tool publicly available, the authors hope to support research, reduce duplication of efforts, and improve accessibility to existing literature.

## General Workflow

The following provides a synopsis of the end to end workflow used to construct a spatial bibliography. More detailed descriptions of the methodologies used at each step are in the case study section that follows.

1. **Determine the purpose, scope, and audience for the spatial bibliography.** Establish a clear scope (i.e., research focus and time bounds) before conducting the literature review. A well-defined scale and scope will save time and ensure consistency while conducting the review and building the annotated bibliography, thereby improving the resulting spatial bibliography and web interfaces. Consider the following:
  - Who is the intended audience (e.g., researchers, stakeholders, other federal offices/agencies) and what information would be most useful to them?

- What types of sources should be included (e.g., peer-reviewed publications, gray literature, traditional knowledge, digital datasets, etc.)?
  - What is the range of publication dates that should be included?
  - What are the focal topic(s) or academic discipline(s)?
  - What is the geographic region of interest?
  - What details are important to pull from each source (e.g., academic discipline, research methodology, study species, depth or altitude range, etc.)? Deciding how to categorize the research will help determine what bibliographic data is recorded for each source later on.
2. **Define the geographic boundaries for the spatial bibliography.** Define the geographic boundaries for the region of interest and any particular areas of interest within that region. Consider the spatial resolution appropriate for the product as well. While fine resolution may be important and achievable, it may not be necessary or feasible for all projects. If possible, it is advisable to develop maps or shapefiles defining boundaries early on (either before beginning the review or prior to annotating the bibliography) — doing so will help refine the sources included in the bibliography and improve the bibliographic data extracted when forming the annotated bibliography.
  3. **Conduct a thorough literature review and construct an annotated bibliography.** Use the best available research methods to conduct a thorough review of sources that fit within the defined scope (e.g., search for literature on Google Scholar and in library databases such as Web of Science, ProQuest, and BioOne; reach out to stakeholders; refer to relevant citations within reviewed sources). When possible, include input from stakeholders to identify seminal papers or gray literature that may not have been captured in the initial review. Using the compiled sources, develop an annotated bibliography that includes a short summary, such as the abstract, for each source. Ensure that each source fits within the scope and geographic boundaries established earlier and weed out any that are beyond the scope of the project.
  4. **Extract bibliographic data from sources.** Pull all relevant information from the sources. Consider the scope defined in step 1. Relevant bibliographic data may include the following categories:
    - Citation information (i.e., author, publication year, journal, etc.)
    - Geospatial references (i.e., latitude and longitude if provided)
    - Geographic region
    - Research methodology

- Academic discipline

It is important to clearly define bibliographic categories and ensure consistency across sources (i.e., using the same format for geographic coordinates). Compile all bibliographic data into a format (i.e., table or CSV file) that can be used to build a database and/or link this data to locations in the spatial bibliography.

5. **Build the spatial bibliography.** A spatial bibliography organizes sources in a geographic context. Based on the project’s regional boundaries, develop a (or use an existing) geographic information system (GIS) base layer to form the geospatial context for the sources in the annotated bibliography. The bibliographic data can then be linked to the GIS base layer by building many-to-many relationship tables.
6. **Build the interface for interacting with the spatial bibliography.** This step will allow users to interact with the spatial bibliography by enabling the filtering of categories by feature (see **Appendix A**). Spatial bibliographies can take many forms. They can be designed for web browsers or desktop GIS apps or as hard copy, paper versions with maps and index tables. Determine which format will be most useful given the project’s scope and audience.
7. **Develop and publish metadata for user reference.** Metadata provide detailed information on the “what, where, when, how, who, and why” of each component of the spatial bibliography (Petersen et al. 2019). For example, the metadata record can help a user answer questions such as:
  - What is the intended purpose of this spatial bibliography?
  - Where is the region associated with this spatial framework?
  - When was the spatial bibliography last updated?
  - How was the raw information assembled into a usable geodatabase?
  - Who is the contact for more information?
  - Why is this information useful?

## Case Study for the Alaska Region

### Background

The Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska and subsequent National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone (NOMECS strategy), its implementation Plan, and Strategic Priorities for Ocean Exploration and Characterization of the United States Exclusive Economic Zone explicitly highlight the need for mapping and exploring

the poorly known Alaska region (OPC 2020; IWG-OEC 2022). Alaska was also identified as a priority during the [Workshop to Identify National Ocean Exploration Priorities in the Pacific](#), which was co-hosted by NOAA Ocean Exploration and the Consortium for Ocean Leadership (COL 2020).

Additional drivers for this work include NOAA’s Deep Sea Coral Research and Technology Program funding in Alaska (Hoff et al. 2021), which provided an opportunity to address priority science questions in the region, and the interagency [Seascape Alaska](#) regional campaign that aims to fully map the U.S. waters off Alaska, in support of the NOMECS strategy.

The NOAA Ocean Exploration Alaska Planning Team consisted of staff from divisions across the office and was formed to achieve the following objectives:

- Assess biological, chemical, and physical marine science knowledge gaps to help inform baselines for potential ocean exploration work in coming years.
- Engage in partnerships to determine priorities, leverage capabilities, and transfer knowledge.

To achieve these objectives, the Alaska Planning Team first needed to learn about the current state of science and exploration in the region. As an initial step, NOAA Ocean Exploration hosted “[Community Scoping for Ocean Exploration Science and Information Priorities in Deep Alaskan Waters](#),” a town hall at the 2020 Alaska Marine Science Symposium. The purpose of the town hall was to introduce NOAA Ocean Exploration, meet and learn about the marine science community in Alaska, and begin a dialog about potential areas of collaboration. The next step was to conduct a literature review of studies conducted in the Alaska region, with input from multiple stakeholders, to assess what work had already been done and what work is left to do. The literature review and resulting products are valuable, both internally and externally to NOAA Ocean Exploration, as a collection of scientific knowledge about the Alaska region. These products include:

- [Alaska Exclusive Economic Zone: Ocean Exploration and Research](#) — An annotated bibliography completed in partnership with the NOAA Central Library.
- Shapefiles — [Regional delineations for the annotated bibliography](#) and [deepwater delimitations for Alaska](#) created by NOAA’s National Centers for Environmental Information (NCEI) based on NOAA’s Alaska Fisheries Science Center’s (AFSC’s) survey and



management areas and [refined regional delineations for the spatial bibliography](#) based on the Seascope Alaska regional delineations<sup>1</sup>.

- [Spatial Bibliography of Deep-Water Exploration and Research in Alaska](#) — An online, publicly accessible tool based on the annotated bibliography that uses a web-based interface completed in partnership with NOAA’s National Centers for Coastal Ocean Science (NCCOS) that aligns sources with the refined regional delineations.
- Documentation — This technical memorandum that describes the process and outcomes of the entire body of work.

## Workflow

### 1. Determine the Purpose, Scope, and Audience for the Spatial Bibliography

The Alaska Planning Team determined the purpose of the annotated bibliography was to learn about the current state of marine science in Alaska to identify deepwater marine science knowledge gaps and help guide NOAA Ocean Exploration’s exploration activities. Specifications for sources included:

- Marine waters deeper than 200 meters
- U.S. Exclusive Economic Zone (EEZ) and outer continental shelf
- Publication date between 2000 and 2020
- Academic disciplines of biology, chemistry, physical sciences, geology, marine cultural heritage, and science to support environmental management

Peer-reviewed publications and technical reports by Alaska Native communities, the U.S. government, the Interagency Arctic Research Policy Committee, and other relevant institutions (including international institutions, mainly Canada and Russia)

The purpose and audience for the spatial bibliography was the same as the annotated bibliography, but the scope was narrowed to reflect refined regional delineations (see **Section 2**).

### 2. Define the Geographic Boundaries for the Spatial Bibliography

The geographic boundary for the initial Alaska annotated bibliography was broadly defined as Alaskan waters within the U.S. EEZ. The Alaska Planning Team then had to determine the appropriate spatial resolution and boundaries. Ultimately, the boundaries selected for the spatial bibliography were more general than those used in spatial bibliographies for other regions (see

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<sup>1</sup> The regions were refined to reflect the adoption of the four sub regions of Seascope Alaska during development of the spatial bibliography, which better reflect, yet don’t represent, NOAA Ocean Exploration’s operational priorities.

Taylor and Nelson 2006 and Nelson et al. 2010) due to a lack of community consensus and clearly defined established boundaries in the region at the time of the project. Portions of the Beaufort, Bering, and Chukchi seas all extend beyond the U.S. EEZ, but only the extent of these seas within U.S. boundaries was considered for the spatial bibliography<sup>2</sup>. The spatial bibliography's boundaries differ from the annotated bibliography's boundaries as described below.

## Annotated Bibliography Regional Boundaries

The boundaries for the annotated bibliography (**Figure 1A**) were based on AFSC's survey and management areas (McConnaughey et al. 2020). The resulting seven regions for the annotated bibliography were:

- Aleutian Islands
- Central Gulf of Alaska
- Southeastern Gulf of Alaska
- Eastern Bering Sea
- Northern Bering Sea
- Chukchi Sea
- Beaufort Sea

These boundaries are of a finer spatial resolution than those used for the spatial bibliography (see **Figure 1B**). The finer spatial resolution allowed the authors to capture distinctions in regional scientific priorities, including:

- Inclusion of the northern Bering Sea because it is an area of emerging management interest for the AFSC due to loss of sea ice, shifting biological distributions, and general lack of commercial fishing activities.
- Separation of the AFSC delineation for the Gulf of Alaska into a central and southeastern Gulf of Alaska because both regions were regularly referenced as distinct regions in the sources.

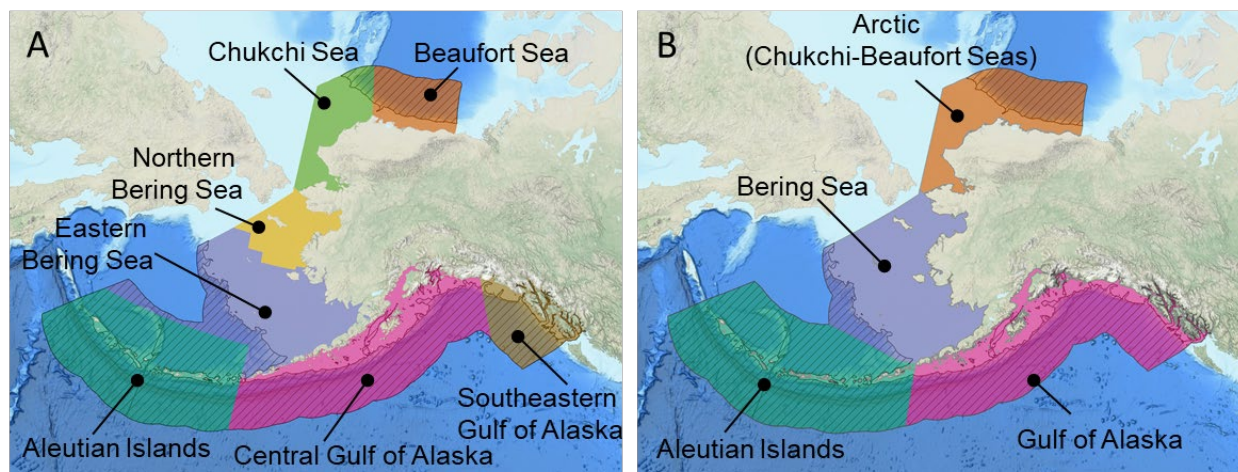
NOAA Ocean Exploration partnered with NCEI to develop shapefiles to provide spatial context for the annotated bibliography (**Figure 1A**). Two shapefiles were necessary: (1) [water depth of 200 meters and deeper](#), developed using the 200-meter contour from the [GEBCO 2019 Grid](#), and (2) [regional delineations](#). The AFSC provided shapefiles for their survey and management areas, which NCEI used in conjunction with the regional delineations established by the Alaska Planning

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<sup>2</sup> The annotated bibliography includes sources with data from the "eastern" Beaufort Sea, but this region is not included on either map, and these sources were excluded from the spatial bibliography.

Team (see bullets above) to build new shapefiles for regional delineations for this project. These files were used in planning documents, presentations, and web pages.

- Two paneled maps with multiple colored polygons displaying the geographical water regions surrounding Alaska and Russia that were used for the left panel (A) to create the annotated bibliography, and in the right panel (B) the spatial bibliography.



**Figure 1.** Maps of regions in Alaskan waters used for (A) the annotated bibliography (produced by NOAA’s National Centers for Environmental Information using NOAA’s Alaska Fisheries Science Center’s survey and management areas) and (B) the spatial bibliography (produced by NOAA’s Integrated Ocean and Coastal Mapping initiative based on Seascape Alaska sub regions). Water depths below 200 meters are denoted by shading. Neither of these delineations are intended to represent NOAA Ocean Exploration operational priorities. Base map and depth delineations source: GEBCO\_2019 Grid.

### Spatial Bibliography Regional Boundaries

During the building of the spatial bibliography, NOAA’s Integrated Ocean and Coastal Mapping initiative released [four sub regions of Seascape Alaska in support of the NOMECS strategy](#). These subregions were derived from Alaska’s large marine ecosystems as defined by the AFSC’s Resource Ecology and Fisheries Management Division. In an effort to maintain consistency with the Seascape Alaska effort, authors adopted these regions for the spatial bibliography even though they differed slightly from those used in the annotated bibliography: the northern and eastern Bering Seas were combined, central and southeastern Gulf of Alaska were combined, and the Chukchi and Beaufort seas were combined into the Arctic (**Figure 1B**). The resulting four regions for the spatial bibliography are:

- Aleutian Islands
- Gulf of Alaska
- Bering Sea
- Arctic (Chukchi-Beaufort Seas)

### 3. Conduct a Thorough Literature Review and Construct an Annotated Bibliography

Partnership with the NOAA Central Library was essential to constructing the annotated bibliography. The library provides [research services](#) to NOAA policy analysts and scientists that include the creation of annotated bibliographies on a region or topic<sup>3</sup>.

The library's workflow was as follows:

1. The library met with the authors to discuss project specifics (e.g., identifying keywords, timeline, examples of sources, etc.). In initial discussions with the library, important topics to cover include purpose, scope, timeline, workflow, and any additional information of interest to capture for each source. The Alaska Planning Team was interested in academic discipline and region of focus, in particular.
2. The library then searched for peer-reviewed literature in library databases (including Web of Science, ProQuest, BioOne, etc.) and additional databases (such as Google Scholar, Dimensions, etc.). The library documented and shared the citations and abstracts for the relevant sources in an EndNote<sup>4</sup> library along with additional requested information, including region of focus, academic disciplines<sup>5</sup>, and major topics of interest within each academic discipline:
  - Biology: fisheries, corals and sponges
  - Chemistry: global carbon cycling, ocean acidification
  - Geology: mapping, bathymetry, tectonic plate reconstruction
  - Marine cultural heritage: human populations that are or were dependent on marine resources
  - Management: climate change impacts, vulnerability of human populations
  - Physical oceanography: currents and circulation, transport of sediment and nutrient
3. The authors refined the library's selection to ensure sources were within scope, noted additional information of interest, and sorted the sources into groups (e.g., Alaska regions).

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<sup>3</sup> After submitting a [request to the library](#), the head of public services assigns one or more librarians to the project, depending on their interest, expertise, and capacity.

<sup>4</sup> While the library hosts reference libraries in EndNote, which is available through NOAA, similar free citation tools, such as Mendeley, are also available.

<sup>5</sup> Full topical discipline summaries are in the introduction to the annotated bibliography.

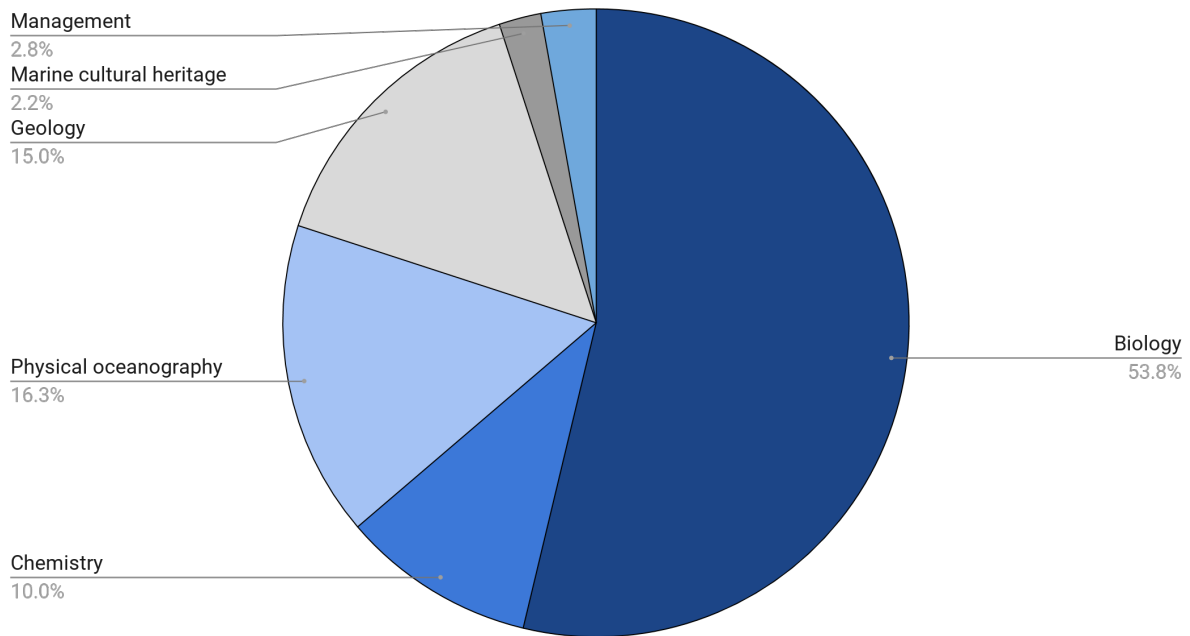
4. The authors identified key regional data generators, including the AFSC and Bureau of Ocean Energy Management (BOEM), and data users, like those at the University of Alaska, a hub for local researchers, and asked them to contribute to the project to ensure all relevant sources were represented. The AFSC and BOEM provided documents and seminal studies that were included as sources in the final annotated bibliography. For example, BOEM provided bathymetry data and maps of the region generated prior to 2000 that were included because they represent a substantial effort in the region and are still useful today.
5. The library located as many digital object identifiers (DOIs), URLs, and full text PDFs as possible for the sources in the annotated bibliography and added them to the EndNote library<sup>6</sup>, which they then exported into a draft document.

The authors added introductory text to the draft document that explains its purpose and scope along with summaries of recurring topics and themes. They then circulated the draft for feedback from the Alaska Planning Team and addressed questions and comments before submitting it to NOAA Ocean Exploration leadership for approval and sharing the final version with the library for publication.

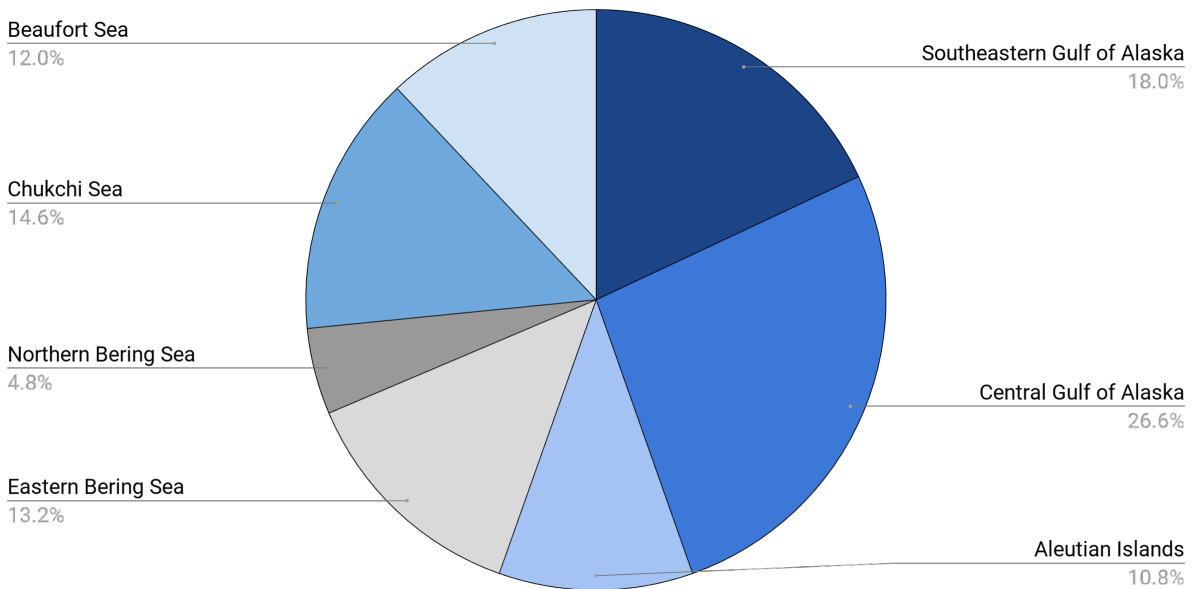
Although not exhaustive, the final annotated bibliography contains 451 sources from six academic disciplines and seven geographic regions in Alaska (see **Figures 2-4**) as well as institutions from a variety of sectors. The library assigned a DOI to the annotated bibliography and submitted it to the [NOAA Institutional Repository](#), making it publicly available. While the PDF version of the annotated bibliography has become dated, the EndNote library is a living resource that can be updated as necessary.

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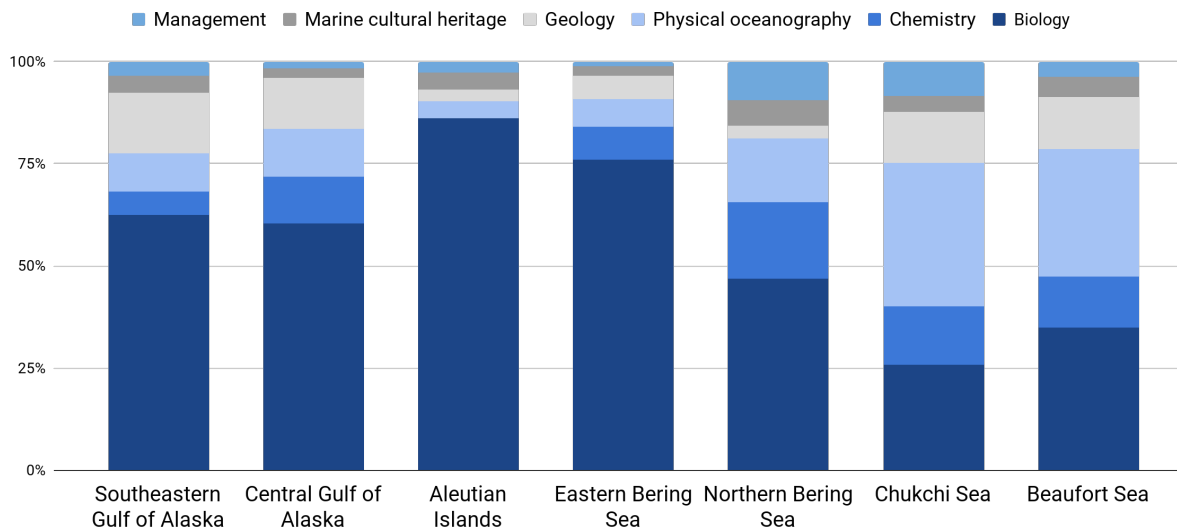
<sup>6</sup> The EndNote library is available upon request.



**Figure 2.** Distribution of studies among academic disciplines as defined in the annotated bibliography (Shinn and Roberts 2020).



**Figure 3.** Distribution of studies among geographic regions as defined in the annotated bibliography (Shinn and Roberts 2020).



**Figure 4.** Distribution of studies among academic disciplines within each geographic region. Academic disciplines and regions are defined in the annotated bibliography (Shinn and Roberts 2020).

## 4. Extract Bibliographic Data From Sources

In addition to the source citations, abstracts, academic disciplines, and geographic regions compiled by the library, the authors manually extracted additional bibliographic data from each source and entered it into a CSV data table for a more comprehensive assessment of existing data and tool development. Data in the following categories were also extracted from each source:

- Sampling site(s) (Location) — Name(s) of specific location(s) where sampling took place, if available
- Geospatial references — Latitude, longitude, and depth, if available; extent and/or point(s) of sampling
- Collection method (Collection) — How the data were collected, e.g., ship-based, autonomous underwater vehicle, mooring
- Sample type (Sample) — What type(s) of sample(s) were collected, e.g., bottom trawl, visual survey)

See **Appendix A** for a full list of “features” used to define data in each of the bibliographic categories.

## 5. Build the Spatial Bibliography

The next step was to combine the bibliographic data extracted from the sources with the GIS spatial layer (the Alaska regional boundaries shapefiles as illustrated in **Figure 1B**) to create a relational geodatabase. To do this, NOAA Ocean Exploration partnered with NCCOS, which has

extensive expertise and experience in creating geospatial tools and spatial bibliographies. All the data and information needed for the spatial bibliography had already been collected for the annotated bibliography, the extracted bibliographic data, in particular<sup>7</sup>. All that was needed was for it to be put into a geospatial context.

NCCOS needed several additional items to create the spatial bibliography on the [NOAA GeoPlatform](#):

- Shapefiles with associated bibliographic data<sup>8</sup>
- A unique citation index (Source ID) for each source (see **Figure 5A**)
- Unique indexes for each feature in a category (e.g., Author 1 through Author N, Region 1 through Region N, etc.) (see **Figure 5B**)
- An intermediate relationship table that has every combination of indexed source and indexed category (e.g., Source1-Region1, Source1-Region2, Source2-Region2, etc.) (see **Figure 5C**)
- A table that has each indexed source with a summary of additional information (see **Figure 5D**)

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<sup>7</sup> The spatial bibliography contains 320 sources from the annotated bibliography as well as other sources collected after the annotated bibliography was published. Some sources in the annotated bibliography were excluded due to lack of relevance (e.g., they were outside of the geographic scope, the eastern Beaufort Sea, in particular).

<sup>8</sup> All products on NOAA's GeoPlatform must comply with NOAA Satellite's Office of Satellite and Product Operations [use of data and products guidance](#).



**A**

SourceID (unique citation index)	Source (full citation)
1	Eisner, L. B. "The Bering Sea: Current Status and Recent Trends." PICES Press 25, no. 1 (Winter 2017): 46-49.
2	Fukuyama, A. K., and J. S. Oliver. "Sea Star and Walrus Predation on Bivalves in Norton Sound, Bering Sea, Alaska." Ophelia 24, no. 1 (1985): 17-36.
3	Alexander, V. "The Influence of the Structure and Function of the Marine Food Web on the Dynamics of Contaminants in Arctic Ocean Ecosystems." Science of The Total Environment 160-161 (1995): 593-603.

**B**

Region (list of all regions)	Region ID (unique region index)
Aleutian Islands	1
Arctic (Chukchi-Beaufort Seas)	2
Eastern Bering Sea	3
Gulf of Alaska	4

**C**

Source ID	Region ID
1	3
2	3
3	3
3	2

**D**

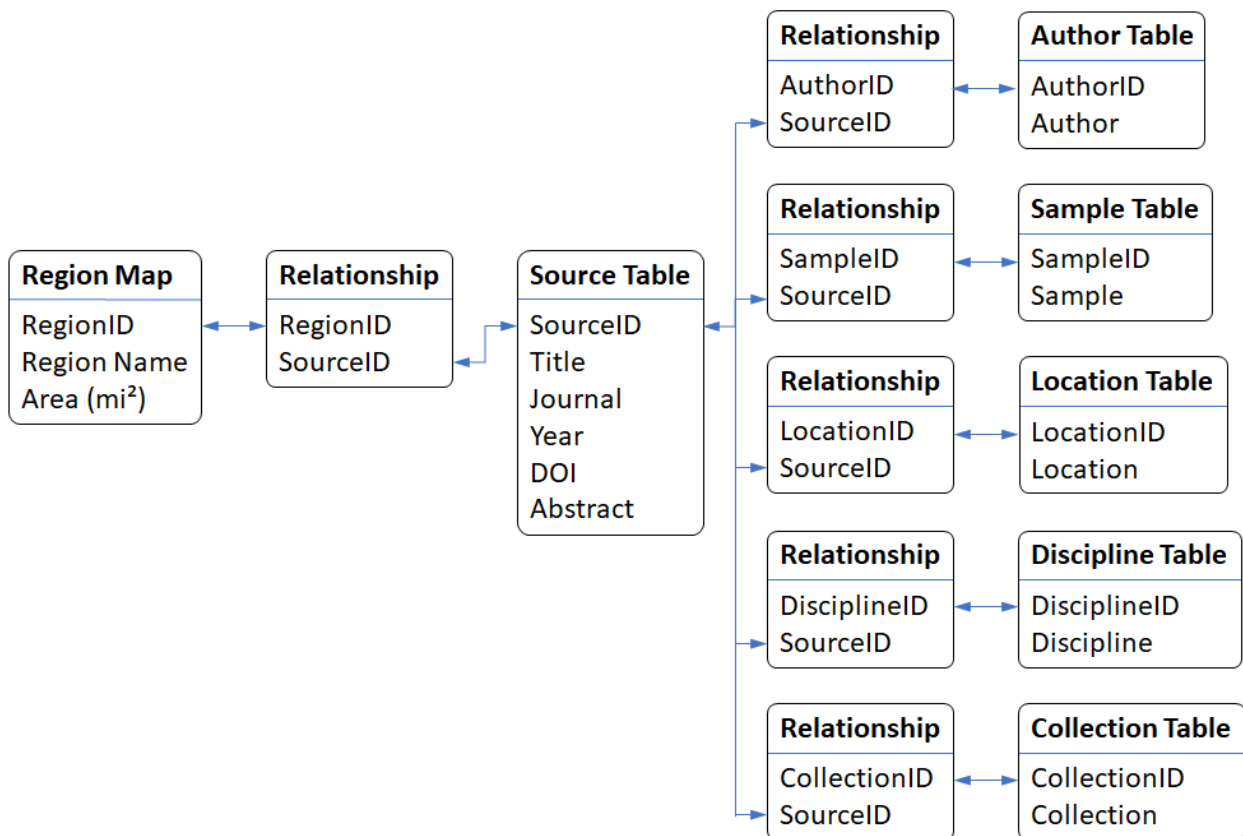
Source ID	Region ID	Region	Location ID	Location	Discipline ID	Discipline	Collection ID	Collection	Sample ID	Sample
1	3	Eastern Bering Sea			6	Physical oceanography	5	Existing Data	20	Climate
1	3	Eastern Bering Sea			1	Biology	5	Existing Data	32	Fisheries
2	3	Eastern Bering Sea	78	Norton Sound	1	Biology	9	Lab-based	11	Bivalve collection
3	3	Eastern Bering Sea			1	Biology	10	Literature review	47	Modeling
3	2	Arctic (Chukchi-Beaufort Seas)		Chukchi and Beaufort Seas	1	Biology	10	Literature review	47	Modeling

**Figure 5.** Representative tables constructed to build many-to-many relationships including (A) an example of a table with each source’s assigned unique citation index (Source ID), (B) an example of a table with unique indices for a category (only the Region category is shown here), (C) an example of an intermediate relationship table combining indexed sources (from A) with the indexed regions (from B), and (D) an example of a table with indexed sources and the other indexed categories.

## 6. Build the Interface for Interacting With the Spatial Bibliography

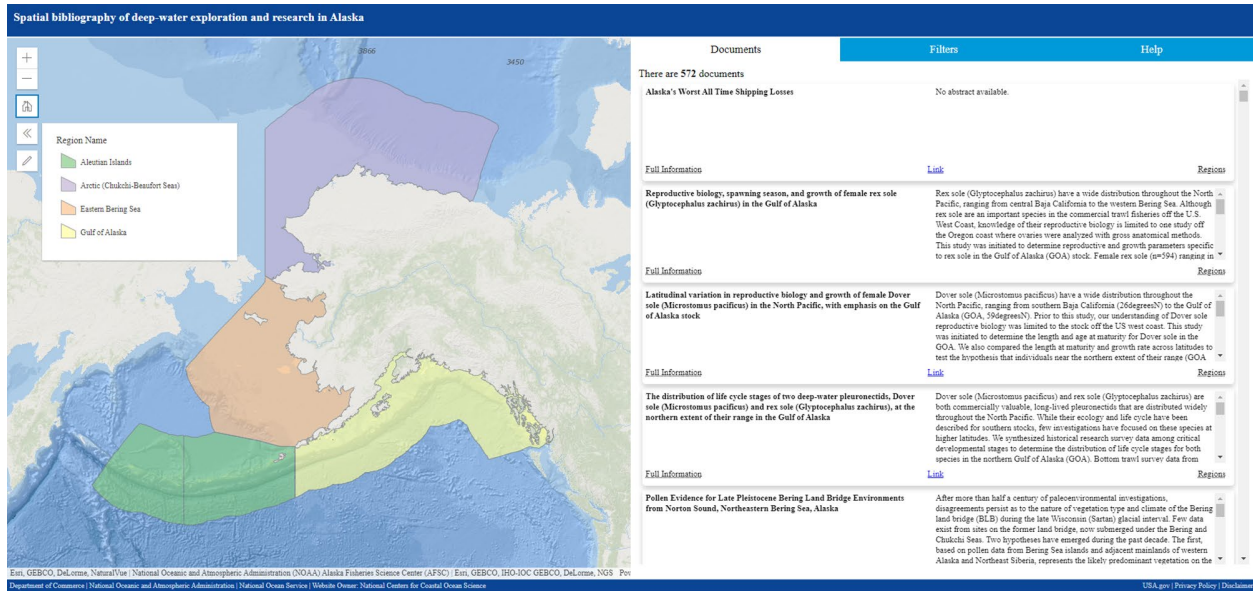
The authors determined a web-based interface would be most useful for allowing the intended audience to interact with the spatial bibliography. This entailed:

- Importing the shapefiles and tables into a geodatabase using the Table to Relationship Class tool in Esri's ArcGIS Online.
- Using ArcGIS Pro to build the many-to-many relationships between the source table and the spatial data and between the source table and the category tables (see **Figure 6**).
- Developing the application using Esri's ArcGIS API for Javascript (version 4.17) and publishing the [spatial bibliography on NOAA's GeoPlatform](#).
- Building the [spatial bibliography's web-based interface](#).



**Figure 6.** Diagram of the relationship schema between the spatial data, the source table, and the filterable categories. Each many-to-many relationship has its own intermediate relationship table to establish the associations between the origin and destination objects.

The interface (**Figure 7**) contains an interactive map showing the geographic regions, “cards” representing each source (document), filterable tables for each bibliographic category, help for the application, and an explanation of the project’s goals.



**Figure 7.** The application interface showing the map and document cards.

The interactive map includes a tool to select single or multiple regions using a point, line, or polygon.

Each document card (**Figure 8**) contains the source title, abstract, and clickable actions; they are each a separate HTML node in the application. Clicking on “Full Information” will reverse the card to show more information about the source, “Link” links to the actual source (if available online). “Region” highlights the region(s) the source covers on the map. The document cards are filtered using Cascading Style Sheets to hide or show the nodes and do not require re-querying the map service, which increases the speed and efficiency of the application.

Tables for each category (Author, Location, Region, Discipline, Collection, and Sample) were added to enable filtering of their features. Each category’s table contains a complete list of associated features, which can be filtered to only show the document cards associated with that feature.

**Latitudinal variation in reproductive biology and growth of female Dover sole (*Microstomus pacificus*) in the North Pacific, with emphasis on the Gulf of Alaska stock**

Dover sole (*Microstomus pacificus*) have a wide distribution throughout the North Pacific, ranging from southern Baja California (26degreesN) to the Gulf of Alaska (GOA, 59degreesN). Prior to this study, our understanding of Dover sole reproductive biology was limited to the stock off the US west coast. This study was initiated to determine the length and age at maturity for Dover sole in the GOA. We also compared

Full Information

[Link](#)

Regions

**Citation:** Abookire, A. A., and B. J. Macewicz. "Latitudinal Variation in Reproductive Biology and Growth of Female Dover Sole (*Microstomus Pacificus*) in the North Pacific, with Emphasis on the Gulf of Alaska Stock." *Journal of Sea Research* 50, no. 2-3 (Nov 2003): 187-97. [https://doi.org/10.1016/s1385-1101\(03\)00062-5](https://doi.org/10.1016/s1385-1101(03)00062-5).

**Authors:** Abookire, A. A., and B. J. Macewicz.

**Locations:** Kodiak Island

**Disciplines:** Biology

**Collection methods:** Ship-based

Title/Abstract

**Figure 8.** The front (top, white background) and back of a document card (bottom, gray background).

## 7. Develop Metadata for User Reference

Metadata is required for all publicly available geospatial data from federal sources collected since 1994, when the National Spatial Data Infrastructure was established by Executive Order 12906. NOAA Fisheries' InPort platform was chosen to host the [metadata record for the Alaska spatial bibliography](#). The InPort platform is readily accessible, user-friendly, compatible with the current metadata standard (ISO Standard 19115), and capable of publishing metadata records to commonly used sites such as data.gov.

## User Feedback

The spatial bibliography was shared with interested partners at several stages during development to improve the final version. For example, AFSC and BOEM provided feedback early on that proved instrumental in determining the scope of sources included in the annotated bibliography and the regional boundaries used for the spatial bibliography. During the initial development of the web interface, staff from NOAA Ocean Exploration's Outreach and Education Division provided feedback that was used to make the interface more user-friendly and appropriate for both scientific and public audiences. The final interface was shared with partners for further feedback regarding the tool's utility and design.

Overall, the users felt that the spatial bibliography is a useful tool that could enable collaboration between NOAA line offices and partner agencies, highlight existing research and resources, and reduce redundancy in NOAA research efforts. To that end, the spatial bibliography was used by the AFSC when developing an [annotated bibliography for the Northern Bering Sea](#). Because their work fits within the context of NOAA Ocean Exploration's larger Alaska project, the authors

updated the Alaska spatial bibliography to incorporate sources from the Bering Sea annotated bibliography.

While further updates are beyond the scope of this project, users did provide suggestions for ways to improve the utility of this and other spatial bibliographies. In general, users:

- Suggested integrating other non-peer-reviewed sources, in addition to white papers, such as local community knowledge (especially tribal knowledge) into future bibliographies.
- Suggested adding a search bar to simplify keyword, location, and/or author searches.
- Identified several aspects of the web interface that were difficult to understand and/or navigate, which could be used to improve future iterations or tools of this nature.

Among the issues identified by users were the following:

- It is difficult to search for authors because sorting is based on first name (first initial) rather than last name.
- The interactive element on the map, which allows users to filter based on a point, line, or polygon, is not obvious or intuitive.
- Some of the language is ambiguous and difficult to interpret (i.e., the sampling method “human survey” could be interpreted as either a human conducting a survey of a location or as an interview of a human subject).
- Filtering on the sample and collection categories is difficult because there are both broad and specific features (i.e., acoustics vs. ADCP, multibeam, and sub-bottom), which makes it difficult to know which to select if interested in a broad topic.
- Duplicate features within a category makes it difficult to filter (e.g., bottom trawl is listed twice in the sample category).

Some of these issues can be avoided by clearly defining all categories and their associated features for users (either in the tool itself or in metadata or supporting documents). Some spatial bibliographies may benefit from a nested interface that allows users to filter based on varying levels of feature specificity. Furthermore, depending on the method used to build the spatial bibliography, quality assurance of the bibliographic data and many-to-many relationship tables is important for removing any duplicative entries or relationships early on.

NOAA Ocean Exploration and users agree that periodic updates of the spatial bibliography would be useful to incorporate new sources. However, it is worth noting that the methodology detailed above requires manual updates to ingest new resources as they become available. This includes manually rebuilding each of the many-to-many relationship tables, which can be a time-

consuming and cumbersome process. If an end goal is to have a readily updated spatial bibliography, it is recommended that a frequency of updates is established and resources are made available. In addition, new resources and processes for automating some of this work should be investigated to save time during initial annotation and future updates. This could include developing pipelines for extracting geographic information from scientific articles (Acheson and Purves 2021).

## Outcomes

The Spatial Bibliography of Deep-Water Exploration and Research in Alaska is a geospatially explicit query platform for peer-reviewed scientific publications and technical reports. It is an interactive tool that allows users to filter sources by author, region, sampling location, academic discipline, data collection method, and sample types. It also provides full citation information and links to the source, if available. More information is on the [NOAA Ocean Exploration](#) and [NCCOS](#) project web pages.

NOAA Ocean Exploration is tasked with exploring the deep ocean. According to the NOME C strategy, ocean exploration “provides a multidisciplinary first look at an unknown or poorly understood area” (OPC 2020). The annotated and spatial bibliographies can inform this work. For example, several studies involved net tows related to fisheries in the central Gulf of Alaska. The information in the bibliographies provides a topic of interest (e.g., life history of commercially valuable fish species) and identifies key data generators (e.g., AFSC and the University of Alaska Fairbanks). If NOAA Ocean Exploration were to conduct future work in the central Gulf of Alaska, the office could review these sources and consider how it can support outstanding science questions and identify potential regional partnerships. This applies to expeditions on NOAA Ship *Okeanos Explorer* as well as the annual competitive grant program and other exploration support mechanisms.

Additionally, the spatial bibliography helps identify where extensive work has been done so NOAA Ocean Exploration can prioritize unexplored areas of interest to the community (e.g., conduct remotely operated vehicle dives along the Aleutian Island chain to validate deep-sea coral and sponge habitat models). By organizing sources and their associated information in a spatial context, users can easily identify what types of studies and data exist in a geographic region. This is powerful for both programmatic and research purposes. As the Alaska region continues to be an area of national interest for topics such as fisheries, deep-sea corals, critical minerals, and geohazards, this tool supports future work by providing geospatially explicit, scientific context to new studies and emerging priorities.

The Alaska spatial bibliography was developed as a case study for identifying existing scientific knowledge and exploring a novel way to compile this information on an interactive web-based

platform. At this time, continued updates to the annotated and spatial bibliographies are beyond the scope of this work. However, the methodology described here can serve as a starting point for others interested in building similar tools for other projects and/or regions.

## Concluding Remarks

The bibliographic products completed for the Alaska region provided an overview of science that had been conducted in the region in a geospatial context. As NOAA Ocean Exploration moves into other regions, similar projects could be useful to identify marine science knowledge gaps and inform exploration efforts that address them. These products highlight NOAA Ocean Exploration's emphasis on community-driven exploration by using the large body of previously conducted work to identify scientific gaps that NOAA Ocean Exploration can help address. Spatial bibliographies can support decisions regarding where NOAA Ocean Exploration and others may be most effective in planning future fieldwork and contextualize the importance of exploration and discoveries.

These products also exemplify a true One NOAA approach, as they resulted in new partnerships and strengthened existing ones. By leveraging existing expertise across line offices, the team was able to create robust products that would not have been possible otherwise.

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# Appendix A. List of Features Within Each Bibliographic Category

## Academic Disciplines (Discipline) — 6 Features

Biology	Management
Chemistry	Marine cultural heritage
Geology	Physical oceanography

## Geographic Regions (Region) — 4 Features

Aleutian Islands	Eastern Bering Sea
Arctic (Chukchi-Beaufort Seas)	Gulf of Alaska

## Sampling Sites (Location) — 129 Features

49 Fathom Pinnacle	Bering Trough
Alaska Coastal Current	Bodfish Island
Alaskan Peninsula	Bogoslof Island
Alexander Archipelago	Bordocinni Island
Alexander Terrane	Bristol Bay
Amatuli Trough	Bristol Bay
Andrews Creek/Stikine Hatchery	Burger Prospect
Azurite Prospect	Cairn Point
Barnabas Trough	Cape Edgecumbe
Barrow	Chichagof Island
Barrow Canyon	Chickamin Hatchery
Beaufort Gyre	Chignik Basin
Beluga River	Chiniak Trough
Bering Canyon	Chirikof Seamount
Bering Strait	Chukchi Borderland

Chukchi Shelf Break	Kaktovik
Coghlan Bay	Kasatochi Island
Colville River	Kayak Island
Cook Inlet	Kelp Bay
Cook Inlet Lease Sale 149	Kenai River
Cook Inlet Lease Sale 244	Kodiak Island
Copper River	Koniuji Island
D4-13A	Kuiu Island
Dillingham Harbor	Kuparuk River
Disenchantment Bay	Kvichak Bay
Dixon Entrance	Lease Sale 193
Eagle Bay	Little Susitna
Eagle River Mouth	Little Takli Island
East Point	Main Talus, Buldir
Endicott Arm	Middle Bay
Fairweather Ground	Mink Island
Fire Island	Monashka Bay
Flaxman Island	Muir Inlet (Glacier Bay)
Frederick Sound	Murray Seamount
Glacier Bay	Naknek River
Gore Point	Navarin Canyon
Homer Spit	Norton Sound
Illiama Lake	Nuiqsut
IODP Site U1417	Nushagak Bay
Islands of Four Mountains	Patton-Murray Seamount
Kachemak Bay	Pervenets Canyon

Pingok Island	Sirius Point, Kiska
Point Hutchinson	Six Mile
Point Mackenzie	Skan Bay
Popcorn Prospect	Smith to Camden Bays
Portlock Bank	Snakehead Bank
Pribilof Canyon	St. George Basin
Pribilof Island	Surveyor Fan
Prince William Sound	Taan Fiord
Prince William Sound, Kachemak Bay, Kodiak Island	Thundering Talus, Kasatochi
Queen Charlotte-Fairweather	Tracy Arm Fjord
Queen Charlotte-Fairweather Fault	Trading Bay
Resurrection Bay	Tugidak Island
Sagavanirktok River	Tuxedni Bay
Salisbury Sound	Unalaska
Samalga Pass	Unimak Island
Seamounts	Unimak Pass
Seward Line	Warwick Seamount
SGaan Kinghlas-Bowie Seamount	Wrangell Terrane
Shelikof Strait	Yakutat Bay
Shumagin	Zhemchug Canyon
Shumagin Planning Area	St. Lawrence Island
Shutter Ridge	Yukon–Kuskokwim Delta
Shutter Ridge	Kotzebue Sound
	St. Matthew Island

## Collection Method (Collection) — 20 Features

Aerial survey	Mooring
Buoy	Museum
Diver	Report
Drifter	ROV
Existing Data	Satellite
Glider	Ship-based
Human Survey	Shore-based
Interviews	Station
Lab-based	Submersible
Literature review	Tagged animal

## Sample Type (Sample) — 93 Features

13C-POC water	Bottom trawl
Acoustics	Bottom trawl
ADCP	Bycatch
Advanced Very High Resolution Radiometer	Camera tows
Animal survey	Chlorophyll
Animal tissue	Climate
Aragonite dissolution	CO2 flux
Atmospheric	Coral
Bathymetry	CTD
Biogeography	Currents
Bivalve collection	Debris
Bones	Digital tide gauges
Bongo net	Drop camera
Bottom pressure recorder	EIA

Expertise	Nutrients
Fish	Observations
Fish	Oceanographic
Fisheries	Octopus
Genetic	Particulate inorganic carbon
Geologic	pCO <sub>2</sub>
High frequency radar	Plankton tow
High-frequency acoustic recording package	Pollution
Human perception	Red king crab
Hydrocarbons	Rock collection
Ice concentrations	Satellite data
Imagery	Sea ice
Imagery	Sea surface height
Isopach	Seabird survey
Landsat	Sediment
Light trap	Sediment
Magnetometer	Sediment cores
Mapping	Sediment traps
Marine mammal	Seismic waves
Midwater trawl	Ship tracks
Modeling	Shipwrecks
Moderate Resolution Imaging Spectroradiometer	Shrimp trawl surveys
Movement	Sills
Multibeam	Snow crabs
Multichannel seismic	Sonar
Net tow	Sponge collection

Stock assessments

Sub-bottom

Subsistence use

Surface trawl

Synthetic aperture radar

Tanner crabs

TKE

Tow nets

Van veen grab

Video

Visual survey

Water

Zooplankton



## Appendix B. Compilation of Alaska Regional Initiatives and Data Sources

Title	Description
<a href="#">Alaska Center for Climate Assessment and Policy</a>	NOAA program to conduct research for informing resource management, planning and public policy, and local climate change adaptation plans
<a href="#">Alaska Open Data GeoPortal</a>	Clearinghouse for geospatial data
<a href="#">Alaska Ocean Observing System Data Portal</a>	Portal containing scientific and management information including real-time sensor feeds, operational oceanographic and atmospheric models, satellite observations and GIS data sets that describe the biological, chemical, and physical characteristics of Alaska and its surrounding waters
<a href="#">Arctic Marine Biodiversity Observing Network</a>	Researcher initiative to build an operational marine biodiversity observation network for the U.S. Chukchi Sea continental shelf
<a href="#">Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiments</a>	Research effort to quantify the physical, chemical, and biological environments of the northern Bering and southern Chukchi seas
<a href="#">Distributed Biological Observatory</a>	Project to develop a change detection array along the northern Bering Sea to the Barrow Arc
<a href="#">Geographic Information Network of Alaska</a>	Portal for the discovery, distribution, and visualization of scientific and spatial data for Alaska
<a href="#">Interagency Arctic Research Policy Committee</a>	Interagency collaboration charged with enhancing scientific monitoring of and research on Arctic issues
<a href="#">MarineCadastre.gov</a>	Bureau of Ocean Energy Management and NOAA partnership to provide an integrated marine information system with data, tools, and technical support for ocean and Great Lakes planning, specifically to support renewable energy siting on the U.S. outer continental shelf
<a href="#">Northern Gulf of Alaska Long-Term Ecological Research Network</a>	Research to investigate the features, mechanisms, and processes that drive northern Gulf of Alaska ecosystem production and foster its resilience
<a href="#">Pacific Marine Arctic Regional Synthesis</a>	Research synthesis effort to assemble written documentation that contributes to understanding the Pacific-influenced coastal shelf ecosystem of the Arctic Ocean
<a href="#">Russian-American Long-term Census of the Arctic</a>	Collaboration between the United States and Russia to collect oceanographic data in the Arctic seas regions shared by both countries
<a href="#">Synoptic Arctic Survey</a>	Researcher-driven initiative aiming to collect empirical data in the Arctic ocean through expeditions and to generate a comprehensive dataset of Arctic systems

Title	Description
<a href="#">Synthesis of Arctic Research</a>	Research effort to leverage interdisciplinary biological and oceanographic research in the Pacific Arctic region for identifying and testing hypotheses that cross scientific disciplines
<a href="#">University of New Hampshire Center for Coastal &amp; Ocean Mapping</a>	Collection of multibeam bathymetry and acoustic backscatter data to support an extended continental shelf
<a href="#">USGS marine ecoregions in Alaska</a>	Files associated with a standard map of mesoscale marine ecoregions for the waters surrounding Alaska