

Identifying Coastal and Submerged Cultural Heritage on the Alaska Outer Continental Shelf



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ABOUT THE COVER

Abandonment of the whalers in the Arctic Ocean, September 1871, including the *George*, *Gayhead*, and *Concordia*. Scanned from the original Harper's Weekly 1871. (Robert Schwemmer Maritime Library, NOAA).

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List of Abbreviations and Acronyms

AFHRA	Air Force Historical Research Agency
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AFN	Alaska Federation of Natives
AHRS	Alaska Heritage Resources Survey
AHS	Alaska Historical Society
ANCSA	Alaska Native Claims Settlement Act
AOHA	Alaska Office of History and Archaeology
AS	Alaska Seafood
ASHSC	Alaska Seismic Hazards Safety Commission
AOCS	Alaska Outer Continental Shelf
ASLF	Ancient Submerged Landform
AAIR	Archaeological Investigation & Research
ACES	ASRC Consulting and Environmental Services, LLC
AWOIS	Automated Wreck and Obstruction Information System
ASN	Aviation Safety Network
BCE	Before Common Era
BLB	Bering Land Bridge
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BP	Before Present
C	Centigrade
CCTHITA	Central Council of the Tlingit & Haida Indian Tribes
CEI	Coastal Environments, Inc.
CEC	Commission for Environmental Cooperation
CE	Common Era
CUI	Controlled Unclassified Information
CMT	Culturally Modified Tree
DSM	Deep Seabed Mining
DPAA	Defense POW/MIA Accounting Agency
DNR	Department of Natural Resources
DOI	Department of Interior
ENC	Electric Navigational Chart
EPA	Environmental Protection Agency
EEE	Equitable and Ethical Engagement

EEZ	Exclusive Economic Zone
FAA	Federal Aviation Administration
FCR	Fire-cracked Rock
GEBCO	General Bathymetry Chart of the Ocean
GIS	Geographic Information System
GPS	Global Positioning System
GOMR	Gulf of Mexico Region
Gray & Pape	Gray & Pape, Inc.
HRA	Historical Research Associates, Inc.
ICF	ICF International
ICA	Institute for Conservation Archaeology
ICCROM	International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOMOS	International Council on Monuments and Sites
ICC	Inuit Circumpolar Council
ICAS	Inupiat Community of the Arctic Slope
km/h	kilometers per hour
LGM	Last Glacial Maximum
LOC	Library of Congress
MOU	Memorandum of Understanding
MMS	Minerals Management Service
MBES	Multibeam Echo Sounder
MOHAI	Museum of History and Industry
NARA	National Archives and Records Administration
NHPA	National Historic Preservation Act
NHHC	Naval History and Heritage Command
NHL	National Historic Landmark
NMFS	National Marine Fisheries Service
NPS	National Park Service
NOAA	National Oceanic and Atmospheric Administration
NOAA ONMS	National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries
NRHP	National Register of Historic Places
NREL	National Renewable Energy Laboratory
NTSB	National Transportation Safety Board
NWS	National Weather Service
NYT	New York Times
NSB	North Slope Borough
NLURA	Northern Land Use Research Alaska, LLC
NAB	Northwest Arctic Borough
NTL	Notices to Lessee
ODHN	Ocean Decade Heritage Network
OE	Office of Exploration

OHA	Office of History and Archaeology
ONMS	Office of National Marine Sanctuaries
OREP	Office of Renewable Energy Programs
OCS	Outer Continental Shelf
PNMHS	Pacific Northwest Maritime Historical Society
POCS	Pacific Outer Continental Shelf
PPW	Potentially Polluting Wrecks
RFQ	Request for Quote
RAC	Russian American Company
SAI	Science Applications, Inc.
SS	Side-scan Sonar
SBES	Single Beam Echo Sounder
SEP	Stakeholder Engagement Plan
SBP	Sub-Bottom Profiler
TOF	The Ocean Foundation
TCPs	Traditional Cultural Places
TLUI	Traditional Land Use Inventory
TRC	TRC Environmental Corporation
UXO	Unexploded Ordinance
UNESCO	United Nations Educational, Scientific and Cultural Organization's
U.S.	United States
USAF	United States Air Force
USAAF	United States Army Air Force
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
USGCRP	United States Global Change Research Program
USN	United States Navy
UAF	University of Alaska Fairbanks
UW	University of Washington
CPNWS	Washington State Archives, Center for Pacific Northwest Studies

Executive Summary

In September 2021, the Bureau of Ocean Energy Management (BOEM) contracted with Gray & Pape, Inc. (Gray & Pape) and its teaming partners Northern Land Use Research Alaska, LLC (NLURA) and ASRC Consulting and Environmental Services, LLC (ACES) to conduct a study to identify coastal and submerged cultural heritage resources in federal waters offshore the State of Alaska. The information was used to develop multiple databases, including an update of a May 2011 list of Alaska shipwrecks. The databases and final report are part of a continuing series of similar baseline studies to evaluate archaeological potential in regions managed by BOEM. For this effort, the study area consists of the entire coastline of Alaska, stretching along the United States (U.S.)/Canadian border westward 200 miles to the end of the offshore planning area or the U.S. Exclusive Economic Zone (EEZ). This study includes documentation of offshore and coastal sites, including those in state waters and inland within the coastal zone, allowing for more comprehensive identification of cultural resources that might be affected directly or as part of ancillary activities related to offshore development. The results of this study will be used in the evaluation of future exploration and development plans, and in the development of future studies aimed at meeting BOEM's information needs.

The primary deliverables for this project were the creation of multiple data entry tables (formatted in Microsoft Excel) identifying cultural heritage resources, which included Alaska Native resources and traditional cultural places (TCP), National Register of Historic Places (NRHP) listed resources, shipwrecks, downed aircraft, coastal pre-contact sites, and potential submerged paleolandforms. The data entry tables correspond with shapefiles in a GIS project; metadata to FGDC standards are included. The combined deliverables will be used by BOEM in identifying specific resources or areas of sensitivity that offshore development may directly or indirectly impact. The database also includes a separate data entry table to capture those remote sensing targets interpreted as potential cultural resources and warranting avoidance and, or further investigation. Multiple approaches were used to identify sites along the Alaskan shoreline and on the Outer Continental Shelf (OCS) and the following report highlights the methods used to develop the individual datasets. Each data set is detailed within the report; however, a brief description of each is described below.

Submerged Paleolandforms Database

The Submerged Paleolandforms Database is a collection of information pertaining to previous sea-level stands and glaciation since the last glacial maximum. It includes environmental data used to assess the preservation potential of possible sites on the OCS and the likelihood that sites will either be exposed at the seafloor or buried below surficial sediments. Submerged paleolandforms are those parts of the formerly exposed landmass that would have been inhabited and or exploited by people and remain preserved following sea-level rise and marine inundation. This information was synthesized from reconstructions and data reported in published papers. As glaciers receded and sea level rose over time, usable land grew in the highlands while it shrank along shorelines, as rising waters inundated the area with seawater, transforming them to a fully marine environment. Using a variety of data to reconstruct these environments is critical for identifying submerged surfaces that are intact and preserve information about the ancient landscapes available for human use. While this database is currently based on publicly available data, it is meant to be expanded as additional research is published and serves as a starting point for delineating higher and lower site occurrence and preservation potential.

Coastal Sites and National Register of Historic Places (NRHP) Databases

The Coastal Sites and National Register of Historic Places (NRHP) Databases are collections of information related to cultural historic sites located along the coast of Alaska. These databases were created thematically, utilizing information from the National Park Service (NPS) listing of NRHP sites and data shared by the Alaska Department of Natural Resources (DNR), and in particular the Office of History and Archaeology (OHA) through the Alaska Heritage Resources Survey (AHRS). The AHRS served as the basis for collecting spatial information on resources, detailing locations of recorded cultural resources sites and districts of all temporal periods.

The Coastal Sites and NRHP databases were developed to capture information on recorded sites ranging from the precontact through historic periods, Alaska Native Tribal resources and TCPs, and coastal heritage places that are listed or eligible for listing to the NRHP. Additionally, the databases were designed to create a record of culturally significant places or resources that may not be identifiable through traditional archaeological survey. As with all the databases from this report, these are meant to be expanded as additional research is undertaken and as resources are identified or reported. Continued collaboration with the Alaska Department of Natural Resources and the Office of History and Archaeology is recommended for maintaining up to date information regarding coastal heritage sites.

In addition to collaborating with State and Federal agencies, this project included engagement directly with Alaska Native communities, Corporations, and Tribes, who were contacted to seek out local subject matter experts and community members to help identify resources or places of cultural significance. Initiating communication and facilitating stakeholder engagement with Alaska Native regions and communities located along the Alaska OCS is necessary to address a more inclusive understanding of significance and allow for the inclusion of Indigenous knowledge. The engagement conducted under this scope of work should be viewed as introductory, and continued engagement and interaction with Alaska Native Corporations, communities, and Tribes is recommended.

Shipwrecks and Downed Aircraft Databases

Prior to the start of this project, a preliminary list of Alaska shipwrecks was created, and last updated in May 2011 by BOEM. BOEM provided copies of the May 2011 table, and an earlier Microsoft Access table, which served as the starting point for the Shipwreck database completed under this scope of work. The Shipwreck database was developed to be consistent, to the extent possible, with Shipwreck databases developed for BOEM's Gulf of Mexico and Atlantic regions. Unique to the Alaska database though is the creation of a data entry table specific to downed aircraft. These two types of cultural resources differ in their physical characteristics, so it was necessary to separate them into distinct data sets. The first task undertaken was to convert the Access table shipwreck list into an Excel format with expanded data entry fields, and then create a standalone data entry table for downed aircraft. Following this, primary and secondary research was completed to collect information on known, reported, and potential shipwrecks and downed aircraft that occurred in the waters off Alaska. Research included collaboration with State and Federal agencies and searches of repositories and local museums, among others, to help collect and update data entries.

As with the other databases created for this study, the information was also processed and made available for GIS analysis. Records were examined for redundancies and all efforts were made to confirm missing data; however, some duplication of records may exist due to multiple sources or variations in spelling. Entries that lack spatial data were included in the tables to facilitate future data entry should spatial information become available. This will negate the need to create and populate a new record, and only the additional spatial data will need to be updated.

Conclusions

The project to identify coastal and submerged cultural heritage on the Alaska OCS was wide ranging in scope, and although extensive, should not be considered complete. All of the data entry tables are built to be updated and expanded. In their present form, models created in this study for submerged paleolandscapes can be used to make initial predictions of potential submerged precontact site locations on the Alaska OCS. Combined with the shipwrecks and downed aircraft information, the resulting tables and GIS can be used by BOEM to make early decisions about survey needs, avoidances, or future study opportunities. Additionally, the creation of the Coastal Sites and NRHP Database can assist in planning purposes for determining impacts from offshore development and identify those areas where early engagement should be undertaken. Maintaining up-to-date databases through continued collaboration with State and Federal agencies is crucial for future database growth. Finally, the newly created anomalies database is intended to capture remote sensing targets interpreted as possible cultural resources.

There are two methods that could be used to update the databases. (1) Data could be added manually to the Excel spreadsheet. XY coordinates in the database coordinate system would need to be calculated to complete the entry. To maintain an up-to-date shapefile, the Excel sheet would need to be converted to a new shapefile in GIS. In this case, the user would also need to regenerate or apply the metadata to the new shapefile to maintain completed metadata status for the database. (2) Data could be added to the spreadsheet and shapefile concurrently. The user would need to add the point to the shapefile manually using Create in the Edit menu of ArcGIS Pro. XY geometry could then be calculated within the attribute table of the shapefile and copied and pasted back to the Excel spreadsheet to complete the database entry.

Because of the additional metadata work and the potential for error or difficulty placing the new point correctly using calculated coordinates, the first method is not recommended.

Preliminary engagement with Alaska Native communities was conducted to identify a more inclusive understanding of cultural significance. Initial feedback from engaged Corporations, communities, and Tribes has been integrated into the resulting GIS. Continued engagement may yield additional information not yet identified in any of the databases.

1. Introduction

For more than 40 years, the Bureau of Ocean Energy Management (BOEM) and its predecessors (Bureau of Land Management [BLM], Minerals Management Service [MMS], and Bureau of Ocean Energy Management, Regulation, and Enforcement [BOEMRE]) have had the authority under the Outer Continental Shelf (OCS) Lands Act to grant leases for the exploration, development, and production of oil and gas and to manage minerals. Further to the OCS Lands Act, BOEM and its predecessors were granted the authority to formulate regulations, as necessary, to carry out the Act. BOEM's permitting process carries with it responsibilities under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA) to balance the country's offshore energy needs with the protection of the "human, marine, and coastal environments." In support of this responsibility, BOEM's regional offices have commissioned various archaeological inventories and analyses to systematically collect and synthesize data for the Gulf of Mexico, Pacific, and Atlantic regions, resulting in the development and maintenance of multiple regional databases (e.g., Coastal Environments, Inc. [CEI] 1977, Garrison et al. 1989, Pearson et al. 2003, TRC Environmental Corporation [TRC] 2012, ICF International et al. 2013). Although BOEM has a list of shipwrecks and associated information for Alaska, the list has not been updated since May 2011. To better support their historic preservation responsibilities, BOEM contracted Gray & Pape, Inc. (Gray & Pape), teamed with Northern Land Use Research Alaska, LLC (NLURA) and ASRC Consulting and Environmental Services, LLC (ACES), to update the May 2011 shipwreck database and develop a comprehensive inventory and analysis of offshore submerged and coastal historic and traditional cultural places (TCPs), traditional use areas, and precontact sites. The purpose of the research is to inform impact assessments and mitigate effects to potentially significant cultural resources. Five primary research objectives were identified by BOEM, including:

- Develop an inventory and database compatible with ArcGIS of known, reported, and potential historic shipwreck and aircraft wreck sites for the Alaska Region.
- Assess potential precontact sites and develop a geographic information system (GIS)-based model to help indicate where intact submerged paleo landforms might be expected to occur.
- Develop a geo-referenced database of known, submerged paleo landforms that could be disturbed or otherwise impacted by offshore infrastructure tied to future exploration and development in the Alaska Outer Continental Shelf (OCS).
- Develop a geo-referenced database of coastal precontact sites that could be impacted by onshore infrastructure tied to future development in the Alaska OCS (or other potential changes to the adjacent seascape and viewshed from future BOEM actions).
- Develop a geo-referenced database of coastal historic and TCPs that could be impacted by onshore infrastructure tied to future development in the Alaska OCS (or other potential changes to the adjacent seascape and viewshed from future BOEM actions).

1.1 Background

As of May 2011, BOEM created a reported shipwreck list for the Alaska OCS, which is available online. The BOEM Alaska Shipwreck Table provided a list of shipwrecks that occurred from the earliest Russian exploration (1741) to 2011 and was compiled from an extensive literature and records search. Working from BOEM's Access database and the subsequent Alaska Shipwreck table (last updated May 2011), the current study updated existing data in the shipwreck list and expanded the database to include new discoveries, shipwreck and downed aircraft names, types, site descriptions, and geology to enhance BOEM's assessment of potential effects to historic resources. The Alaska OCS retains the potential for submerged and coastal precontact sites related to human migration into and settlement of Alaska and the Americas. The database is meant to be a planning and data management tool for BOEM, allowing early

and informed conversations about potential effects to known resources and a repository for historic resources and potentially significant sites identified through cultural resource surveys completed in support of project permitting.

1.2 Previous BOEM Studies

BOEM has sponsored multiple studies to collect information on cultural resources in the OCS within the Gulf of Mexico, Atlantic, and Pacific regions. These studies have been used to help design and guide submerged cultural resource management plans intended to identify the potential for cultural resources on or within the OCS seafloor. A brief overview of the previous BOEM-sponsored investigations conducted within the OCS is presented below and serves as the foundation for the current study.

The Gulf of Mexico has one of the longest histories of archaeological research and modeling of any of BOEM's programmatic regions, beginning in 1977 (CEI 1977). Pearson et al. (2003) represents one of the most recent updates to the model of shipwreck distributions in the Gulf of Mexico, building upon work presented in the Garrison et al. (1989) study. The 2003 study resulted in a reevaluation of the survey strategies and instrumentation recommended by BOEM for use in archaeological surveys. The objectives for the Pearson et al. (2003) study included:

- Update the then existing MMS (now BOEM) Gulf of Mexico Region (GOMR) shipwreck database by examining and reviewing primary and secondary sources for shipwreck information.
- Determine the spatial correlation between reported shipwreck locations in the updated shipwreck database and recorded seafloor hang sites and side-scan sonar targets and anomalies representing potential shipwrecks identified during previous OCS lease block surveys.
- Conduct survey over selected locations where hang sites and reported shipwreck locations appear to correlate to determine if hang sites are shipwrecks.
- Conduct a marine magnetometer survey over several verified shipwreck sites using both the then "industry-standard" proton precession magnetometer, the (as of 2003) "newer" cesium magnetometer, and two other types to determine whether there is a significant difference in their performance in detecting shipwrecks and to assess whether changes are warranted in MMS GOMR survey methodology.
- Prepare a revised predictive model for shipwrecks in the GOMR and recommend survey instrumentation and strategies that would be the most effective in locating previously unidentified shipwrecks.

During the shipwreck database research, information on reported and known shipwrecks in the GOMR was collected from a variety of sources to expand the information presented in the 1989 study. The existing 1989 shipwreck database was revised, and additional attributes were added to include a number of variables on vessel characteristics and circumstances of loss that might aid in wreck identification, if discovered. All of the collected information was incorporated into a relational database (Microsoft Access) and into a GIS program (ArcView) that was used by MMS personnel for the continued assessment and monitoring of shipwreck data in the GOMR. Data on a variety of variables relating to the characteristics of vessels and objects were collected for the over two thousand entries ultimately included in the shipwreck database. The sample of reported shipwrecks was examined in terms of a variety of factors such as year of loss, season of loss, types of vessels, causes of loss, etc., to characterize the population of wrecks that exists in the GOMR.

The collected shipwreck data were compared against other classes of submerged objects, such as reported snags and hangs, to determine if spatial correlations existed. To determine if reported hangs and

unidentified objects equated with shipwrecks, remote-sensing survey and diving were conducted at selected hang sites, unknown objects, unknown vessels, and reported shipwreck locations. The results of the field work for this task did not identify any correlation between reported hang sites or obstructions, raising further questions regarding the accuracy of reported coordinates.

Magnetometer survey work was undertaken as part of the Pearson et al. (2003) study to determine if revisions were needed to the existing survey guidelines provided by BOEM to offshore lessees in support of their National Historic Preservation Act (NHPA) Section 106 permitting obligations. Of relevance to the current study, the results indicated that there is no statistically significant difference between finding a shipwreck in a designated “high-probability” area and finding one in any other area. In the revised model for locating shipwrecks, Pearson et al. recommended incorporating quantitative measures of “reliability” into the positions of loss recorded for reported shipwrecks. The study also found that the various magnetometer sensors performed well in field trials, but that survey transect spacing was found to have a greater impact on survey results.

TRC completed the first comprehensive inventory and assessment of the Atlantic OCS region for BOEM in 2012. The study divided the Atlantic region, extending from the Bay of Fundy in eastern Maine to Key West, into smaller regions based on natural features such as embayments and bights. The study is built upon two earlier studies that were conducted between the Bay of Fundy and Cape Hatteras (Institute for Conservation Archaeology [ICA] 1979) and from Cape Hatteras to Key West (Science Applications, Inc. [SAI] 1981). Both of the earlier studies had examined relative sea-level curves to develop and refine existing models for locating intact precontact deposits and predictive models for locating shipwrecks. The TRC study had two primary objectives:

- Evaluate current theories on precontact settlement patterns, paleoshoreline positions, relative sea-level rise, and regional geology to identify potential areas on the Atlantic OCS where submerged archaeological sites may be located.
- Provide historical context for and construct a database of historic shipwrecks within the Atlantic OCS.

Multiple sea-level curves were identified for the various regions along the Atlantic OCS, and results of precontact site potential research suggested a composite that may be appropriate for general modeling with the understanding that local and regional variation may deviate from the model. The TRC study identified archaeological sensitivity as three separate zones along the OCS, as defined by water depth (TRC 2012:133) and tailored to the individual region:

- No sensitivity: defined as areas where current water depths exceed the potential for subaerial exposure during or since the last glacial maximum (LGM) and were therefore unavailable for human habitation.
- Low sensitivity: defined as areas where water depths correlate with instances of subaerial exposure from the LGM until approximately 13,000 years Before Present (BP) and may but are unlikely to have been subject to human habitation while exposed as dry land.
- High sensitivity: defined as areas where water depths correlate with subaerial exposure during known periods of human occupation since 13,000 years BP.

By correlating precontact archaeological sensitivity to water depths, the database was able to use bathymetric contours to identify zones of preliminary sensitivity that could be easily shown in a GIS format.

The shipwreck database developed as part of the TRC 2012 study was modeled after the Pearson et al. 2003 study (discussed above) and was generated using Microsoft Access (TRC 2012:155); modern iterations of the Atlantic shipwreck database are provided to researchers as a Microsoft Excel table and

Google Earth KMZ. A total of 10,519 entries were recorded in the database, which borrowed many of its attribute types and database codes directly from the GOMR database developed by Pearson et al. 2003. Although the TRC study did identify historic sailing routes and shipping patterns, the discussion was restricted entirely to boats and ships.

Completed in 2013, ICF International (ICF) conducted a study of coastal and submerged site potential in and adjacent to the Pacific Region Outer Continental Shelf (POCS). For this study, the POCS study area consisted of a 1.6-kilometer (km)-(1-mile [mi])-wide strip of land along the modern coastline stretching from the United States (U.S.)/Canadian border to the U.S./Mexican border and extending westward 321.9 km (200 mi) to the end of the offshore planning area, encompassing the entirety of the U.S. Exclusive Economic Zone (EEZ). This differed from previous BOEM studies in the GOMR, which did not extend inland, and the Atlantic OCS, which extended only 0.4 km (0.25 mi) inland from the coast. Extending the width of the coastal resources study area was intended to include a greater number of onshore historic archaeological and built resources, and TCPs, that might be subject to direct or indirect impacts resulting from offshore development. The ICF study was aimed at three objectives:

- Develop paleolandscape reconstructions to help predict submerged prehistoric site locations.
- Conduct research and outreach to identify significant coastal sites.
- Conduct research and outreach to collect information on shipwrecks located in the POCS.

Initial methods used to identify culturally sensitive submerged landforms to predict the potential distribution of submerged precontact sites on the POCS included the following: modeling of modern bathymetry, calculating crustal deformation, modeling ancient stream systems, and analyzing eustatic sea level history and relative sea level. Researchers used this information to construct a GIS-based model for locating potential areas that may contain precontact sites and suggesting areas most likely to have remained intact through the marine transgressive processes. The predictive modeling was a two-part process that began by creating a GIS-based paleolandscape model showing the extent of formerly subaerial lands on the POCS during the LGM (defined for the Pacific as 19,000 years BP). The second part of the process projected the positions of eustatic shorelines at each millennium since the LGM onto the maximum paleolandscape extent model.

The identification of coastal properties was undertaken to assemble a database of known archaeological sites, TCPs, and historic-built resources along the coasts of California, Oregon, and Washington that have the potential to be adversely affected by future offshore development activities. Coastal resources identification included research at state repositories for archaeological and built environment cultural resources, Native American Tribal outreach, and consultation with experts in the archaeology and ethnography of the Pacific coast and historical interest/preservation groups. Online research was conducted to identify additional sensitive landscapes along the coast, such as state and national parks, preserves, national monuments, and Tribal reservations. Locational and basic descriptive data for each identified resource was entered into a GIS-linked database to aid BOEM in future project planning in the POCS.

The coastal resources research resulted in the identification of 2,383 coastal cultural resources with the potential to be impacted by future offshore development projects, including 683 archaeological resources, 1,719 built environment resources, and 78 culturally significant places. It was also recognized by the study that many archaeological resources and TCPs may not be listed in a state or national register. Further, the study identified areas and locations where sensitive resource types are concentrated. As no fieldwork was conducted during this study, the ocean view from these resources was not confirmed, their current condition was not verified, and resources not previously determined to be historic were not surveyed and evaluated.

Researchers conducted primary and secondary research to collect any information on known, reported, and potential shipwrecks that occurred in the waters off California, Oregon, and Washington. In addition to research, the study authors consulted with maritime archaeologists, historians, shipwreck researchers, and other interested individuals. The study identified 5,813 vessel records for reported losses; some duplication of records was anticipated due to multiple sources and variations in spelling. The shipwreck data were entered into a Microsoft Access database and GIS.

In 2013, BOEM entered into an interagency agreement (IAA No. M13PG00018) with National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries (NOAA ONMS) for compiling and analyzing cultural resource data for the marine environment surrounding the main Hawaiian Islands, which are included within BOEM's Pacific OCS region. The interagency agreement defined three objectives to facilitate the management and protection of cultural resources and places and enhance agency communication with local communities:

- Develop a database of known, reported, and potential submerged cultural resources e.g., shipwrecks, submerged aircraft.
- Develop a database of land-based historic resources that could be adversely impacted by the alteration of the view of the ocean.
- Develop a proactive approach with Indigenous Native Hawaiian communities in identifying areas of cultural significance.

Relevant to the current study is the inclusion of submerged cultural resources other than shipwrecks in the database; downed aircraft were explicitly included as a submerged resource type. The completed study included a contextual background for the Polynesian discovery and settlement of the islands, and descriptions of selected near-shore Hawaiian resource types but did not provide an inventory of Native Hawaiian submerged resources per se, as the study's authors state that describing these living practices and traditions in terms suitable to "property" lists is considered to be inappropriate. Instead, information regarding marine locations that are culturally important to gathering and fishing activities were traditionally the responsibility of specific *konohiki* (resource managers) or families and individuals, and not suitable for general distribution. The historic and archival research for submerged cultural resources, however, identified 2,120 sites within the study area, including lost aircraft, watercraft, motor vehicles, Amtrak train losses, and other unspecified resources.

As the NOAA 2017 study identified, characterizing areas as being culturally sensitive or having cultural meaning may contradict local practices. Recognizing that not all sites can or will be shared with regulators, Van Tilburg et al. (2017) developed guidelines for characterizing Native Hawaiian cultural resources and places. Through an examination of three case studies, the authors sought to collaborate with Native Hawaiian communities to test their framework to a limited degree for efficacy, specifically on issues related to methodology, data collection, and processes. The case studies took place in three different traditional Hawaiian land areas, Waikīkī, Waialua, and Lānaʻi. Each area was specifically selected based on being a different type of land area: Waikīkī is a single *ahupuaʻa* (land division usually extending from the uplands to the sea), Waialua is a *moku* (island district), and Lānaʻi is a *mokupuni* (island). In each case, community groups were identified to advise the case study; their role in the project varied based on the individual case study.

There were no specific development projects associated with the case studies, therefore it was not possible to test all elements of the proposed framework. The case studies were limited to assessing effective methods, data collection, and processes for data collection. As a result of the study, the authors were successful in demonstrating the role of Native Hawaiian communities as valuable partners in gathering and aggregating important cultural information. The level of agency involvement or other professional staffing needs necessarily vary from community to community, but there is little doubt that communities have an impressive level of capacity that warrants the attention and respect of both the

public and private sectors. This capacity, coupled with the extraordinary cache of Native Hawaiian language resources and primary historical documents, emphasized that any project that ignores traditional and local knowledge and does not utilize local ethnographic experts may not adequately meet the “best data available” standard set forth under NEPA, or the “good and reasonable effort” standard required under Section 800.4 of the NHPA.

Conducted as a companion to the NOAA 2017 study, Watson et al. (2017) conducted independent research at the State of Hawai‘i Historic Preservation Division and related collections to develop a report and digital file of terrestrial resources that may be visually affected from offshore renewable energy siting. The data collected included historic and archaeological information related to all resources, including those nominated to—or determined to be eligible for listing on—the National Register of Historic Places (NRHP), compiled into a geographic inventory. Additionally, the authors drew from a breadth of Hawaiian language resources to develop a unique thematic inventory consisting of two subcategories, including: “akua viewsheds” or viewsheds that are significant through their historic association with spiritual figures or deities; and “ali‘i viewsheds,” which are viewsheds that are culturally significant through their association with Hawaiian chiefs. While there is some overlap between the categories, the latter category was primarily developed through Hawaiian language resources, chants, mo‘olelo (stories), and other products of Native Hawaiian, intangible cultural heritage, highlighting the value of both native language and oral history resources in identifying culturally significant places.

The previous studies conducted on behalf of BOEM and its predecessors demonstrate an expansion of the concept of submerged cultural resources and resources management. While many of the earliest studies focused on protecting shipwrecks, the concept of historically significant resources has expanded with each new regional database to include downed aircraft and submerged landscapes. Most of the regional studies demonstrated an early awareness of the potential for submerged precontact sites associated with areas on the OCS that were previously exposed as dry land. More recently, though, it has been demonstrated that physical assemblages of archaeological material do not represent the entirety of historically or culturally significant places in the OCS. Based on the collective work of NOAA (2017), Van Tilburg et al. (2017) and Watson et al. (2017), a new paradigm was developed in approaching the identification of culturally significant sites in Hawai‘i. Previously, archaeological inventories focused on archival and historic research to identify things and sites within the OCS, but the 2017 studies demonstrated that standard methods alone are largely insufficient in identifying places of historic significance to Indigenous populations.

The previous BOEM regional databases provided multiple lessons learned that were applied to the design and construction of the Alaska OCS database. First and foremost, the database is designed to accept points, polygons, and polylines, allowing locations to be shown as coordinate-based points, such as for shipwrecks, or polylines, such as those used to illustrate retreating shorelines associated with sea-level change over time. Further, the Alaska OCS database includes multiple data entry tables, tailored to the specific resource type. Minor issues with earlier databases were also addressed, such as correcting the coordinate entry columns so that all entries use the same coordinate system and therefore appear as data points in corresponding shapefiles. The inclusion of resources along the coastal zone and shoreline, and state waters, allows for a more comprehensive view of proposed undertakings and their ancillary activities. The incorporation of sites along the shoreline also addresses feedback given by engaged parties about their concern for coastal sites threatened by changing climatic conditions. Finally, the inclusion of polygons allows for the identification of areas of interest to Alaska Native communities or other Consulting Parties who may not wish to provide specific locational information regarding culturally sensitive resources but creates a mechanism to identify their area of interest so BOEM can engage that party at an early stage.

1.3 Engagement

To compile database content and meet project goals for BOEM, it was necessary to partner and collaborate with a broad group of entities. The groups, agencies, and communities that were contacted and collaborated with on this project fall into three groups: Federal Agencies, State Agencies, and Indigenous Communities. Each of these entities has different jurisdictions, responsibilities, and historical and cultural connections that contribute to defining key considerations for BOEM.

1.3.1 Federal

Multiple federal agencies were consulted to help develop content for BOEM's Alaska databases based on their unique perspectives, jurisdictions, or historical connections to the project area as a significant part of Alaska is held as public land (Figure 1-1). For instance, the National Park Service (NPS) helped to corroborate areas of Park Service jurisdiction and provided cultural context for resources located within National Parks. NPS maintains a regulatory interest in projects planned near or adjacent to NPS units and usually seeks participation in the consultation process.

Additional federal agencies were consulted due to their ongoing research within the Alaska OCS or due to a historical connection to the region. The National Oceanic and Atmospheric Administration (NOAA) does offshore survey work, and while much of that work is geared towards bathymetric mapping or biological surveying, they have also conducted historical and archaeological surveys. The Naval History and Heritage Command (NHHC), U.S. Coast Guard (USCG), Defense POW/MIA Accounting Agency (DPAA), and the Air Force Historical Research Agency (AFHRA), were all collaborating partners that helped provide historical and cultural contexts representative of their agencies and missions in the Alaska region. More detailed information regarding individual agency contributions is discussed in subsequent report sections.

1.3.2 State

The State of Alaska is responsible for coastal waters out to the 5.5-km (3-nautical mi) mark but also collects and monitors data beyond the state/federal boundary, making it necessary to work directly with the State to help develop content for each of the databases. The Alaska Department of Natural Resources (DNR) was a direct collaborator in developing and updating content for databases. In particular, the Office of History and Archaeology (OHA) helped to provide extensive data for content development. As will be referenced frequently throughout the report, the OHA's Alaska Heritage Resources Survey Mapper (AHRS) tool was used extensively throughout the research process. The AHRS Mapper tool is the visual, spatial interface, detailing locations of recorded cultural resources sites and districts of all temporal periods on a variety of background layers. Through the AHRS Mapper, eligible users can retrieve AHRS site record information and follow links to other relevant information, such as National Register Nominations, Determinations of Eligibility, Document Repository, and AHRS References modules. Use of AHRS by the authors was granted following a review of credentials and allowed for database content development. Explicit location information contained in the AHRS is considered confidential and is, therefore, not displayed in this report. Further sections include contextual information derived from the use of the AHRS.



Figure 1-1. Map of public lands in Alaska (Source: National Park Service)

1.3.3 Indigenous Communities

ASRC Consulting and Environmental Services, LLC (ACES) was tasked to organize, communicate, and facilitate stakeholder engagement with Alaska regions and communities located along the Alaska OCS to identify areas of cultural and historical importance or concern. With project engagement, this study emphasized working with Alaska Native communities to seek out local subject matter experts and community members to help identify sources of cultural significance. The database was designed to allow for the inclusion of Indigenous knowledge without requiring exact locations, which may be sensitive. Indigenous knowledge can be defined as knowledge that is culturally and or spatially context specific, collective, holistic, and adaptive (Mistry 2009).

BOEM implements Tribal engagements through both formal government-to-government consultations and informal dialogue and collaborations. In addition to Tribes, consultation with Alaska Native Claims Settlement Act (ANCSA) Corporations is required (BOEM 2018). Agencies are directed to conduct Tribal consultation in a meaningful and good-faith manner before and outside the public process, and to follow up with Tribes and ANCSA Corporations about the results of the consultation (Brooks 2022). Through these federal consultation policies, the project team designed the stakeholder engagement process to be open and transparent in its approach to presenting the project and provided opportunities for information exchange.

BOEM database development involved gathering information throughout the entirety of the Alaska OCS. The stakeholder engagement effort reflects the project methodology by designing the engagement process to include regions along the Alaska OCS. Letters of request for regional and community engagement were sent to the following ANCSA Regions:

- North Slope Alaska
- Northwest Alaska
- Bering Straits Region
- Southwest (Yukon-Kuskokwim)
- Aleutians Islands
- Kodiak Island
- Cook Inlet Region
- Southeast Alaska

If regional leadership recommended local travel for engagement, coordinating meeting(s) in the regional hub communities would be done first. Once engagement in hubs was completed, the next steps would follow the regional leadership recommendations for additional contacts (i.e., engagement in local communities). Examples of regional hubs for community engagement included:

- Utqiagvik
- Kotzebue
- Nome
- Bethel
- Unalaska/Adak
- Kodiak
- Anchorage (other neighboring communities)
- Juneau

1.4 Report Structure and Terminology

This report is organized into ten numbered chapters. Chapter 1 gives an overview of the study's background and objectives and previous BOEM-related OCS database studies. Chapter 2 presents an overview of marine and terrestrial site formation processes that impact the preservation potential of all resource types identified within the final inventory and database. Chapter 3 includes a discussion of the submerged paleolandforms database, including the oceanographic and environmental data used in its construction. Chapter 4 presents a discussion of the coastal precontact database and an overview of the precontact cultural traditions most likely to have occupied the now submerged federal waters portion of the Alaska OCS. Chapter 5 provides an overview of the historical context for the shipwreck and downed aircraft databases and describes the methods and data sources used in constructing the databases. Chapter 6 includes a discussion of NRHP eligibility for historic vessels, historic aircraft, and Traditional Cultural Places (TCP) and describes the data sources and methods used in constructing the database for the NRHP coastal places. Chapter 7 presents a summary of the database for previously recorded anomalies that potentially represent significant cultural resources. A description of Alaska Native engagement activities is provided in Chapter 8. Conclusions and recommendations are presented in Chapter 9. References cited follow in Chapter 10. Six appendices (A–F) follow. Appendices A–D include the definitions for each column of data, including the attribute name, information to be captured in the column, and all drop down menu options or abbreviations and their full meaning for the four database tables (Coastal Precontact and NRHP; Historic Shipwrecks; Downed Aircraft; and Anomalies). Appendix E is a listing of historic shipwreck sources and their corresponding abbreviations, which were developed for use in the original draft BOEM Alaska shipwreck database and imported into the current historic shipwreck database. Appendix F provides supplemental information on geophysical remote sensing and interpretation, to support the anomalies data entry table discussed in Chapter 7.

In preparing this report, it was understood that the project area, including the State of Alaska and its surrounding waters, encompass a diversity of Alaska Native communities and that the use of certain terminology may be perceived as inappropriate or insensitive to some audiences. Wherever possible, the report uses culturally appropriate language and preferred spellings. Where necessary, terms and names are used as presented in the source documentation; some of the terms used in this document are rooted in former industry standards and regulatory language. While the report encourages the use of inclusive terms, some of the nomenclature used in this report may be outdated or based on standard terms used in law, regulation, and policy. The AHRS data, specifically that cited in Chapters 4 and 6, are referenced in this report using the categories and terminology as they appear within State of Alaska records to maintain consistency and reduce confusion or the need for manual editing of data entry tables with subsequent updates. Although the current version of NPS National Register Bulletin 38 specifically refers to “Traditional Cultural Properties”, that term does not appear in law or regulations and is instead a vernacular term commonly used in historic preservation and Section 106 compliance (BLM n.d.). The term “property” can carry inferences to land ownership that may not be compatible with the term’s use in describing places of traditional religious or cultural importance, therefore this report uses the term “place” instead of “property.”

1.5 Database Table Attribute Data Definitions

The scope of work for this project was to satisfy five primary research objectives. These objectives were to create database tables, formatted in Microsoft Excel, and a georeferenced dataset (NAD83), for content specific to the following cultural resources:

- Assessment of potential precontact sites and development of a GIS-based model to help indicate where intact submerged paleo landforms might be expected to occur (Sections 1.5.1 and Section 3).

- Development of a geo-referenced database (NAD83) of coastal precontact sites that could be impacted by onshore infrastructure tied to future development in the Alaska OCS (Section 1.5.2 and Section 4).
- Development of a geo-referenced database (NAD83) reported and potential historic shipwreck and downed aircraft wreck sites for the Alaska Region (Section 1.5.3 and Section 5).
- Development of a geo-referenced database (NAD83) of coastal historic and TCPs that could be impacted by onshore infrastructure tied to future development in the Alaska OCS (Section 1.5.4 and Section 6).
- Development of a geo-referenced database (NAD83) for survey anomalies in the Alaska Region (Section 1.5.5 and Section 7).

Each of these database tables will be discussed in depth in the following chapters and are introduced below. Additionally, a brief discussion of the GIS data structure will be available in Section 1.5.6 and will also be mentioned in each of the appropriate sections.

1.5.1 Submerged Paleolandforms Database

Submerged paleolandforms refer to those parts of the continental shelf that were exposed as dry land during the Late Wisconsin glacial period when sea-levels were globally lower than at present; this time period is also referred to as the last glacial maximum (LGM). Following the LGM a warming climate and melting glaciers resulted in sea-level rise that inundated the continental shelf, submerging the formerly exposed landscape that would have been inhabited and or exploited by people. The processes associated with marine inundation contributed to preferential preservation of landforms that may contain evidence of these early populations. The Submerged Paleolandforms Database is therefore a collection of information pertaining to previous sea-level stands and glaciation since the LGM. The inclusion of environmental data allows for an assessment of the preservation potential of possible sites on the OCS and the likelihood that sites will either be exposed at the seafloor or buried below surficial sediments. While this database is based on publicly available data, it is meant to be expanded as additional research is published and serves as a starting point for delineating higher and lower site occurrence and preservation potential. The methods and resources are detailed in Chapter 3. The data are formatted as polyline contours and raster graphics in the report.

1.5.2 Coastal Sites and NRHP Database

The Coastal Sites and NRHP Database is a standalone collection of information pertaining to offshore sites, and sites located within a 160-km (99.4-mi) buffer of the shoreline of Alaska. The shoreline is defined by using the U.S. Census Bureau's 2020 TIGER shapefile for the Alaska coastline (U.S. Census 2020). Any following reference in this report to a study area buffer references this shapefile from the U.S. Census Bureau to define the shoreline for Alaska. The Coastal Precontact database, formatted in Microsoft Excel, is the result of a collaborative effort with the State of Alaska to identify locational and contextual information of precontact sites located on the coast or within a 160-km (99.4-mi) buffer of Alaska's coastline. Additionally, efforts to document Alaska Native Tribal Sites, from the perspective of Alaska Native communities is discussed. As with the other databases, this database is meant to be constantly updated as additional information becomes available. The methodology for the Coastal Sites Database creation, the data sources researched and used to populate the database, and potential GIS-related productions based off the data collected are detailed in Chapter 4.

1.5.3 Shipwreck and Downed Aircraft Database

The Shipwreck and Downed Aircraft Databases are standalone collections of information pertaining to offshore and nearshore sites located in Alaska. Although similar in historic and contextual properties, it

was determined to separate the two cultural types into two database structures, each with a unique set of attributes.

1.5.3.1 Shipwreck Database

The Shipwreck Database is a standalone collection of information pertaining to lost vessels of all types that are near or off the coast of Alaska. This database, formatted in Microsoft Excel, is separate from other databases and is the result of a collaborative effort to identify locational, historical, and physical contextual information of vessels lost or sunk off the coast of Alaska, extending out to the EEZ. This database is meant to be constantly updated as additional information becomes available. Section information includes a description of the methodology used for creating the Shipwreck Database, sources researched and used to populate the database, and GIS-related productions based in the data collected.

1.5.3.2 Downed Aircraft Database

The Downed Aircraft Database is a standalone collection of information pertaining to lost aircraft of all types that are near or off the coast of Alaska. This data entry table, formatted in Microsoft Excel, is separate from other data tables and is the result of a collaborative effort to identify locational, historical, and contextual information of aircraft crashed or lost off the coast of Alaska, extending out to the EEZ. This database is meant to be constantly updated as additional information becomes available. Section information includes a description of the methodology used for creating the Downed Aircraft Database, sources researched and used to populate the database, and GIS-related productions based in the data collected.

1.5.4 Coastal Sites and NRHP Database: NRHP Database

The Coastal Sites and NRHP Database is a listing of sites within Alaska and refers to sites located within 160-km (99.4-mi) of the modern shoreline or within state and federal waters that are listed in or eligible for listing to the NRHP. This data entry table is formatted in Microsoft Excel. No fieldwork was done to confirm eligibility determinations, and no determinations were made or recommended as part of this scope of work. This database is meant to be constantly updated as additional information becomes available.

1.5.5 Survey Anomalies Database

The Survey Anomalies Database is a separate database and is intended as a forward-looking tool to be maintained by BOEM. Magnetic anomalies, side scan sonar targets, or other features identified as potential cultural resources from other geophysical data sets have and will continue to be identified from remote sensing surveys. When reports submitted to BOEM in compliance with Notices to Lessee (NTL)-directed surveys contain targets that may represent submerged cultural resources, their attributes can be added into this data entry table, formatted in Microsoft Excel, and displayed within the GIS. By plotting these features, BOEM can identify targets where additional information may be necessary in advance of planned or proposed surveys, or where exploration or studies may be warranted.

1.6 GIS Data Structure

A key component of the current project was the development of a GIS-based inventory and related mapping documentation of known, reported, and potential historic places, precontact sites, and other cultural and historic resources important to Alaska Native Tribes and corporations and other stakeholders (BOEM 2021a, 2021b). Additionally, an assessment of potential precontact sites and locations, and the development of a GIS-based model to indicate where intact submerged paleolandforms might be located, was created as part of the final deliverables for this project (BOEM 2021a, 2021b). Georeferenced

databases delivered to BOEM upon project completion included metadata and shapefiles compiling the resources for known and recorded sites documented during the project. All data used to produce the maps, databases, and specific layers, including a geographic footprint of the study area, are included as part of the georeferenced database deliverables (BOEM 2021a). Differences in the content available for each georeferenced database are discussed in subsequent sections.

To ensure coordinates and projection were universal for all of Alaska, The North American Datum 1983 (2011) Alaska Albers (Meters) coordinate system is used for all maps and generated databases (EPSG 2024). Point geometry was calculated within the GIS after points were entered and projected from their original source coordinates. Thus, both tables and GIS files contain the location information in a consistent coordinate system, enabling multiple update methods and regeneration of the shapefile from textual data as needed. Source data often presented locations with latitude and longitude, and with various datums. In case of errors in projection or original recording, we have preserved coordinates from source material under the column headings “Original Coordinate System”, “Original X,” and “Original Y.” It is recommended to continue preserving original coordinate data for database updates for the same reasons. For items that were polygons or lines in the original data source, the centroid point was calculated to serve as representative within these point databases.

There are two methods that could be used to update the databases. (1) Data could be added manually to the Excel spreadsheet. XY coordinates in the database coordinate system would need to be calculated to complete the entry. To maintain an up-to-date shapefile, the Excel sheet would need to be converted to a new shapefile in GIS. In this case, the user would also need to regenerate or apply the metadata to the new shapefile to maintain completed metadata status for the database. (2) Data could be added to the spreadsheet and shapefile concurrently. The user would need to add the point to the shapefile manually using Create in the Edit menu of ArcGIS Pro. XY geometry could then be calculated within the attribute table of the shapefile and copied and pasted back to the Excel spreadsheet to complete the database entry.

Because of the additional metadata work and the potential for error or difficulty placing the new point correctly using calculated coordinates, the first method is not recommended.

The original Request for Quote (RFQ) (BOEM 2021a) and agreed contract (BOEM 2021b) stipulated that final georeferenced databases would be provided as a GIS project file (.mxd) compatible with ArcGIS 10.8.1. Given that ESRI announced that they would discontinue support for ArcGIS desktop, including version 10.8.1, in 2026, BOEM approved a request to migrate the GIS deliverables to ArcGIS Pro 3.1.0 (ESRI 2023).

2. Site Formation Processes

Inundated archaeological sites, in all forms, represent a unique resource for modern study into the past. The waters off Alaska offer a singular opportunity for the potential to explore resources ranging from formerly subaerial landscapes that connected the hemispheres, to historic-era vessels and more modern downed aircraft. As soon as archaeological sites are created, they are subjected to environmental and cultural forces that may act to either degrade their integrity or aid in their preservation. Site formation processes may be initiated in an instant, as in a ship that is torpedoed by enemy vessels, or more gradually, as in the drowning of terrestrial landscapes during sea-level rise. There are a wide array of variable environments, mechanics, and processes that can impact archaeological sites between these two extremes. Most importantly, site formation processes influence the appearance and preservation potential of archaeological resources. Effective survey for previously unidentified resources needs to account for the effects of site formation processes.

Coastal, tidal, and fully inundated sites are impacted differently by site formation processes, but all of these impacts cumulatively affect site preservation potential. A summary discussion of site formation process analyses and current research trajectories, as related to terrestrial and marine archaeological sites, is provided below to identify key variables that may have or will likely impact known or potentially historically significant sites. Additionally, changing climatic conditions have been identified as a key concern among Alaska Native communities who commented on the project for sites in the modern coastal zone. Methods of assessing the impact of climate change on cultural heritage sites are explored in this section, including specific observations on the impact of climate change on terrestrial, coastal, and offshore cultural heritage sites in Alaska.

2.1 Introduction to Coastal Alaska

The U.S. Geological Survey (USGS) states that the shoreline of Alaska, including islands, fjords, river deltas, inlets, and bays, is approximately 106,217 km (66,000 mi) long. The extensive coastline ranges across a diversity of environments, including but not limited to rockbound coast, silty tidal flats, gravelly bottoms, and mobile sand banks, and is incredibly dynamic (USGS 2023a). The waters off of Alaska are not a single body; NOAA reports that Alaskan waters are comprised of the Pacific Ocean, Bering Sea, Chukchi Sea, and the Beaufort Sea (NOAA 2023a). This vast amount of coastline, both in Arctic and Sub-Arctic regions, represents a plethora of maritime environments and landscapes on which humans depend and still do engage with while accessing coastal and open water regions and resources.

Westerdahl (1992) pioneered and popularized the idea of the maritime cultural landscape to help define what has come to be perceived as the bond of both underwater and terrestrial remains of maritime cultural materials, ideas, and expression. Coastal Alaska, seen either as a unified entity or a series of congruent units, can be viewed through the lens of the maritime cultural landscape.

Alaska's environmental diversity is partly attributed to its massive land area. The modern boundaries of Alaska extend from Point Barrow in the north at 71° 23' 20" N 156° 28' 45" W to Attu Island, the westernmost Aleutian Island centered at approximately 52° 45' 00" N 172° 45' 10" E. From Attu Island, Alaska extends as far eastward as Hyder at 55° 56' 29" 130° 3' 16W', which is located along the Portland Canal, a 210-km (130-mi) long fjord that separates southeastern Alaska from British Columbia, Canada. The length of the three legs of a triangle to connect these points stretches over 8,256 km (5,130 mi). That is almost twice the length between Boston and Los Angeles or almost twice the length across the continental U.S.

2.1.1 Precontact (Ancient/Late Pleistocene-Early Holocene) Site Potential

During the LGM, global sea levels are estimated to have been approximately 140 m (460 ft) lower than present, with some local variation due to glaciated uplift or subsidence. The Bering Sea, which averages modern depths of approximately 30 to 50 m (100 to 165 ft), would have been largely exposed as dry land. It is believed that the exposed Bering Land Bridge (BLB) represented a habitable environment for occupants prior to marine inundation but would have undergone all the typical coastal processes of erosion, accretion, wave action, currents, and iceberg scouring that present coastlines in Arctic regions experience. The four primary processes of sedimentation are the mechanical accumulation of materials either by wind, water, or gravity, chemical precipitation through water, the decomposition and accumulation of organic material, and volcanic eruptions (Waters 1992). These processes would have been active during and after inundation and are likely to have created differential conditions for site preservation not just over the BLB but over all of the formerly exposed landmass of Alaska. Post-LGM sea-level rise reworked the extant shorelines as previously subaerial lands, rivers, freshwater lakes, and lagoons, along with the river valleys, mountains, and planes, now present on the Alaskan Continental Shelf (ACS) were inundated.

Pleistocene rivers in this region would have had annual flooding cycles, as rivers in arctic regions with annual snowmelt still do. Floods or rushing water caused by heavy rains or snowmelt, also known as freshets, may have carried a sediment load which could have covered any riverside settlements or camps and interred them as archaeological deposits. Additionally, sediments would have washed out to sea, contributing to sediment accretion and the burial of potential sites. This process of flood-inundated archaeological sites has been recognized around the world from Mesopotamia to the Mississippi River valley. Flemming (1983) has reported on several lithic and ancient sites around the world that have survived the LGM inundation, thus showing evidence that sites can survive marine transgression. Additionally, he posits numerous geomorphological settings that are likely to provide protection to sites during marine transgression, such as rai, lagoon, or estuary, sea caves, sink holes, the leaside of coastal islands or archipelagos, and more (Flemming 1983). While Flemming (1983) provides worldwide locations of sites, Stright (1990) focuses her listing on those on the North American Continental Shelf. Others believe that environments that would be hospitable for habitation are locatable via remote sensing. Via geophysical methods, i.e., sub-bottom profiling, areas of peat, indicating fresh water and recognized for decades as having a greater potential for archaeological sites, can be inferred from seismic data. With such data, paleolandscapes may be inferred without the need for coring (Plets et al. 2007).

2.1.2 Precontact Maritime Potential

In addition to sites located on or within submerged landscapes, early populations in Alaska used the marine environment extensively for fishing, whaling, and transportation, and it is possible that evidence of their maritime culture may be preserved within modern marine settings. Numerous authors have addressed the issue of boat usage by early populations and have derived a few main types of possible watercraft. The materials for early boats would have to be derived from the local flora and fauna. The simplest craft would be a log or inflated animal skin, such as a raft created by the combination of two or more logs or skin floats. Bundles of reeds or small sticks also offer buoyancy and are seen in ethnographic studies. More advanced craft would be a dugout log for a canoe and finally, early craft could be a frame of sticks, wood, or bone covered by either tree bark or animal skin (Greenhill 1976, Johnstone 1988, McGrail 1998).

The organic material required for early vessels, including wood or treated animal skin, rarely survives for long periods in dynamic environments. Environmental variations such as temperature and humidity, biological activity such as fungal decay, or the materials themselves being exploited as a source of animal nutrients have resulted in very few examples of early watercraft (Florian 1987, Grattan 1987). The types of resources that late Pleistocene and early Holocene inhabitants of Beringia and the Pacific Coast would

have had access to were limited to the prevailing environmental conditions. Trees of sufficient size for large dugouts, such as those that were used by the coastal peoples during initial encounters with Europeans in the eighteenth century, were unavailable in an arctic tundra environment. Hopkins (1983) presents a short description of a selection of vegetation that existed and may have been available to inhabitants of the BLB and Pacific coastal regions during the period around the LGM. The materials he notes, including small trees and plant material such as reeds, are not believed to be the constituents of large craft. However, small trees and reeds for bundle rafts may have been a possibility for short-distance navigation. The potential for animal skin floats is also not out of the realm of possibility. However, the ability to locate and identify these materials is extremely limited, due to their ephemeral nature. Worked stone tools, or lithics, are more commonly identified within early archaeological contexts, as the material is durable and more likely to survive burial and/or inundation.

2.1.3 Historic Maritime Potential

A ship, vessel, boat, or plane is a construction of the individual or community that built it for a purpose. It may be a tool, a machine, a political statement, or any other object that humans deem valuable. The one thing these crafts have is a purpose, which is to transport goods and/or people over the water for whatever reason its creator desires. From the simplest log canoe to a supertanker, the largest vessel afloat, this maxim holds. A vessel is an investment in resources, time, thought, and utility. Unfortunately, as in all human endeavors, failures or unforeseen accidents may occur.

A wreck site is the result of a series of occurrences that happen to a vessel or aircraft when it can no longer function for its intended purpose in the form in which it was created. It may be a slow foundering due to poor maintenance, or a dramatic event such as running aground on a reef at speed or complete engine failure at altitude. There are many factors that precede a wrecking event, the event itself, settling to the bottom or final resting place, and the immediate through long-term aftermath of the event. After the wreck happens, and time passes, the remains can be considered a potential archaeological site. Submerged watercraft may range from a dugout canoe (as discussed above) to the most sophisticated modern vessel, containing hundreds if not thousands of separate components. Once lost in a marine environment, however, all resources are impacted by cultural and natural processes and environmental conditions that influence any potentially discovered remains.

Archaeological sites undergo various and continuous changes from their creation to their present context, be they anthropomorphic, biological, chemical, or physical. Throughout their existence, these changes are considered part of the site formation process. They are dynamic and can be exceedingly rapid or excruciatingly slow. Muckelroy (1978) was one of the first to attempt to qualify site formation processes of shipwrecks. He described the importance of modeling site formation, stating that, “The shipwreck is an event by which a highly organized and dynamic assemblage of artefacts are transformed into a static and disorganized state with long-term stability” (Muckelroy 1978:157). More recently Ward et al. (1999) have attempted to add a new dimension to wreck formation theory based on a process-focused model that incorporates physical, biological, and chemical processes of degradation that have predictive reliability.

In the rare cases where lost ships are found largely intact, an examination of site formation processes can help identify long-term changes that have altered the ship from its original condition to the present find. One of the few examples of a largely intact shipwreck find is the Swedish warship *Vasa* (Cederlund and Hocker eds. 2006), where archaeologists have differentiated damage caused during the 1628 wrecking event from damage caused during salvage attempts in the 1960s from natural deterioration.

More recent modeling of site formation processes has resulted in a complex flowchart that identifies pre-wrecking behaviors in a self-styled disaster response model, that includes pre-, active, and post-wrecking events (Gibbs 2006). This builds on decades of work by Schiffer (1972, 2000, 2010), who proposes social and behavioral archaeology as a way for archaeologists to examine the relationships between people and

the artifacts that are left behind. Site formation process research in maritime contexts was initially developed as a framework to better understand shipwreck sites, but all sites in the marine environment experience a continuous feedback loop of site formation through degradation or accumulation.

2.2 Terrestrial Site Formation Processes

Understanding terrestrial site formation processes is necessary to inform research plans and ongoing management strategies for formerly terrestrial sites that are now located in submerged environments. Maritime site formation processes, discussed in Section 2.3, are complementary to terrestrial site formation processes and, combined, can have measurable impacts on archaeological sites (e.g., Muckelroy 1978, Ferrari 1994, Ferrari and Adams 1990, Gibbs 2006, Godfrey et al. 2011, 2012, Gregory 1996, Oxley 1998, Plets et al. 2008, and Richards 2008).

Terrestrial site formation process studies are used to identify and separate naturally occurring processes from those of anthropogenic origin. For example, geological stratigraphy is the result of natural, cyclical processes, while human activity interrupts and introduces features that cannot be properly understood using just the three established laws of geological stratigraphy (superposition, original horizontality, and original continuity) (Harris 1979, Holland 2015). During the survey and reconnaissance phase of investigation, interruptions to the natural stratigraphy may be interpreted as the presence of an archaeological site or resource. Conversely, natural geological stratigraphic processes, such as erosive scouring related to shoreline regression, can reduce the potential for archaeological preservation and may also be observable in survey data.

Site formation processes include all actions that impact an archaeological resource from the time of deposition until long after its discovery and documentation, including those of natural origin (as described above) and cultural impacts (Schiffer 1987:7). Schiffer (1987) stated that natural processes may impact the individual components of a site (such as natural decay of organic matter), the site as a whole (such as through scouring and reworking of materials), or the region (such as through rising sea-levels and inundation). He further stated that cultural processes included but were not limited to reuse and recycling; cultural deposition, such as burial and intentional abandonment; reclamation; and disturbance, including ploughing and large-scale earth-moving (Schiffer 1987). In all cases, Schiffer contends that the effects these processes have are regular, predictable and, most importantly, quantifiable (Schiffer 1987).

Included in the analysis of the terrestrial site formation processes is differentiating short-term and unpredictable events (e.g., earthquakes, tsunamis) and long-term, predictable modifications to archaeological sites through erosion and sedimentation (Sullivan and Dibble 2014). This often includes interpretations about how these processes have potentially skewed or affected the cultural remains found at archaeological sites. One broad class of environmental formation process includes studies to understand the impact of vegetation growth during and after site usage; the impact of microenvironments shifting localized vegetation patterns; and damage from impacts of climate change, such as wildfires, tree falls, and similar catastrophic events (Sullivan and Dibble 2014); see Section 2.4 for a discussion of climate change and cultural heritage. Each of these can have specific and identifiable impacts on archaeological sites. Lastly, Sullivan and Dibble discuss the impact of animal behavior on archaeological sites. Animal behaviors that can impact sites include burrowing, trampling, and scavenging on a site concomitant with deposition and site formation in both short- and long-term cycles.

Sites must first be identified to be protected against adverse effects. The use of site formation processes in modeling the potential for site occurrence and preservation allows for the incorporation and analyses of multiple lines of evidence. It is necessary to not just understand where sites may have once been, but where they are likely to also be preserved in situ. Terrestrial sites that were formed on the exposed outer

continental shelf continued to be impacted by site formation processes following inundation and the conversion of the OCS to a fully marine environment.

2.3 Marine Site Formation Processes

Within Alaskan waters, archaeological sites include those that were once created on dry land and have experienced terrestrial site formation processes (discussed above), and those that were created and deposited within the marine environment. Most literature regarding marine archaeological site formation processes is directed towards shipwrecks and defines the impacts as they relate to the wrecking event and post depositional processes. Pre-wrecking behaviors, such as an inattentive captain or crew, or owners trying to gain one more voyage out of a compromised vessel before repairs, may not be ascertained by the observable remains of the wreck. Behaviors are varied, complex, and cannot be intuited without supplemental detail provided by documents, interviews, or other non-archaeological sources. Post depositional processes, however, have a direct impact on the appearance, state of preservation, and the best methods for detection for all submerged cultural resources.

2.3.1 Pre-wrecking Event

Shipwrecks can occur for a myriad of reasons including human factors. The captain and crew may be inexperienced, negligent, or incompetent. Human factors such as tiredness or the use of alcohol or pharmaceuticals may also impair judgement. Poor or erroneous judgement may lead to the loss of a vessel or its cargo. The ship's management may forestall required maintenance for financial or other reasons that could imperil the vessel. How to quantify this in the archeological record is a bit amorphous.

The most famous wrecking event in Alaskan waters may be that of the *Exxon Valdez*. The *New York Times* (NYT) reported that, due to fatigue and excessive workload, the third mate failed to maneuver the vessel properly and the captain of the vessel, impaired by alcohol, failed to provide a proper navigation watch. Although the ship was saved, at least 10.8 million gallons of oil were lost in the waters of Prince William Sound (NYT 2022). A series of human errors caused a vessel to run aground and create an ecological disaster affecting the coast and the surrounding populations for decades.

Occasionally, human actions prior to a wrecking event result in observable phenomena that can help identify an archaeological site. In many cases, vessels experience a distressing circumstance, be it external to the vessel like a violent storm or something internal like flooding or shifting cargo. During these emergencies, the crew can take many measures to preserve the vessel and themselves. One method is to jettison material, either as jetsam or lagan. Jetsam is material put over the side to decrease the weight of the vessel and make it more stable. This can sink or float away and may or may not be included in the archaeological record of a shipwreck site as a seabed scatter. Lagan, like jetsam, is jettisoned with the intent of saving the vessel in distress. However, lagan is the focus of a much more optimistic action, as it is attached to a buoy or other marker for, a hoped, eventual recovery. Both these actions remove material from a wreck site prior to wrecking and can, in cases, prevent a wreck. Can this material, purposefully removed from a craft, be differentiated from flotsam, the material that floats away from a vessel after the sinking process had been initiated? Either way, this material may become part of the archaeological record either as part of a shipwreck scatter or as isolated material on the seafloor.

There are many other pre-wrecking variables and factors that can be considered. However, those mentioned give a sense of the diverse collection of activities and conditions that may make a wrecking event more likely and affect what eventually is included in an archaeological site.

2.3.2 Wrecking Event

The process by which a ship or downed aircraft ceases to be a functioning vessel and enters the archaeological record is known as the wrecking event. Wrecking events can be intentional, accidental, gradual, or catastrophic with each influencing the appearance and level of preservation exhibited by the resulting archaeological sites. Where known, information about the wrecking event can help to locate, interpret, or even identify the name of a submerged vessel or downed aircraft.

Abandonment is a common method of discard, and there are many areas of the world where ships are intentionally abandoned en masse. San Francisco was a bustling goldrush port, Mallows Bay in Maryland was a storage area for WWI vessels, and the Falkland Islands were the last opportunity for emergency ship repairs due to passage around Cape Horn (Shomette 2009, Throckmorton 1987). Authors such as Richards (2008) discuss numerous practical and rational motivations for abandonment. Whether they are abandoned individually, like a fishing vessel along a shore or placed in an anchorage specifically for laid up vessels, discarded vessels provide a resource for archaeological examination.

The Atlantic (2020) reports that abandoned vessels are beginning to accumulate on Alaska's shores, and that by 2025, there will be as many as 3,000 more vessels that have outlived their use life and may add to the number of abandonments. The article's purpose was to highlight potential ecological harm and discuss how to eliminate it. This indicates a behavioral change from when vessels were routinely cast ashore.

Abandonment is not just the considered or negligent removal of a watercraft from active service. It can also mean leaving a vessel during a period of distress, an action taken by the crew and passengers of the ill-fated *Titanic*. The *Titanic* sunk due to its catastrophic collision with an iceberg. But what about vessels that are abandoned under seemingly catastrophic circumstances but do not sink. The most famous instance of abandonment may be the story of the *Mary Celeste* in the late nineteenth century. The 282-ton brig was found abandoned at sea west of southern Portugal on December 4, 1872, with approximately 1 m (3 ft) of water in its hold but otherwise in fair condition (Fay 1988). Thus, the vessel, if not encountered, may have eventually foundered, or been driven to shore and in either case ended up as part of the archaeological record.

Shipwrecks commonly occur due to contact or collision with a coast or submerged obstruction. The *Exxon Valdez*, noted above, was one such dramatic occurrence of contact, and known to be due to human rather than natural factors. Catastrophic contact can be made with a rocky coast, sand banks, or even mud flats. Each of these environments will impact the vessel's structure. Additionally, it is not unheard of for ships to collide with each other, which may lead to the sinking of one or both. Ship collisions away from the coast may not experience many of the deteriorating processes of nearshore or shallow reef environments.

A collision in a nearshore context is only the first step of wreck formation. If not salvaged or pulled off, the vessels will inevitably be exposed to many of the other factors considered in this section such as constant pounding of surf, tidal changes, and biological and chemical processes caused by intermittent wetting and drying within the tidal range. After a vessel is subjected to these natural processes, any remains on the seabed undergo further reorganization, disarticulation, or scrambling. The study of formation processes in shallow water has been examined by O'Shea. Focusing specifically on wooden vessels in the upper Great Lakes region, he attempts to illustrate how different elements can be integrated into a unified approach for study. Ship traps and associated debris traps are considered because of their systematic ability to concentrate material. He posits that even material that becomes disarticulated from a vessel and drifts off after its initial demise and deposition may enhance research potential if the local environmental conditions are known (O'Shea 2002).

Ships may encounter catastrophic events such as explosion and or fire. The causes of explosions and fire aboard ships are many and may include leaky fuel or oil line, overheated bearings, an electrical short, and improper storage of combustible material. This is a much more hazardous ordeal for wooden vessels where, as the ship's fabric goes up in flames the hull becomes more buoyant and rises allowing the vessel to continue to burn down to the water line leaving less material for eventual discovery. An iron or steel ship may buckle and be deformed, but the hulls can survive a fire and may float for considerable time before sinking or being salvaged. During the writing of this chapter, in the summer of 2023, the Associated Press reported that the car-carrier *Fremantle Highway* burned for a week in the North Sea. The vessel was allowed to burn, as attempting to extinguish the fire may have made the vessel unstable and thus in danger of foundering or turning turtle and sinking. Once the fire was out, the ship was towed to port for salvage (Dejong 2023).

Explosions are a more violent form of conflagration that can disable a vessel enough to cause its eventual sinking or destroy it instantly. The causes of explosions are numerous, ranging from an ignition source in an area filled with explosive gasses to intentional scuttling charges or military action. Both sink a vessel, but the former is unintentional while the latter is purposeful. The sinking of the *Defense* during the American Revolution was caused by an intentional detonation of the magazine to keep the vessel from falling into the hands of the British (Switzer 1987). Although dramatic, the explosion assisted the rapid sinking of the vessel to the bottom of Stockton Harbor, Maine. The vessel soon silted in with fluvial sediments. These conditions allowed for subsequent archaeological investigations approximately 200 years later. Explosion and fire can destroy a vessel, but the same actions can also cause an event that ironically assists in preserving the remains of a vessel.

Flotsam is the material that floats away from a shipwreck on the sea's surface. It can be removed as the vessel slips beneath the waves, or its natural buoyancy may dislodge it from a sunken vessel where it floats to the surface. Once on the surface, this material is at the mercy of wind and wave and may be forever disassociated with a vessel. However, if a ship is lost near a coast, the flotsam may be driven onto a beach or other coastal area where it can be associated with a wreck site. In either instance, flotsam, by its buoyant and mobile nature, will not be located with the hull remains.

Foundering is a process in which a ship fills with water, therefore losing buoyancy, and eventually sinks. It is considered a slower process than a catastrophic wreck. A wooden ship may founder if there is a sprung or rotten plank below the waterline and a modern steel vessel may founder due to a rupture in a thru-hull fitting, propeller shaft, or other breach in the hull or machinery. In calm waters, a vessel may slowly settle and keep its general hull integrity. The process of jettison, noted above, may take place to prevent foundering. And any deck or buoyant material may float off as flotsam. Both processes reduce the potential for archaeological material to be associated with the lost vessel. However, foundering may be an unexpected event as well. During the War of 1812, the *Hamilton* and *Scourge* had maneuvered within sight to the enemy fleet in calm waters with the possible expectation of a future engagement. A Great Lakes squall suddenly sprang up and both vessels were put on beams ends and rapidly foundered. Today both vessels are sitting upright in the cold, deep waters of Lake Ontario. The circumstances surrounding the foundering process have left the vessels and their contents in excellent condition (Cassavoy and Crisman 1988).

Ice flows and icebergs are especially relevant to discussions of wrecking events in Alaskan waters. An icebound coast is a common feature in the Arctic regions, which can extend into the northern portions of temperate zones and can include frozen seas and icebergs. The remains of HMS *Erebus*, HMS *Terror*, and HMS *Investigator* have all been identified, largely intact, below the seasonal pack ice of the Canadian Arctic (Parks Canada 2023, Cohen 2013) at approximately 69° N parallel of Latitude. The remains of the well-known maritime disaster of the *Titanic*, lost due to inadvertent contact with an iceberg, lie south of the 42° N parallel of Latitude. That is over halfway to the equator from the North Pole.

Alaska, with the exception of its southern panhandle, the Alaska Peninsula, and the Aleutian Islands, lies exclusively north of 60° N latitude. Although the southern coast can remain free of ice due to the relatively warm Pacific currents, Alaska's many seaside glaciers contribute to an ice load. Seas north of the Aleutians can and do become ice covered for part of the year. The most dramatic event of sea ice as part of a wrecking event occurred in 1871. During the spring of that year, 40 whaleships headed north through the Bering Sea toward the Arctic Ocean. During the summer, ice began to accumulate in and around the fleet, and by the middle of September, 33 ships were iced in. Their crews abandoned the ice-locked ships and amazingly found the remaining seven ships of the fleet and were rescued with no loss of life. The following year whalers returned to salvage the vessels but found only one, the *Minerva*, to recover. The remaining 32 were crushed or otherwise destroyed, and their remains littered the seabed and coastline. Several were burned by the local inhabitants of the region. Five years later another 12 whaling vessels were lost, along with the lives of approximately 50 mariners, due to sea ice (Dolan 2007).

The power of ice flows and icebergs is no match for a wooden vessel. Today, vessels are still lost because of ice in the Arctic regions. Ice, slowly accreting on the upper works of a vessel, can make it top heavy and encourage it to turtle or founder. Unlike being crushed by massive floes, this wrecking event can actually aid in preserving the vessel as the ice encapsulates the hull, and slowly melts away in relatively warmer, although still very cold waters. Additionally, a vessel that is sunk by ice coverage may arrive on the seabed in an upright position as ice is less dense than water and would, while submerged, act as a buoyant righting force. Therefore, ice can function as both a scrambling, while crushing, and a stabilizing, while accreting, process during a wrecking event.

Weather at sea was an unpredictable event in the Age of Sail (i.e., approximately 1570-1860). Today's weather can be predicted but it changes rapidly. Even if a vessel leaves port during fair weather, they may encounter rough and stormy weather. The two main methods to measure wind and waves at sea are the Beaufort and Saffir-Simpson wind scales. The Beaufort scale ranges from calm winds and glassy seas (force 0) to hurricanes (force 12). The Saffir-Simpson scale starts at Beaufort force 8, for tropical storms, and proceeds to categorize hurricanes numerically from 1 to 5. Typhoons are western Pacific equivalents of Atlantic hurricanes. Although Alaska is not in the tropics, where hurricanes and tropical storms generate, the coastal regions and waters of Alaska experience hurricane force storms with regularity. Blowing over open seas with a long fetch, such as those surrounding Alaska, high winds also generate huge waves and surges.

Using a Beaufort scale provided by the National Weather Service (NWS) winds of Force 3 (7-10 knots or 12-19 km/h) will produce a general wave height of 0.6–1.2 m (2–4 ft), while a fresh gale at Force 8 will include winds of 34-40 knots (62-74 km/h) with wave heights ranging between 5.5–7.5 m (18–25 ft). Beaufort Force 12 is a minimal hurricane/typhoon with winds greater than 64 knots (118 km/h) and associated waves greater than 14 m (46 ft) (NWS 2023). Many ships that proceed to sea, through no fault of their own, encounter storms and survive. Some do not. Waves do not only affect the sea surface they can impact the coast and seabed. U.S. Department of Agriculture (USDA) reports that the Bering and Chukchi Seas are regularly affected by intense storms. During ex-typhoon Merbok in 2022, high wind, waves, and storm surge were responsible for vessels being scattered up to 14.4 km (9 mi) inland (USDA 2023). Other areas of Alaska are affected by storms of equal ferocity.

2.3.3 Post-depositional Processes

Post-depositional processes impacting marine archaeological sites, like terrestrial site formation processes, can be divided into environmental and cultural actions that influence site integrity and preservation (Table 2-1). The dynamic environment off Alaska presents a diverse range of conditions that can impact site appearance and preservation. Cultural processes that have a direct impact on submerged cultural resources off the coast of Alaska include a range of extractive industries, and all are detailed below.

Table 2-1. Marine site formation processes

Environmental	Tides and currents
	Biological degradation
	Chemical reactions
	Vulcanism, tectonics, and tsunamis
	Tsunamis
	Wind, storms, and ice
Cultural	Energy development and mineral extraction
	Dredging and trawling
	Salvage
	Warfare

2.3.3.1 Tides and Currents

Tides are the daily variations in coastal water height caused by gravitational action of the moon and sun. This vertical rise and fall has a horizontal component of the tide coming in and going out, creating tidal currents. Therefore, tides have an immediate twofold impact on archaeological sites. The vertical change may contribute to the biological and chemical degradation of a shipwreck site in shallow water as the constant wetting and drying of a surface may promote microbial and faunal growth. Water and salt incrustation of seawater may promote corrosion and other chemical reactions. Both these processes are constant and dynamic. Mechanical process may also be a factor as with the tidal rise and fall, if there is any wave action, the breaking of waves will impact both the seafloor and any material protruding above it.

As the Alaskan coast is widely variable and long so too are the variation in tidal ranges. Using the month of August 2023 as an example, the predicted tidal variation at Anchorage was reported to be -1.2 m (-4.0 ft) to +10.0 m (+32.7 ft) for a total range of 11.2 m (36.7 ft) (NOAA 2023b). To the south on the inside passage of the Alaskan Panhandle at Juneau the August tide range was reported to be -1.3 m (-4.3 ft) to +6.0 m (+19.4 ft) for a total range of 7.2 m (23.7 ft) (NOAA 2023c). To the north in the Beaufort Sea at Prudhoe Bay tidal range was reported as +0.1 m (+0.3 ft) to +0.4 m (+1.4 ft) for a total range of 0.3 m (1.1 ft) (NOAA 2023d). In the Aleutian Islands at Unalaska the tidal range was between -0.4 m (-1.3 ft) to +1.3 m (+4.4 ft) for a total range of 1.8 m (5.7 ft) (NOAA 2023e). The geographic and geologic variability of tides in Alaska may impact sites that fall within their reach.

The sampled tidal ranges indicate the vertical masses of water moving in and about Alaska. The other component of tides is the current produced by the horizontal movement of these masses of water. As with tide ranges, tidal currents can be quite variable in Alaskan waters. While the vertical component is increasing or decreasing, the horizontal action of water adds another mechanical force that affects any material on or above the seabed. Currents can mobilize bottom materials, sands and gravels which would have an abrading effect on softer or corroded material. Additionally, they can introduce biological or chemical processes that degrade materials. The horizontal force of water on any surface above the bottom of the seabed will also impact the materials.

Weekly current predictions are provided by the NOAA Tides and Current website. For the areas sampled above relative to tide ranges, the following are tidally induced currents for the week following August 4, 2023. There are numerous current meters in the waters surrounding Anchorage, for example the current predictions at Point Woronzof, located approximately one and a half miles from Anchorage, were a maximum of 3.54 kilometers per hour (kmh) (1.91 knots [kt]) on the flood tide and 5.2 kmh (2.81 kt) on

the ebb tide (NOAA 2023f). At Juneau Harbor, the current predictions on the flood tide were a maximum of 0.93 kmh (0.55 kt) and 2.26 kmh (1.34 kt) on the ebb tide (NOAA 2023g). The most northerly current meter in Alaska maintained by NOAA is not at Prudhoe Bay but off the northwest coast of St. Lawrence Island in the Bering Sea and the current predictions on the flood were a maximum of 1.83 kmh (0.99 kt) on the flood tide and 1.9 kmh (1.02 kt) on the ebb tide (NOAA 2023h). Finally, at Akutan Pass, off Unalaska, the current predictions on the flood tide were up to 12.07 kmh (7.15 kt) and 7.29 kmh (4.32 kt) on the ebb tide (NOAA 2023i). Tidal currents are highly variable throughout Alaska, but need to be considered as part of a dynamic system that may continually impact shipwreck sites. Using the well-known formula for the force of moving water, $\text{Force} = \text{Area} * \text{Density} * \text{Velocity}^2$, one square foot of sea water moving at 1 knot² (or [1.69 ft per second²]) creates a force of 185.65 pounds per square foot. By their direct impact or via scouring or other bottom modifying processes these daily back and forth forces express themselves.

Tidal currents, as discussed above, are one of three types of ocean currents that also include coastal and oceanic currents. River drainage and tides also affect coastal currents. Ocean currents, meanwhile, are comprised of surface currents and deep-water currents and are part of a wider world system dependent on prevailing winds, solar heating, gravity, and the Coriolis force. Surface currents such as the well-known North Pacific, Alaska, and Bering Sea Currents slowly mobilize sea water around Alaska but lose speed with depth. Deep-water currents happen when relatively warm water becomes cooler and thus more dense, due to an increase in salinity caused by cooling and evaporation. Deep-water currents typically sink to deeper depths but continue moving very slowly. Unlike tidal currents, deep-water currents are unidirectional, so their force may act as a stabilizing agent. However, they may carry nutrients and chemicals that may affect any remains of a shipwreck over which they flow.

Currents also act on materials on or along the seabed, such as seabed sediments, be they light silts, clay, sands, or gravels, or biological such as microbes and other marina fauna transported by the sea. The mechanical movement of physical material may cover and protect a site beneath the seabed or abrade the various components of a wreck site standing proud of the bottom. The hydrologic process of current flow around an object above the seabed creates scour that can have both negative or positive effects on a site or portions of it. The upstream side of a site may endure the negative impacts of mechanical weathering while the downstream side may accrete sediments that protect artifacts or create scour trenches that destabilize some or all the complete structure (Quinn 2006). This process is continual and dynamic if the current flow is disturbed by material impeding it.

2.3.3.2 Biological Degradation

Wooden vessels have a high content of carbon, oxygen, and hydrogen, with trace amounts of other minerals (Rowell et al. 2012). These elements are essential as part of the biological aspects of this cycle to return carbon to the environment when wood, which is a store of carbon, is digested by various organisms in the environment that then release carbon back into the environment. Whether bacteria and fungi or crustaceans and mollusks, the biological processes these creatures facilitate negatively impact archaeological resources. *Teredo navalis*, commonly known as the naval shipworm, is a mollusk that has a worldwide distribution. In the adult form, it can survive in waters that range from -1.4° to 30° centigrade (C) (29.5° to 86° Fahrenheit [F]) but are most active in temperatures ranging from 15° to 25° C (59° to 77° F) (Roch 1932 in Björdal & Gregory 2011).

Teredo navalis attach themselves to wooden surfaces in their larval stage and then begin to bore into the wood. These animals create long tunnels by eating and digesting the wooden fibers. As the wood is digested the vessel hull becomes frailer due to the loss of internal structural integrity. Another subarctic organism that eats wood is the gribble, which is found as far north in Alaska as 58° circa Kodiak Island but is known to range as far north as 70°. The gribble (*Limnori lignorum*) is a small wood boring crustacean that lives in the tidal zone but can be found down to 30 m (98 ft) in seawater and has a

temperature tolerance range between 0° to 20° C (32° to 68° F). Their actions create an eroded wooden surface that is both porous and friable (Shalaeva 2023). As wood loses strength due to either Tereido or gribble actions, other forces like currents or mobile bottom sediments may more quickly abrade and destabilize the remaining seabed materials. Wood is attacked from within and without.

Pacific Blue Mussels (*Mytilus trossulus*) are another marine animal that may have negative effects on wooden vessels. Blue mussels cling to rocks and other structures in the intertidal zones via byssal threads that are very resilient and strong. They grow in clusters and can add weight to compromised structures, such as those attacked by teredoids and gribbles. They can accumulate in dense formations and are found throughout Alaskan waters (Rozell 2005). Other creatures and microbes can negatively impact both submerged and tidal wooden structures associated with maritime activities. These organisms represent the most common, but not all, biological organisms that can adversely impact wooden archaeological remains.

Organic materials at any inundated site, be they precontact or historic, are also prey to various biological activity. As mentioned above, wood is actively degraded by many organisms. A yearlong study off the west coast of Scotland examined five types of organic materials that would have been used extensively on wooden ships in the Age of Sail and can still be found on modern vessels: bone, canvas/textile, cordage, leather, and wood. All materials were seen to be degraded by microbial activity, either bacterial or fungal. There may also have been some biochemical activity, particularly with bone. Both leather and wood were also assaulted by larger predators, including mollusks and tube worms. The environment's high level of dissolved oxygen may have contributed to the rapid colonization of microorganisms (Gregory 1995). The active consumption of organic materials in a dynamic sea environment often leads to their complete deterioration. The only apparent salvation is to be rapidly encased in an anoxic, or cold-water environment. Even then anoxic microorganisms that can digest inorganic compounds such as sulfates and nitrates may present a danger.

2.3.3.3 Chemical Reactions

Seawater contains concentrations of salts and acts as a solution that deteriorates specific materials that contact it. The most common elemental ions in seawater are chlorine and sodium and to a lesser extent sulfate, magnesium, calcium, and potassium. The concentrations of salts and ions in the water make it chemically reactive to many submerged materials, particularly metals. There are many other forms of dissolved matter in seawater but at much reduced concentrations (Floran 1987a). Thus, the sea, the medium that a shipwreck, or any other marine archaeological site sits in can act as a chemical bath that leads to deterioration.

Certain metals in an electrolytic solution, such as seawater, eventually corrode. This corrosion is an easily observable occurrence to most metals found on wreck sites. Iron and steel, has iron as a basic component, are the main components of modern vessels and were also used in many applications on historic wooden vessels, especially for fastenings, anchoring, and defense. One might believe that iron would corrode at the same rate on a vessel; however, a detailed study of the corrosion potential of five cannons on a wreck in Scotland indicates that metal components from the same wreck can corrode at vastly differing rates. The microenvironments of the five cannons were found to be a key factor in their individual corrosion rates. Those that were exposed to active currents had higher corrosion rates, while another showed less corrosion due to presumed cycles of exposure and burial, while the most preserved cannon was only partly exposed (MacLeod 1995). Thus, corrosion and overall deterioration at a site cannot be considered stable or uniform as time continues.

Noble metals like gold and platinum are resistant to corrosion due to their elemental properties, but more susceptible metals can react directly with seawater. Different metals in contact with each other and seawater can initiate corrosion at rapid rates. The interaction of iron and copper in the eighteenth century

is an excellent example of how different metals can interact with seawater in unexpected ways. In the eighteenth-century, shipbuilders began using copper sheathing to protect a vessel's lower hull, and while sheathing protected wood, it adversely effected iron components of the hull. Galvanic coupling between the two metals caused the rapid corrosion of iron which weakened the fastenings of numerous vessels. This is best illustrated in the American Revolutionary-era warship HMS *Charon*, in which the copper sheathing was apparent at the wreck site but only corrosion products were found from where the iron drift pins should have been (Steffey et al. 1981). North and MacLeod state that it is impossible to predict what will happen to any object given the complexity of reactions, but that some generalizations can be made. They list numerous factors from metal type to seawater composition and temperature to proximity to other metals and the seabed, among other variables that factor into corrosion (1987). Thus, there is a dynamic and complex interplay in the corrosion of metal objects in sea water. In the days of sail, the metals used were based on iron, copper, and lead and used in distinct and different applications. Modern vessels use a complex array of metals in many interconnecting applications. Thus, the number of chemical processes that may occur to promote corrosion or other detrimental changes to the fabric of a shipwreck are multiplied.

2.3.3.4 Vulcanism, Tectonics, and Tsunamis

Unlike most of the rest of the U.S., Alaska has a vast number of volcanoes. Over 80 of the approximately 140 total volcanoes are in the Aleutian Arc, which extends for over 2,500 km (1,553 mi) and comprises the border between the Bering Sea and the Pacific Ocean. Most of the rest of the active volcanoes in the U.S. are also located in Pacific rim states. The U.S. Army Corps of Engineers notes that 44 have erupted since records have been kept in 1741. These volcanic eruptions add a unique dimension to the Alaskan littoral zone as both a destructive and creative force. Relative to the survival or destruction for archaeological potential, during the late Pleistocene and early Holocene, any volcanic eruptions that occurred during that period may have placed a layer of ash and other volcanic debris over sites, known as volcanic siltation.

The Aleutian Trench, a deepwater feature immediately south of the Aleutian Island chain in the Pacific Ocean, is an oceanic feature caused by the Aleutian Subduction Zone. The Alaska Department of Natural Resources (ADNR) indicates that it is the major tectonic feature in Alaska as it comprises an approximately 4,023.4-km (2,500-mi) east-west front where the Pacific Plate moves approximately 5.6 centimeters (cm) (2.2 inches [in]) a year as it is subducted under the North American Plate. The resultant friction causes the previously discussed vulcanism and tensions between the plates. When that resulting friction is released, it serves as the source of earthquakes. The Fairweather/Queen Charlotte fault, a slip-strike fault where the Pacific Plate grinds along the North American plate, runs approximately 998 km (620 mi) in a north-south direction along Alaska's southeast Pacific coast. There are numerous other faults that are on the terrestrial side of the coast as well (ADNR 2023).

The largest recorded earthquake in Alaska occurred on March 17, 1964. Centered around Prince William Sound, the quake lasted approximately three minutes. During this time, over 1,346,794 square km (km²) (520,000 square mi [mi²]) of Alaska and its surrounding waters were vertically displaced by approximately 14 m (46 ft). There were approximately 11.5 m (37.7 ft) of uplift in some areas and 2.3 m (7.6 ft) of subsidence in other regions. An associated tsunami, with a recorded wave height of 67 m (220 ft), devastated many towns along the Gulf of Alaska (USGS 2023b).

While the statistics from the largest recorded earthquake are striking, the release of energy from much smaller earthquakes can still cause landslides, tsunamis, liquefaction, ground shaking, and rupture. These physical effects can affect all material around them causing any previously established equilibriums to be disrupted, and therefore should be considered as part of a dynamic component of the site formation processes. The Alaska Seismic Hazards Safety Commission (ASHSC) states that, on average Alaska has one "great" quake every 13 years, one magnitude 7 to 8, six magnitude 6, 45 magnitude 5, and over 300

magnitude 4 earthquakes in a year. In fact, Alaska experiences over 1,000 earthquakes a month of varying magnitudes (ASHSC 2023). Although these happen all around the state, many are centered along the seismic coastal zones making them a consideration for marine cultural site preservation.

Tsunamis exchange energy from rapid land displacement of water in the ocean usually caused by earthquakes. The energy released in the earthquake, volcanic explosion or landslide is expressed in the ocean as waves, which may appear small at the source of creation, but as they near the shore energy stored within the water column begins to increase wave height due to shortening the wavelength of the energy and the slowing movement of the wave (NOAA 2023j).

The world's largest recorded tsunami occurred on July 9, 1958, and was directly caused by a landslide, which in itself was caused by an earthquake. Localized in Lituya Bay, Alaska, the force of the wave was expressed by removing all vegetation, including trees to an elevation of 524 m (1,720 ft) (Geology.com 2023). Most tsunamis are not as dramatic or geologically confined, and they are rare. However, the destruction they create along the littoral zone when they occur can have a major effect on all cultural materials in the impacted environment.

2.3.3.5 Wind, Storms, and Ice

Normal wind and storm generated wave action may negatively impact seabed cultural material. Deep water waves and surf zone waves have different characteristics but both express energy beneath them. The reach of the force of a wave below the surface is based upon the wave's cycle rate characteristics. This is the surge that one feels while underwater. In open water, it is considered that wave energy is dissipated beyond one half of the wavelength between two adjacent crests of a wave. For example, if a 3 m (10 ft) wave has a crest-to-crest distance of 18.3 m (60 ft), the force of the wave is considered to have dissipated at 9 m (30 ft). The force of a wave below that depth is considered negligible. For surf zone waves, where the wave period length is less than half the distance to the seabed, the force or surge can be felt through the breaking of the wave on the shore. Thus, seabed materials may be impacted not necessarily based on their depth but on the wavelength of the overpassing waves, which is a variable distance depending on the sea state. Ice floes and icebergs may also act as a potential annual scrambling device for any archaeological remains in waters where their depths reach. An iceberg or floe presents approximately 10 percent of its mass above water. The remaining 90 percent lay below the surface. According to those calculations, an iceberg with relief of 3 m (10 ft) above the water surface may have a vertical reach of 27 m (90 ft) below the water's surface. Any material on the seabed underneath the ice may be crushed, moved, or rearranged as icebergs are mobilized both by currents and wind.

2.3.3.6 Energy Development and Mineral Extraction

Under the Outer Continental Shelf (OCS) Lands Act, BOEM has the authority to grant leases for the exploration, development, and production of oil and gas and to manage minerals in federal waters offshore Alaska (see Chapter 1). These industries can and often do have accompanying direct bottom disturbing impacts, which may be temporary (such as rig placement or anchoring during drilling) or long-lasting (such as pipeline installation). Indirect effects from development on the OCS may be observed through changes in sediment scouring around seafloor installations or deposition of drilling fluids or "muds" (Evans and Firth 2016:136-146). To date, a total of 109 wells have been drilled offshore Alaska in federal waters (Table 2-2). Dredging and discharge associated with mineral extraction can result in significant sediment disturbance and reworking (Evans and Firth 2016:147-149). Previous impacts to historic shipwrecks, including SS *Gulfstag* and the Mica wreck, in BOEM's Gulf of Mexico Region resulted in changes to the survey methods required under shallow hazard and archaeology NTLs to prevent similar impacts (Evans and Firth 2016:139-141,151-152). As technologies change, regulations and survey requirements issued by BOEM's Alaska region must keep pace with current industry practices

to make sure that culturally significant resources are identified and protected from adverse impacts if or when projects are proposed (see Chapter 8).

Table 2-2. Wells drilled in federal waters, offshore Alaska

Alaska OCS Area	Exploratory Wells	Other Wells	Total Count
Gulf of Alaska	12	1	13
Kodiak	0	6	6
Cook Inlet	13	1	14
St. George Basin	10	2	12
North Aleutian Basin	0	1	1
Norton Sound	6	2	8
Navarin Basin	8	1	9
Beaufort Sea	31	8	39
Chukchi Sea	6	1	7
Totals	86	23	109

Source: BOEM Alaska Cadastral Data (www.boem.gov/Alaska-Cadastral-Data/#GIStable); as of 06/12/2020.

2.3.3.7 Dredging and Trawling

Commercial fishing is a multibillion-dollar industry in Alaskan waters. For 2020, *Alaska Seafood* (AS) reports that the industry created over 100,00 jobs worth over \$5.6 billion in income. The investment in vessels and gear, combined with the sale and transport of the products adds billions more to the economy (AS 2020). Some fishing activities, such as recreational angling may have little impact on marine cultural resources. Wrecks, intentionally or not, used as local artificial reefs may contain hooks, lures, and sinkers which may impact a vessel in a minor way and again shows the multiple and continued use of a potential archaeological site. However, fishing can seriously impact shipwreck sites.

Commercial fishing that includes bottom trawling poses more of a risk to underwater sites. The Alaska Department of Fish and Game (ADFG) provides information on the state's commercial fisheries. Scallop dredging rakes the seabed with an apparatus that is towed along the bottom of the sea. This direct contact with the bottom can encounter and damage wrecks. Ground fishing for species that live at or near the bottom of the sea represents a similar hazard. Shrimp trawling may represent a hazard if done in shallow water or near the seabed. The actively moving gear, being towed by a large commercial vessel can destroy an archaeological site on the seabed. Another fishing technique is pot fishing which involves dropping heavy pots or traps to the seabed to entrap their intended species, whether fish or crabs. Pots dropped on an archaeological site will create physical impacts. Pelagic trawling, that is towing the net in the water column, is considered less damaging to the bottom than the other methods (ADFG 2023a). However, it is known that pelagic trawling gear may occasionally contact the seabed. Fishing is a constant and important industry in Alaskan waters, but the associated methods may impact sites repeatedly.

2.3.3.8 Salvage

Salvage is another cultural process that can impact a site post-wrecking, as vessels and their cargo represent an investment in material or financial resources. Salvage can take place in the immediate aftermath of a wreck. The wreck itself may be saved or removed or the cargo may be the focus of salvage attempts. The immediate need to recover cargo and materials may require the vessel to be partially disassembled. Occasional salvage may take place well after the wrecking event, picked over by opportunistic interlopers and ship breakers. Both short term and long-term efforts at recovery diminish the

integrity of a site. Additionally, actions taken by salvors are a factor in the immediate and subsequent wreck formation process and may encourage or accelerate existing deterioration rates.

2.3.3.9 Warfare

Another human-derived source for marine wrecks is war. Although Alaska has not been the main theater of war there have been campaigns in Alaskan waters that have contributed to the archaeological record. During World War II, the Aleutian Islands Campaign stretched from Unalaska in the east to Attu in the west. Numerous aircraft and ships were lost during the actions that happened in and around these islands. Some ships sunk while others ran aground. Like all loss categories there are multiple reasons for the loss of various craft during war. Some aircraft presumably ran out of gas while others were shot down. NHHHC reports the loss of several aircraft and vessels during the campaign (1945). Modern war also leads to the obvious conclusion that there may be unexploded ordnance in the maritime areas of conflict.

2.3.4 Summary

The initial formation and post-depositional processes that impact submerged cultural resources can have a direct and significant impact on the form and condition of an archaeological site. Site formation processes may influence the ability to detect archaeological resources on or below the seafloor. The Shipwreck and Downed Aircraft databases, therefore, include attribution of the wrecking event, water depth, location, and other factors, as separate variables. Geologic fault zones, sediment types, and sea-level contours are also provided in the Submerged Paleolandscape Database.

2.4 Cultural Heritage and Climate Change

During initial community engagement conversations, threats caused by changing climate conditions along the modern coastal zone were identified as a noteworthy concern for the long-term preservation of cultural resources. Some participants stated that the loss of existing coastal cultural sites presented a greater concern than the identification of previously unknown sites that are already fully submerged.

2.4.1 National Park Service Approach to Climate Change

Considering the ongoing and accelerating impacts of climate change, NPS has developed guidance regarding the management of impacts from climate change on cultural heritage that can be applied in other settings. Climate change, and the resultant impacts to archaeological sites, can also serve as a proxy to understanding past site formation processes.

The NPS acknowledged in 2010 that global climate change posed a real and increasing threat to the cultural and natural resources managed within the national park system and, as a result, they published best-practice guidance for understanding these impacts on a wider scale, and suggested ways to navigate these threats for future management (NPS 2010:3). At the time of publication, the NPS was acting on guidance from the fourth report from the Intergovernmental Panel on Climate Change (IPCC), which was the leading global body for assessing and understanding climate change, established by the United Nations Environment Programme and the World Meteorological Organization (IPCC 2007). Similar to the IPCC guidance, publication and collaboration were cited as key action areas for each of four themes identified in the NPS guidance: science, adaptation, mitigation, and communication.

The science theme presented in the 2010 NPS report advocated the concept of “stewardship science,” described as a multidisciplinary approach involving biophysical, socioeconomic, and cultural disciplines. Stewardship science as applied in national parks focuses on the relationships between connected systems at different scales, and is conducted through the analysis of existing information, ongoing research, and inventorying and monitoring known resources. Most importantly, stewardship science requires

communicating relevant information to site managers and stakeholders, which can further serve to increase institutional capacity and scientific literacy about climate change (NPS 2010:12). Of the four themes, adaptation may be the most unavoidable and inevitable as both a research approach and an outcome. Acknowledging that adaptation will affect virtually all NPS units and operations, it was seen as the area where science is applied, and action is taken. Adaptation includes the ability to identify and implement actions that can anticipate effects of climate change at a local and regional scale to potentially mitigate adverse impacts (NPS 2010:14).

The final theme, communication, builds on the international reputation of the NPS and its ongoing educational programs that address more than 300 million park visitors annually. With such a large potential audience, the NPS can raise awareness about climate change by including it in their educational programming and overall mission as it applies to both natural and cultural resources (NPS 2010:21–22). All four of these themes and their related actions require that resources be recorded and documented so that action can be taken,

A 2014 NPS policy memo provided more specific guidance towards the development of protocols within the organization regarding the impacts of climate change and its specific commitment to stewardship of cultural resources within NPS units (Jarvis 2014). The memo suggested three focus areas, broadly drawing on the guidance the 2010 NPS report discussed above, and identified as adaptation, processes of decision-making, and communication (Jarvis 2014:2–3).

The NPS policy memo includes several items of direct relevance to BOEM and the OCS database. According to the policy memo, processes of decision-making for cultural resources can be reframed to focus on those resources that are or will be impacted by climate change. Specific recommendations include refocusing inventory assessments on the most vulnerable areas within each park, prioritizing cultural resources according to current levels of vulnerability relative to their significance, understanding the range of climate change effects within a given area, consulting with a broad range of stakeholders, adding questions about adaptation and sustainability in the past and present into considerations of significance, and recognizing that loss may in some cases be inevitable (Jarvis 2014:3–4).

Communication, as defined in the NPS policy memo, includes public outreach and education. NPS guidance emphasizes the idea that cultural resources are inextricably linked to the stories they can tell, directly linking past cultures with present park visitors. These stories provide NPS staff with the opportunity to discuss issues related to climate change (including past human successes and failures, methods of adaptation, potential to learn from Indigenous or traditional knowledge), with the acknowledgement that this must be done even if it is uncomfortable as these conversations can spark discussion, inform choices, and lead to a wider understanding of the impacts and risks (Jarvis 2014:5). This type of storytelling can be just as important for cultural resources that are inaccessible for public visitation.

2.4.2 Cultural Resources and Climate Change

Whereas BOEM has a regulatory responsibility to protect cultural resources as part of the offshore lease permitting process, NPS is tasked with managing and caring for cultural resources on federal lands, including archaeological sites, cultural landscapes, ethnographic resources, museum collections, and historic buildings (Rockman et al. 2016:1). As of 2013, this included 27,000 historic and precontact structures; 3,500 statues, monuments, and memorials; an estimated 2 million archaeological sites; and more than 159 million museum objects and archival documents (NPS 2013). Given the quantity of resources likely to be impacted, NPS set out a science-based approach to mitigate against loss of significant elements of the nation's history and developed a framework for understanding the direct impact of climate change on cultural resources (Rockman et al. 2016). Four goals are outlined as part of this strategy (Rockman 2015, Rockman et al. 2016).

Goal 1: Connect impacts and information: Set out the broad scope of cultural resources and climate change response by connecting the concepts of impacts and information with the four pillars of climate change response: science, adaptation, mitigation, and communication.

Goal 2: Understand the scope: Coordinate science, management, and communication to identify and improve understanding of the effects of climate change on cultural resources.

Goal 3: Integrate practice: Incorporate climate change approaches with ongoing cultural resources research, planning, and stewardship practices.

Goal 4: Learn and share: Connect with partners to grow the body of knowledge for cultural resources and climate change (Rockman et al. 2016).

NPS recognized early that there are two primary considerations regarding the management of cultural resources and the impact of climate change: "... (1) cultural resources are primary sources of data regarding human interactions with environmental change; and (2) changing climates affect the preservation and maintenance of cultural resources" (Jarvis 2014:2). Climate change can therefore be viewed as a complex set of modern site formation processes.

Of specific relevance to an inventory and database of coastal historic resources is the ability to prioritize sites where mitigations are most needed or desired. Multiple adaptation options have been developed by NPS but are broadly applicable to any agency or group charged with the protection of cultural resources. The adaptation options, listed below, can be used individually or combined and can be considered in a sequence based on known data about the resource(s) under consideration. For sites that have been identified or areas where a density of sites are believed to exist, these adaptation options may be applied.

1. No Active Intervention: In some cases, it may be decided taking no action to intervene is the best decision, whether this is due to constraints such as economic feasibility and technological requirements. Such a decision can be made with the condition that it can be revisited in the future, particularly if conditions change (Rockman et al. 2016:36).
2. Offset Stress: If the active stressor on the site can be removed, deflected, or reduced in some way(s) with minimal intervention, this may be the best approach. The long-term goal here is to minimize impacts and enhance the chance of survival (Rockman et al. 2016:36).
3. Improve Resilience/Resistance: Taking steps to increase the resilience of the resource and its ability to resist change may be an option if it is decided the benefits (i.e., improved survival potential) outweigh impacts to the integrity of a resource. In this case, the benefit of applying mitigation may offset the unintended impacts to the resource (Rockman et al. 2016:36).
4. Manage Change: This can be a single action or a suite of actions, which either incorporate change into the resource directly, or into its overall management plan. The goal is to preserve character-defining features, while accepting the specific original materials or traits are gone (Rockman et al. 2016:36).
5. Relocate/Facilitate Movement: This adaptation strategy is a two-pronged approach, that focuses on physically moving all or part of a resource to a safer location or, alternatively, to allow natural movement or to remove difficulties that would inhibit movement of resources. In the second instance, this may be more applicable to ecosystems that contain species with cultural significance that can naturally migrate out of the area (Rockman et al. 2016:36).
6. Document and Prepare for Loss: In some instances, ongoing degradation to a resource may be unavoidable and inevitably lead to loss. In this instance, the focus should be on an appropriate level of documentation of the resource and an analysis of the full effects on the resource that can help managers to prepare for total loss. The level of documentation (full excavation/complete documentation vs. a reduced effort approach) should be decided based on current level of threat to the resource, and considerations such as economic feasibility, scale of anticipated impacts, or a

determination that the resource does not merit a comprehensive level of documentation (Rockman et al. 2016:37).

7. Interpret the Change: Bearing in mind the assertion that, “Climate change is the heritage of the future,” an action or set of actions at this point acknowledges the ongoing impacts present on the resource and uses this as a springboard to engage people in the future about the impact of climate change. In some ways, this integrates climate change into the biography for the resource and becomes the most recent site formation process impacting the resource. In many ways, this adaptation strategy could be used singly or in combination with any of the strategies (Rockman et al. 2016:37).

With these seven adaptation options in mind, it is worth noting that the choice of approach(es) should consider the resource(s) itself, and the broader context within which management decisions are made. This context could include “financial, technological, time-frame-urgency, and constraints and opportunities that may derive from technology, Tribal consultation, public engagement and participation, and cost-sharing, among others” (Rockman et al. 2016:35).

BOEM does not directly issue permits for activities within state waters or on state lands, but offshore development projects often have connected actions that will impact state resources. Offshore oil and gas platforms or wind farms generate power that is usually transported to shore via pipelines or transmission cables that cross state waters before coming onshore in state lands. Therefore, it is beneficial for BOEM reviewers to have information about coastal resources threatened by climate change and be in direct communication with the relevant authorities regarding potential communication, mitigation, or adaptation strategies. This can include a wide variety of potential partners including in the U.S., local/state/federal governments and agencies, Tribal governments, academic institutions, and non-governmental organizations. Internationally, such partners may run the gamut from large organizations, such as the United Nations Educational, Scientific and Cultural Organization’s (UNESCO) World Heritage Organization, the International Council on Monuments and Sites (ICOMOS), the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), to smaller organizations, such as local/regional/national scale organizations, governmental and non-governmental organizations and strategic planning programs.

2.4.3 Climate Change Impacts to Alaskan Cultural Resources

For several years, Alaska has been seen as the “canary in the coal mine” where ongoing impacts from climate change are concerned (Joling 2019). Ecosystem-wide environmental changes are being recorded across the Arctic that indicate a region in transition because of increasing air and sea temperatures, receding ice levels, extreme weather, wildfires, sea-level rise, and unusual wildlife mortality events (Druckenmiller et al. 2022:2, Hollesen et al. 2018). Seasonal shifts, coastal flooding, and more numerous severe storms occurring as part of these ecological changes are having a direct impact on the land, inland and offshore waters, and on local human populations. Indigenous communities, many of which rely on obtaining from 60 percent to 80 percent of their food from wildlife, are navigating the impact of these changes daily. Many see meaningful engagement and collaboration between Indigenous communities, scientists, and decision-making experts as critical to how these ever-increasing changes will be addressed in the future (SEARCH et al. 2022).

Inevitably, the climate change realities occurring broadly in the Arctic, and specifically in Alaska, are having direct impacts on Alaskan cultural heritage sites. Approximately 45,000 cultural resources sites (including archaeological sites, buildings, structures, objects or locations, and some paleontological sites) are recorded within the AHRS by the Alaska Office of History and Archaeology (AOHA) (AOHA 2023). While a substantial number is unknown, duVall (2023) estimates that as little as 5 percent of the state has been surveyed for cultural resources, meaning the type of potential sites present and the density of those sites have not been documented. Alaska’s rich and extensive Indigenous history, in combination with its

more recent historical settlement and modern development, have combined to create a state rich in archaeological and historical resources. duVall (2023) notes, “An understanding of the depth and breadth of human history in Alaska informs our global understanding of human evolution, migration, occupation, adaptation, and cultural change around the planet.” In many ways, Alaskan cultural resources are at the forefront of climate change concerns and are as much a part of the ‘canary in the coal mine’ analogy as are the impacts to local human populations.

Out of necessity, comprehensive discussion of the impacts of climate change in Alaska is not possible within the confines of this report. Reference is made to the following sources for additional information: Bering Sea Elders Group n.d., Druckenmiller et al. 2022, Thoman and Walsh 2019, U.S. Global Change Research Program (USGCRP) 2018, Hollesen et al. 2018, and Johnson 2011.

2.4.3.1 Submerged Sites

Expansive research on submerged archaeological sites offshore of Alaska is not readily available, but broader analysis has highlighted relevant concerns regarding climate change and offshore cultural resources in general (Gregory et al. 2022, Wright 2016, Rockman et al.:6). It has been suggested that predictions on the scale of global impacts at local scales on specific submerged archaeological sites are impossible to accurately calculate (Dunkley 2015:218, Wright 2016:257). Many ongoing climate change-related impacts are affecting submerged cultural resources to varying degrees based on locally observed conditions. The following lists some of those impacts, with a brief description of how each can cause dramatic changes on submerged archaeological sites (Wright 2016, Gregory et al. 2022). While not comprehensive, it does present primary concerns for ongoing site management. It also illustrates how intertwined many of these impacts are, with one often increasing the effect of another on submerged materials.

- **Sea-level rise:** The most obvious impact of sea-level rise comes in the form of impacts to coastal sites, flooding events, rapid erosion, and more powerful wave action. For submerged sites, this could have few mechanical impacts due to wave action or currents but could cause changes in temperature, ocean chemistry, site erosion leading to increased biological and chemical degradation processes or increase or decrease in seagrass cover (Wright 2016:257–259).
- **Sea temperature rise:** Ocean warming, especially in depths that are shallower than 100 m (328 ft), can affect site preservation to organic and metal materials. Warmer temperatures are leading to increased rates of metal corrosion, and loss of ice cover leading to increased oxidation can destabilize artifacts, encouraging deterioration. An increase in temperature can alter biological interactions with underwater sites, including changing the range and density of species of shipworm and zebra and quagga mussels. The rise in temperature can create a ripple effect in a number of environmental conditions that have a direct effect on submerged cultural resources (Wright 2016:260–261, Gregory et al. 2022:6–7).
- **Physical impacts:** A major impact to submerged sites comes from mechanical damage from the increased frequency and strength of storm/hurricane/typhoon events, increased storm surge, and erosion of stabilizing sediments and site integrity. These effects, combined with increased wind speeds and precipitation rates, can be enough to expose a previously buried and stable site and to potentially cause the total loss of a submerged site. In some instances, physical impacts causing changes in sediment dynamics can have an overall positive effect, such as when the construction of jetties and sea defenses results in deposition rather than erosion. Understanding the physical impacts, positive and negative, is key to managing underwater sites in relation to climate change (Wright 2016:259–260).

- Ocean acidification: Global carbon cycles have shifted dramatically since the 1980s. Oceans absorb much of the carbon dioxide created through the industrialization of the modern age; however, it does not have an infinite capacity to continue to absorb and filter the quantities of carbon dioxide being produced today. The rise in sea temperature means that seawater cannot continue to absorb the ever-increasing levels of carbon dioxide, leaving more in the atmosphere and causing further warming to the planet. This is causing an increase in the acidity of ocean waters, potentially causing significant impacts to submerged archaeological materials. More research is required but, for example, metal-hulled shipwrecks appear to be particularly vulnerable to these chemical changes (Wright 2016:261–263, Gregory et al. 2022:8–10).
- Seabed erosion: Sea-level rise and physical/mechanical impacts can cause changes to the seabed. Seabed erosion is called out here as changing weather conditions can directly affect submerged sites. Significant research has been completed on some individual shipwreck sites using marine geophysical techniques for mapping and monitoring. However, most submerged sites have not been surveyed with these techniques, meaning managers lack the baseline record against which they could measure seabed changes after severe storm events. It is possible fluid dynamics could be used to model some of the complex processes at work. However, severe weather events can be difficult to predict and exhibit strong regional variations making such modelling also nominally effective with current methods (Gregory et al. 2022:7).
- Wood-boring bivalves: Sea temperature rise, as discussed above, is changing habitats and ecology of marine flora and fauna. Recent investigations into the distribution of nine species of shipworms indicate that their habitats are expanding, the higher temperatures allowing them to comfortably thrive in areas where once colder temperatures made this impossible (Borges et al. 2014, Gregory et al. 2022:8). The proliferation of shipworms in ocean and sea areas where they have not previously been present places wooden shipwrecks in a precarious position for long-term, in situ preservation.
- Dissolved oxygen: The amount of dissolved oxygen in seawater is declining (hypoxia), broadly a result of overall climate warming due to the increase in water temperatures. Ironically, this hypoxia may have some benefits to submerged cultural heritage as it could limit the growth of the shipworms. However, it is unsustainable for the environment as a whole in the long term as it disrupts the natural balance of oxygen supply and demand. In the short term, it is largely unknown if there may be downsides for cultural heritage not yet observed or documented (Gregory et al. 2022:10).

Though not exhaustive, the above list presents several of the challenges faced by submerged archaeological sites from climate change. As noted in Gregory et al. (2022:10), “Caution should be exercised, however, as it is the ‘interrelatedness of everything’ (Sesana et al. 2021:10) that influences deterioration processes.” Several of the impacts above overlap and are interconnected, one causing an inevitable ripple effect on another. Unlike a large proportion of coastal sites, the full scale of the impact of climate change on submerged archaeological sites is largely unknown. Few such sites have been subjected to baseline surveys and fewer still undergo regular monitoring to provide current data on how they are being impacted. In many ways, coastal and submerged sites together lag behind investigations into natural resource conservation considering climate change. While somewhat discouraging, an increase in citizen-science projects in coastal areas and underwater is highlighting the difficulties in preserving these sites. Ongoing efforts to engage the public through a better understanding of the ‘blue’ economy is helping to show the alignment between economic and trade activities, such as tourism, and the need to focus on conservation and sustainability as viable management tools (Gregory et al. 2022:12–13). One such initiative, the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) (the Decade) is well underway. The Ocean Decade Heritage Network (ODHN) is actively working to

integrate considerations of archaeology and cultural heritage into the marine sciences within the context of the Decade (Trakadas et al. 2019). As noted throughout this discussion of climate change and its impact on cultural heritage resources, the way forward focuses on the need for interdisciplinary communication and engagement at all levels, inclusive of as many stakeholders as possible.

2.4.3.2 Modern Anthropogenic Impacts and Climate Change

While the connection is perhaps not immediately obvious, modern anthropogenic activities are also being impacted by climate change and are subsequently becoming a threat to coastal and underwater cultural heritage sites. A recently announced partnership between The Ocean Foundation (<https://oceanfdn.org/>) (TOF) and the Lloyd's Register Education Foundation Heritage and Education Centre, entitled Threats to Our Ocean Heritage, is one of only two officially recognized underwater cultural heritage research projects under the Decade program. The project has been designed to investigate threats from potentially polluting wrecks (PPW), bottom trawling, and deep seabed mining. Outcomes from the project include publication of a three-book reference series to be freely available, one book on each threat; convene a global network of experts to give guidance regarding policy change in relation to each threat; and work with ocean stakeholders and policymakers to work toward conservation action and seek best management practices (TOF 2023a). A recent online seminar held by the North American Heritage at Risk organization, affiliated with the Society for Historical Archaeology, presented aspects of each threat, as well as current understanding and research trajectories (Jarvis 2023). Of note in the discussion was the recommended terminology of referring to the combination of underwater cultural heritage and underwater natural heritage as simply 'ocean heritage' (Jarvis 2023). Each of the threats is briefly presented below, including notes on implications for maritime cultural heritage in Alaska.

- Potentially polluting wrecks (PPW): TOF will be building on work conducted by the NOAA, which has acknowledged that many of the approximately 20,000 shipwrecks in U.S. waters could potentially impact the surrounding environment from decay of the cargo, fuel leaks, and ship integrity (NOAA 2013). As these wrecks age and are impacted by accelerated corrosion and hull degradation caused by climate change, they are actively polluting the surrounding environment and require management to avert disaster. Many of these wrecks are freighters and World War II casualties. Globally, as many as 8,500 wrecks have the potential to leak as much as 6 billion gallons of oil into the sea (IUCN 2023). Investigating the problem is hampered by the variety of governments involved, and a general lack of data. Leaks at such a scale pose a direct threat to human health and marine ecosystems around the world (Jarvis 2023).
 - Of the wrecks listed by NOAA in the 2013 report, one Alaskan wreck (the *Princess Kathleen*) has undergone recent remediation, removing 2,620 barrels of heavy fuel oil. Two wrecks in Alaskan waters have had risk assessments and are considered high or medium priority for potential removal of oil in coming years (https://sanctuaries.noaa.gov/protect/ppw/wrecks_regions.html).
 - Brennan et al. (2023) presents data for two World War II wrecks, the *Coimbra* and the *Munger T. Ball*, which included assessment of site formation processes and hull integrity for pollution mitigation. Remediation of the *Coimbra* removed an estimated 450,000 gallons of oil, which was disposed of at a facility in New York. Remediation of the *Munger T. Ball* pumped approximately 35,000 gallons of heavy fuel oil from the site. The article provides important information about the approach followed for site assessment and documentation of potentially polluting wrecks, site integrity, ongoing deterioration, and anthropogenic impacts, such as fishing and trawling.

- Bottom trawling: Industrial-scale fishing utilizes bottom trawling to herd and capture target species by towing a large net along the ocean floor. The netting contains the fish, trapping them to prevent escape. In addition to the targeted species, it also traps a significant amount of bycatch, often sea turtles and marine mammals (NOAA 2022). Efforts have been made to reduce the amount of bycatch, but until now little attention has been paid to the damage these nets and the act of dragging them along the seafloor can do to submerged cultural heritage. Bottom trawling removes sediment, destabilizes the physical environment, and leaves behind evidence of scraping similar to plowing. Waste is typically dumped overboard, further impacting the marine environment. Coastal trawling can be particularly destructive; deep sea trawling is increasing, which paves the way for equally destructive deep-sea resource extraction, such as deep-sea mining (discussed below) (Jarvis 2022, 2023). The ongoing loss of sea ice due to climate change mentioned above is opening new fishing areas and/or leaving them vulnerable for longer periods of the year. Areas in the Arctic and around Alaska may be the front line of these changes to fishing habits and areas to be trawled. TOF is researching the effects of bottom trawling and seeking ways to limit or mitigate the method. However, challenges abound in coordinating such an effort between governments, states, international fishing conglomerates, etc.
 - Though not fully investigated in the scope of this report, the following two websites are noted as relevant to recent bottom trawling survey work in Alaska. Surveys were completed by NOAA in 2023: <https://www.fisheries.noaa.gov/alaska/commercial-fishing/alaska-groundfish-bottom-trawl-survey-data> and <https://www.fisheries.noaa.gov/foss/f?p=215%3A28>.
- Deep seabed mining (DSM): DSM poses a distinct threat to underwater cultural heritage. Some of this threat will likely be focused on Alaskan waters and the Arctic due to the loss of sea ice expanding the areas where commercial industry will be able to search for minerals, such as manganese, copper, cobalt, zinc, and rare earth minerals (TOF 2023b). Commercial DSM is not yet a reality, but a number of companies are developing the methods, surface vessels, and seabed vehicles capable of harvesting the minerals. TOF already anticipates the impacts from DSM could include waste dumped into the water column, physical mining of the seafloor, and a potentially toxic slurry left over from processing being dumped into surface waters (TOF 2023b). As so little is known about the deep seabed, it is difficult to assess the potential impacts. However, what is known about DSM indicates that it poses a real threat to the environment and to underwater cultural heritage (TOF 2023b). TOF is actively working with organizations such as the Deep Sea Conservation Coalition (<https://savethehighseas.org/>) to advocate for the protection of the deep seabed.
 - An initial investigation into the marine minerals present offshore of Alaska was completed by the U.S. Geological Service in 2022 (Gartman et al. 2022). The investigation identified several prospective seabed areas that may contain ferromanganese crusts and manganese nodules. The report notes that “Deep-ocean ferromanganese crusts are known to occur in two regions: (1) the Gulf of Alaska seamounts and (2) the Chukchi Borderland in the Arctic Ocean. Limited sampling has occurred in both regions, and along the Chukchi Borderland the sampling was outside of the OCS and the U.S. EEZ (Gartman et al. 2022:1). Investigations such as this one appears to be laying the groundwork for understanding the current state of knowledge in advance of further developments in DSM occurring in Alaskan waters.

2.4.3.3 Seabed Mapping, Site Formation Processes Analysis, and Climate Change Monitoring in Alaska

In the discussion of bottom trawling above, reference is made to recent surveys conducted by NOAA assessing fish stocks and habitats, reporting on the status of the Alaska marine ecosystem, and creation of a fisheries life database, and other tasks. In 2023, NOAA completed hydrographic surveys on several regional areas offshore Alaska (NOAA 2023k). Projects included Approaches to Nome, Pribilof Islands, Togiak Bay, Bristol Bay, Seascope Alaska (Seascope AK), and Approaches to Revillagigedo. In reviewing the individual project descriptions in the ArcGIS Story Map, overlapping goals of the surveys included providing baseline mapping data for the individual area; assessing safety of transit routes; obtaining data on climate change, referencing the damage left by Typhoon Merbok in 2022; developing accurate navigational charts; supporting marine geohazard studies; continuing earlier mapping campaigns with updated data; and gathering data for and supporting the Seascope Alaska project discussed below. In comparison to Alaska's vast coastline, the survey areas may seem small, but they are indicative of the data needed to manage impacts of climate change on natural and cultural heritage and maintain active, safe, healthy seas in the region.

Working closely with a group of partners (including the State of Alaska, NOAA, BOEM, the U.S. Coast Guard, the U.S. Army Corps of Engineers, the National Renewable Energy Laboratory (NREL), the U.S. Geological Survey, the NPS, the Alaska Center for Energy and Power, Woolpert, Saildrone, and Fugro), Seascope AK is a regional mapping campaign working in partnership with federal, state, Tribal, and non-governmental partners to fully map Alaskan waters (Seascope AK 2023). Like the current project, it is working to centralize data across the U.S. EEZ. The initiative is part of the 2020 National Strategy for Mapping, Exploring, and Characterizing the U.S. EEZ. Specifically, Seascope Alaska is described as an effort to collect bathymetry data that can also be used to characterize and provide information on the physical seafloor, marine habitats, and biological and archaeological resources (Seascope AK 2023). The goal of the project is to use the high-quality data generated to inform science and management decisions, including fisheries management, and gain a better understanding of hazards, and develop appropriate management strategies. The three main objectives include inventorying pre-existing data into centralized locations, encouraging mapping of areas that either are unexplored or underexplored, and encouraging multidisciplinary planning and technology innovation to maximize data collection for every surveyed nautical mile (Seascope AK 2023). It is hoped that increasing understanding of the habitats, underwater archaeology, and biological, geological, and chemical characteristics of the seabed will have benefits to Alaskan communities and beyond. For underwater cultural heritage, it also has the potential to provide baseline data on new and previously documented archaeological sites, which could include information about current site formation processes active on the sites and impacts from climate change that require ongoing monitoring and management.

A final mapping initiative not specific to Alaska, but nonetheless worth mentioning in the context of the current discussion, is Seabed 2030 (Seabed). Another direct action from the Decade, Seabed is a partnership between The Nippon Foundation, General Bathymetry Chart of the Ocean (GEBCO), International Hydrographic Organization, and UNESCO (Seabed 2023). When first launched in 2017, only 6 percent of the seabed was mapped. In the intervening years, this has grown to a quarter of the seabed being mapped. In 2021, Seabed was recognized as a flagship program for Decade projects, leading the way as the Decade proceeds. The long-term goal is centrally organizing current mapping data and making it freely available to all. The Global Center for the project is in the British Oceanographic Data Centre, with other regional centers located around the world. GEBCO intends to produce comprehensive, publicly available bathymetric data, which can then be used by anyone for local and regional projects (Seabed 2023); GEBCO data were used in the construction of maps presented in Chapter 3 of this report. While not specifically tracking underwater cultural heritage, site formation processes, or climate change impacts, the mapping generated can be used as baseline information for all three around the world.

2.5 Site Formation Processes as Database Content

The site formation processes reviewed in this chapter influence all aspects of submerged cultural resources, including but not limited to where sites may have been created or formed, how they appear on geophysical data, the chances of site discovery, and the likelihood of site preservation. The various databases developed as part of this study provide a comprehensive illustration of conditions offshore. While it is understood that BOEM operates within a specific regulatory authority, improved communication and data sharing with other land managers and agencies within the Alaska OCS region may result in enhanced identification of significant submerged cultural resources and opportunities for collaborative research actions or public engagement activities.

3. Submerged Paleolandforms Database

3.1 Historical and Contextual Overview

The question of how to identify submerged and buried archaeological sites on the world's continental shelves where they exist has been addressed since at least the 1970s. Historically, researchers observed that most precontact artifacts identified to that point were the result of isolated or accidental finds by recreational divers, fishermen, or offshore construction (Masters and Flemming 1983:611). An archaeological inventory of historic resources conducted in the Gulf of Mexico (CEI 1977), and an edited volume resulting from an international symposium on human occupation and exploitation of the world's continental shelves (Masters and Flemming 1983) resulted in some of the earliest best practices guidance for identifying submerged and buried archaeological sites offshore. Instead of emphasizing artifact assemblages or other more typical site types, the early best practice focused on the association of sites with preserved landforms in the offshore environment. The emphasis on landforms was suggested because there is a greater chance of landforms being imaged through marine survey techniques, including bathymetric seafloor mapping, side scan sonar survey, and subseafloor acoustic profiling than individual lithics or sites consistent with hunter gatherer populations. Remote sensing methods, according to best practices, had to be assessed within the context of local geomorphology to identify areas with high preservation potential and the potential presence of recognizable features. Finally, the recommendations suggested that research must confirm that the area of interest contained physical landscape features that would sustain basic human needs, such as access to fresh water, protection from the elements, and/or access to reliable food sources (Masters and Flemming 1983:623).

Multiple predictive models have been proposed and refined over the last several decades with the purpose of refining the identification of submerged precontact sites, the majority of which share the basic premise of identifying the same types of landforms in the offshore environment as landforms from terrestrial contexts that correlate with the documentation of known archaeological sites (e.g., Pearson et al. 1986, Dix et al. 2004, Benajmin 2010, Evans and Keith 2011, Bailey et al. 2017). Described as a spatial application of middle-range theory, the intent is to take what is known about human behavior and archaeological site modeling on land at a given point in time and extend those expected behaviors and practices to an area offshore that would have been exposed as dry land at the same relative time (Evans 2016:4). While relatively few indisputable archaeological sites have been identified from submerged and buried contexts, these best practices have resulted in the identification of high probability areas for archaeological significance. As summarized by Flatman and Evans (2014:6), archaeological significance is the sum of multiple factors, defined as “W (area) + X (potential) + Y (likelihood) = Z (significance)” (Flatman and Evans 2014:6).

The investigation of submerged paleolandscapes consists of both synchronic reconstruction of a specific landscape or geological horizon at a given point in time, and a diachronic reconstruction of the changes that have impacted and altered that same landscape horizon from the time of interest until the time of investigation and analysis (Evans 2016:6). Given that the techniques recommended as best practice include geophysical remote sensing followed by ground truthing of sediments through either coring or surface sampling, it is understood that any landscape modeling must start at the seafloor and image vertically through various sediment facies to the horizon of interest. This top-down approach begins with the identification of “modern marine sediment at the seafloor and works backward through time with depth” (Evans 2016:6). Marine site formation processes (previously detailed in Chapter 2) play a critical role in determining where sites would have been most likely to have been preserved.

The intent of the Submerged Paleolandscapes Database is to generate information pertaining to the physical landscapes within the Alaska OCS and surrounding shorelines to aid in identifying landscape features and environmental attributes. This is considered the first step in assessing archaeological

sensitivity and is consistent with previous BOEM regional approaches to paleolandscape modeling (CEI 1977, TRC 2012, ICF 2013).

3.2 Methodology and Data Sources

The information used in the Submerged Paleolandscapes Database was pulled from publicly available sources based on literature reviews and research. Many of the identified studies referenced small, concentrated study areas, with few studies that directly addressed the entirety of the Alaska OCS. The methods used in creating the data layers shown in the Submerged Paleolandscape Database often required the synthesis of multiple data sets, and extrapolation over areas with limited to no data. Because the methods and data sources are intrinsically linked, they are grouped together in the discussion presented below. Figure 3-1 displays the state and federal waters boundaries along with a 140-m (459-ft) below-sea-level elevation contour. This extent for submerged landform investigation is used in the proposed BOEM rule change for surveys in the Gulf of Mexico and is based on general global sea-level curves. While rates of change vary among places and data sets, most eustatic sea-level models indicate that sea levels were approximately 140 to 125 m (459 to 410 ft) lower than present mean sea level at the end of the LGM (Bailey and Flemming 2008, Bird 1993:14). For this study, the estimate of 140 m (459 ft) was used as it provided maximum coverage and helped to offset any potential variation related to regional or localized uplift, or shoreline variability.

3.2.1 Sea Level and Glaciation

Sea level and glaciation histories are tightly linked, with the increasing global water storage in glaciers during ice ages causing oceans to shrink, sea levels to decline, and continents to grow. The large ice masses assert pressure on land, causing the continents under them to subside due to isostasy. Having hosted widespread glaciation in the recent past and continuing to hold glaciers in some areas today, Alaska's sea-level history is complex (Figure 3-2). Oceans are currently growing globally due to thermal expansion (warming) and glacial meltwater inputs, while the continental region here is rising due to isostatic rebound from the melting of the Cordilleran ice sheet. The rate of current global warming is such that Arctic regions, including Alaska, are experiencing rapid environmental change today (e.g., Farquharson et al. 2018, Jorgenson et al. 2018, Litzow et al. 2020, Maraldo 2020, Chen and Zhang 2021), with coastal Alaskan communities experiencing dramatic impacts (e.g., Albert et al. 2018, Berman and Schmidt 2019, McDaniel et al. 2019, Birchall 2020, Fitton et al. 2021). Maps of the modern shoreline and glacial extent in Alaska, therefore, have relatively limited longevity compared to those for other areas of the U.S. Our models of sea level and glaciation from the LGM to today synthesize the recent literature for Alaska (Figures 3-2 to 3-7) (Seguinot et al. 2016, Lesnek et al. 2018, Lesnek et al. 2020, Wang et al. 2021, Haeussler et al. 2022).

3.2.2 Sedimentation and Tectonics

There are many influences on sediment flux and disposition in the oceans. Just like on land, sediment moves downward in potential with any force strong enough to carry it. In terms of global sediment volume deposited in the oceans, the primary transport method is alluvial. For the waters surrounding Alaska, glaciation, ocean currents, and (of course) tectonics play critical roles in sediment flux and its ultimate fate - whether it is deposited and, if so, where (Figure 3-8) (Straume et al. 2019). There are several areas with notable sediment accumulation surrounding Alaska, speaking to persistent deposition dynamics.

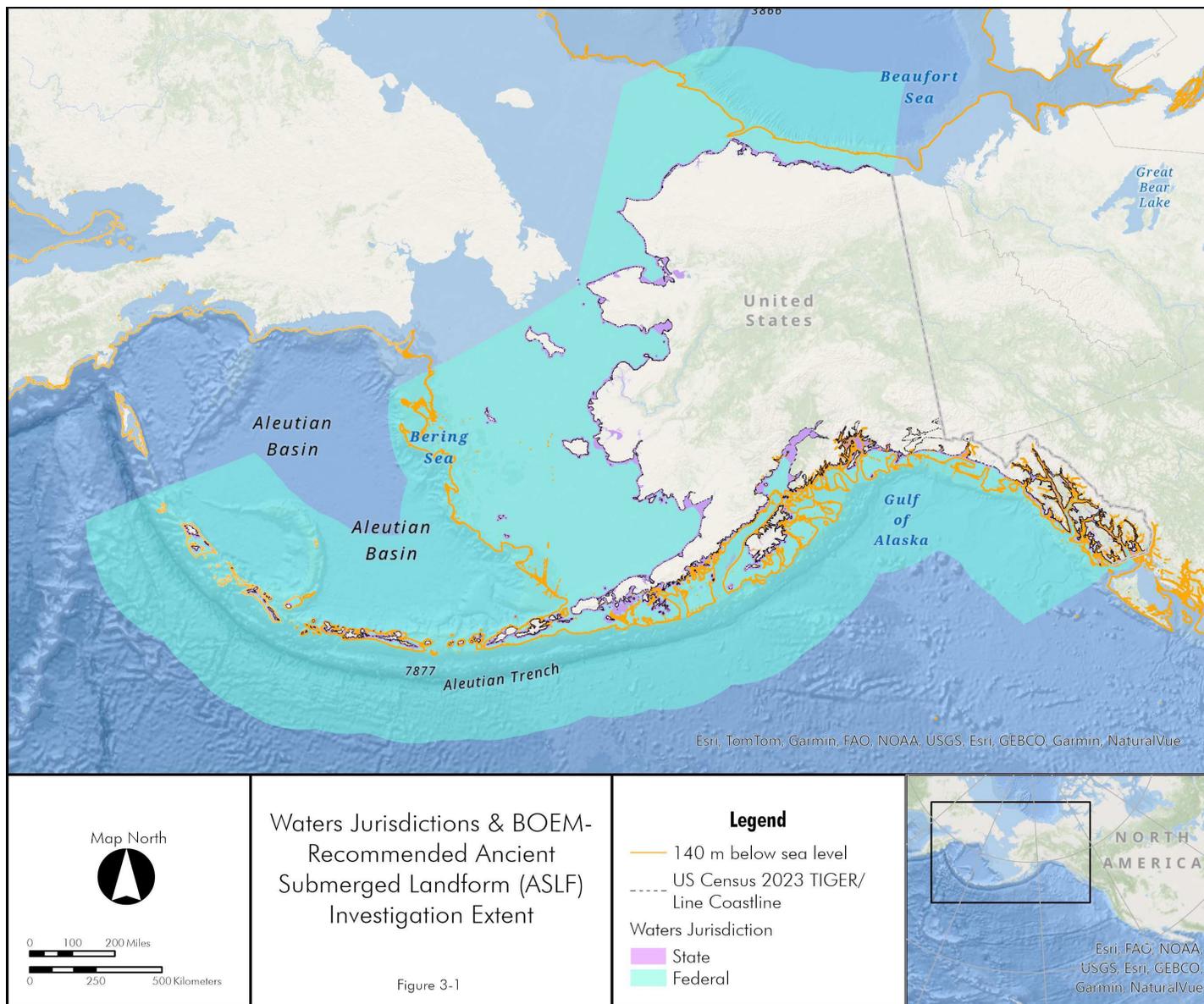


Figure 3-1. Waters jurisdictions and typical ancient, submerged landform (ASLF) investigation extent

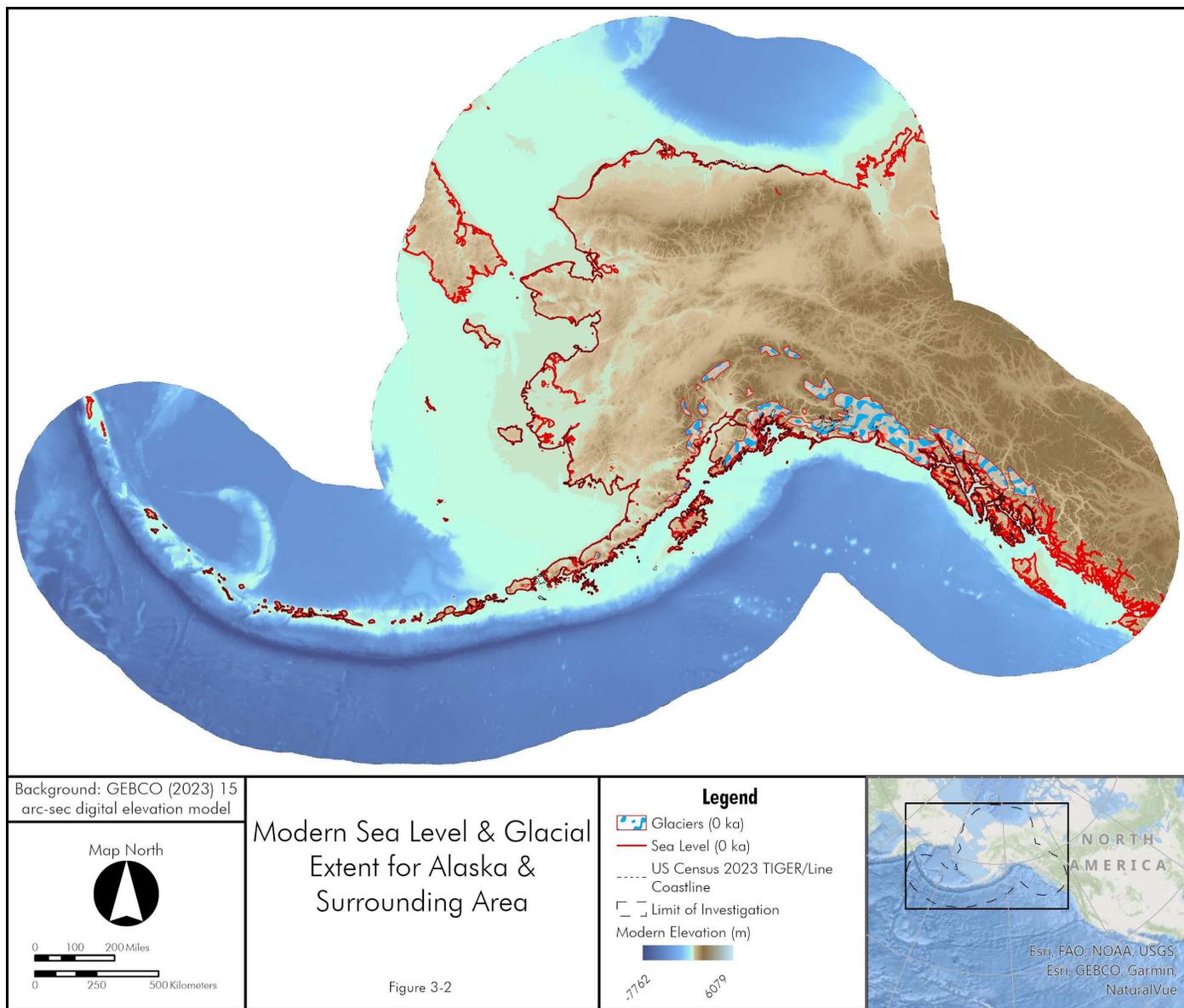


Figure 3-2. Modern sea level and glacial extent for Alaska and surrounding area

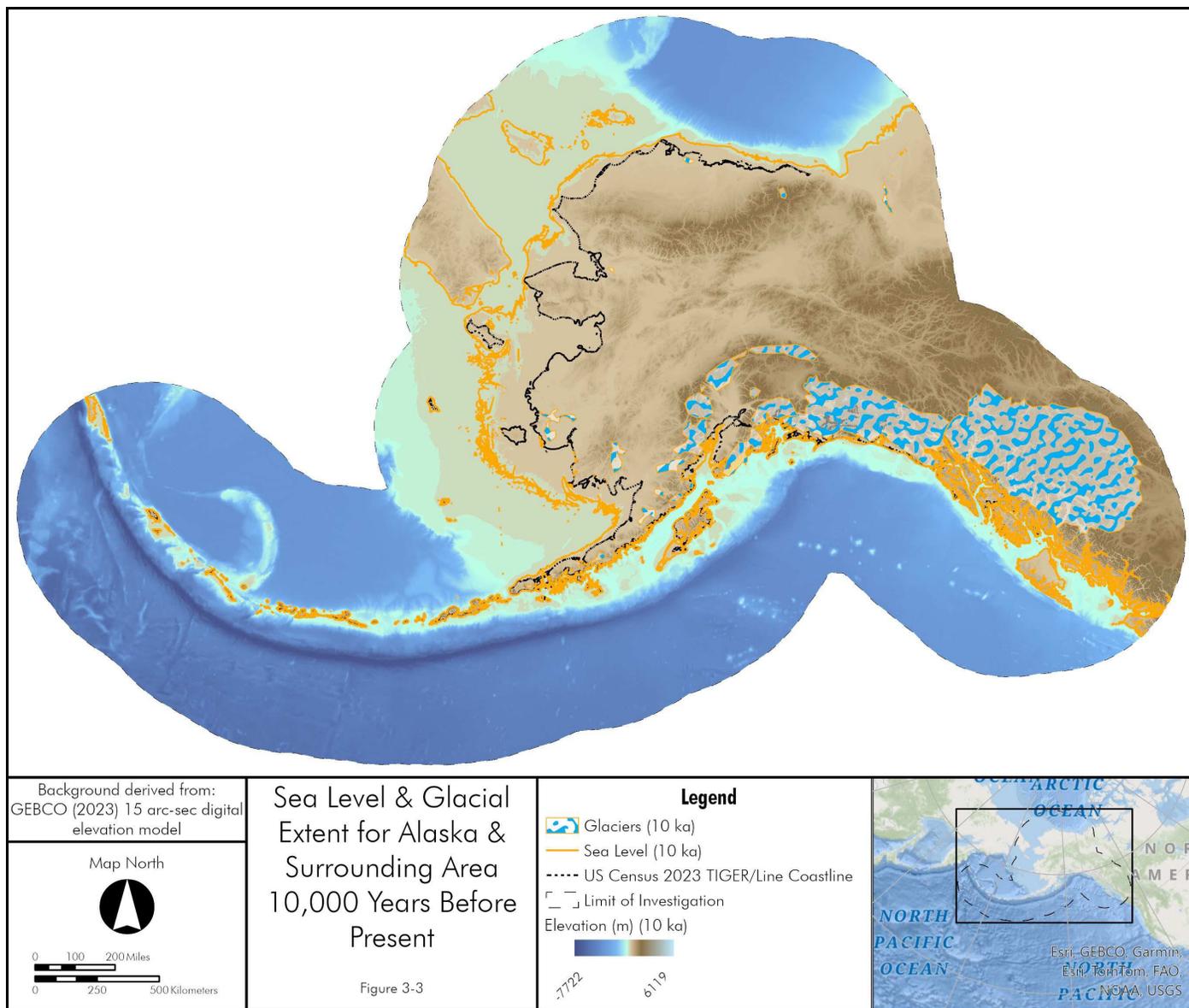


Figure 3-3. Sea level and glacial extent for Alaska and surrounding area 10,000 years Before Present

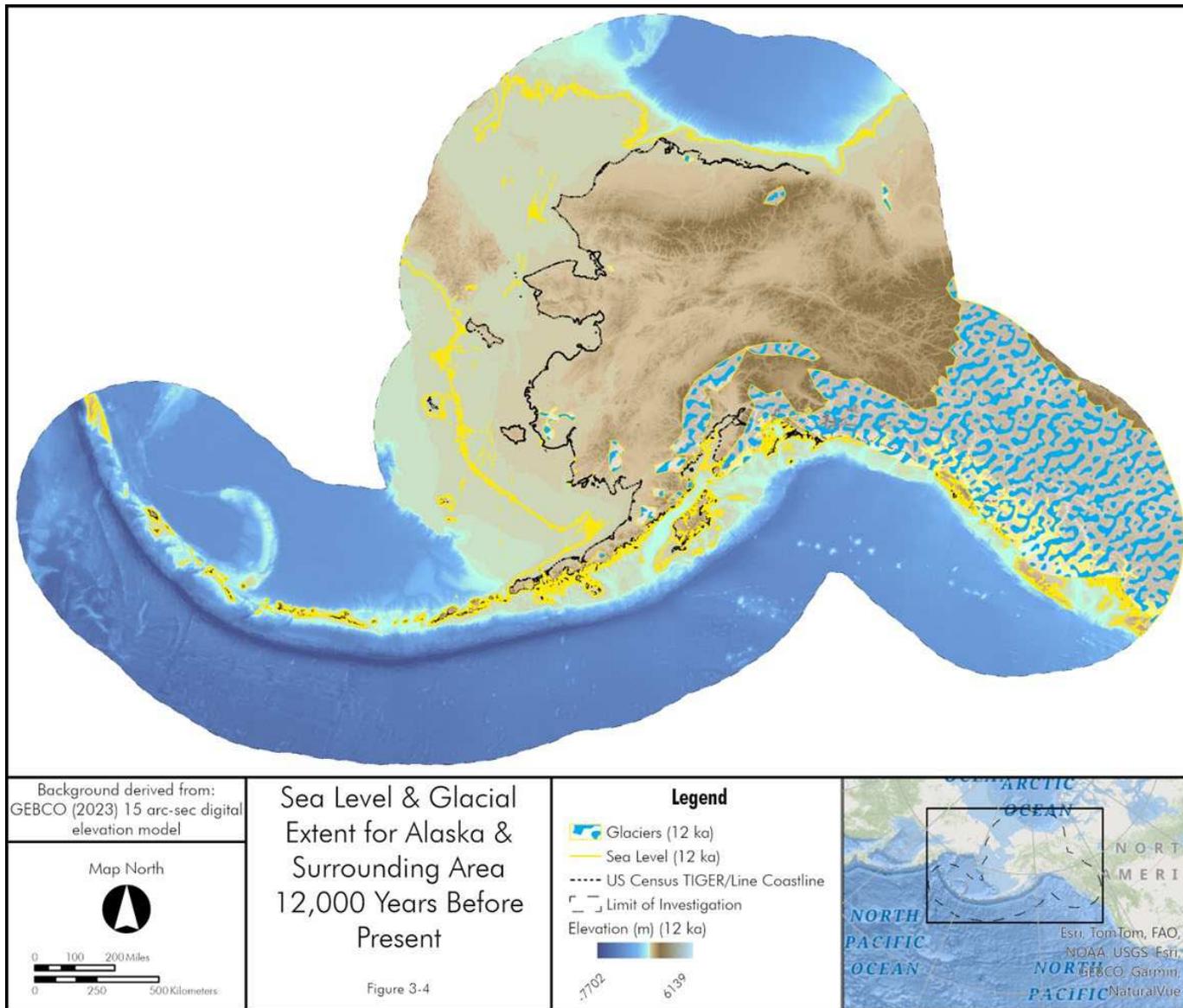


Figure 3-4. Sea level and glacial extent for Alaska and surrounding area 12,000 years Before Present

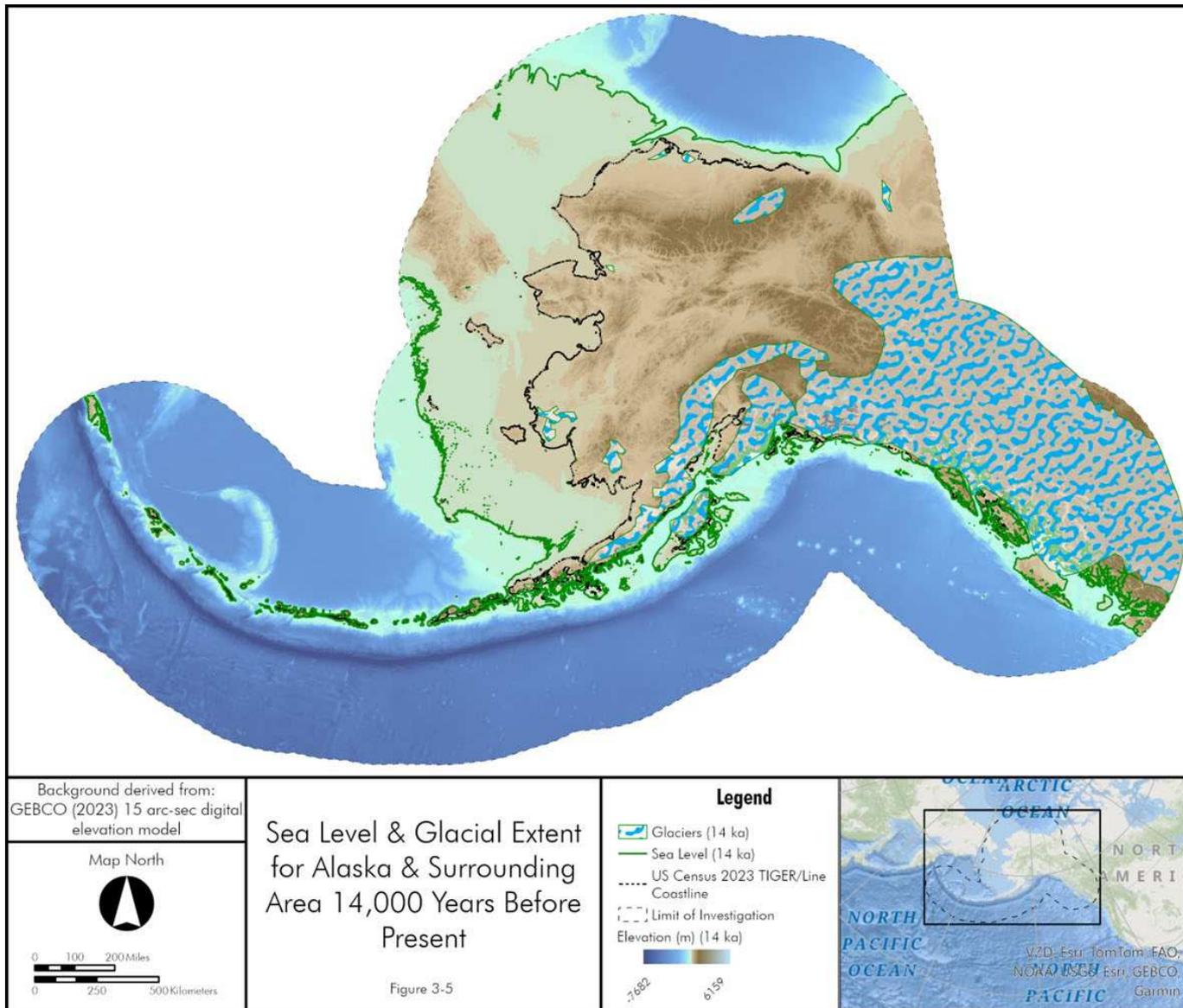


Figure 3-5. Sea level and glacial extent for Alaska and surrounding area 14,000 years Before Present

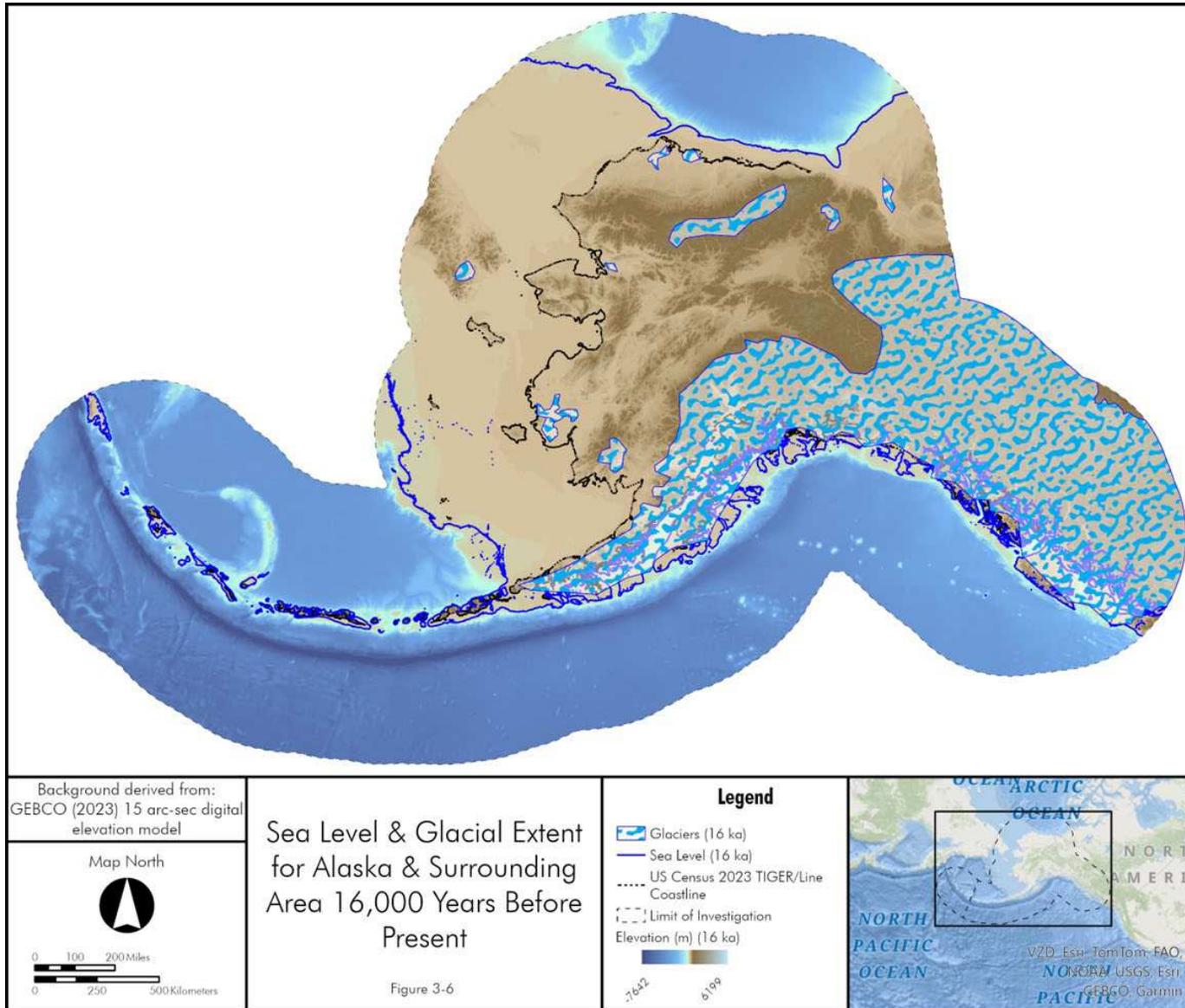


Figure 3-6. Sea level and glacial extent for Alaska and surrounding area 16,000 years Before Present

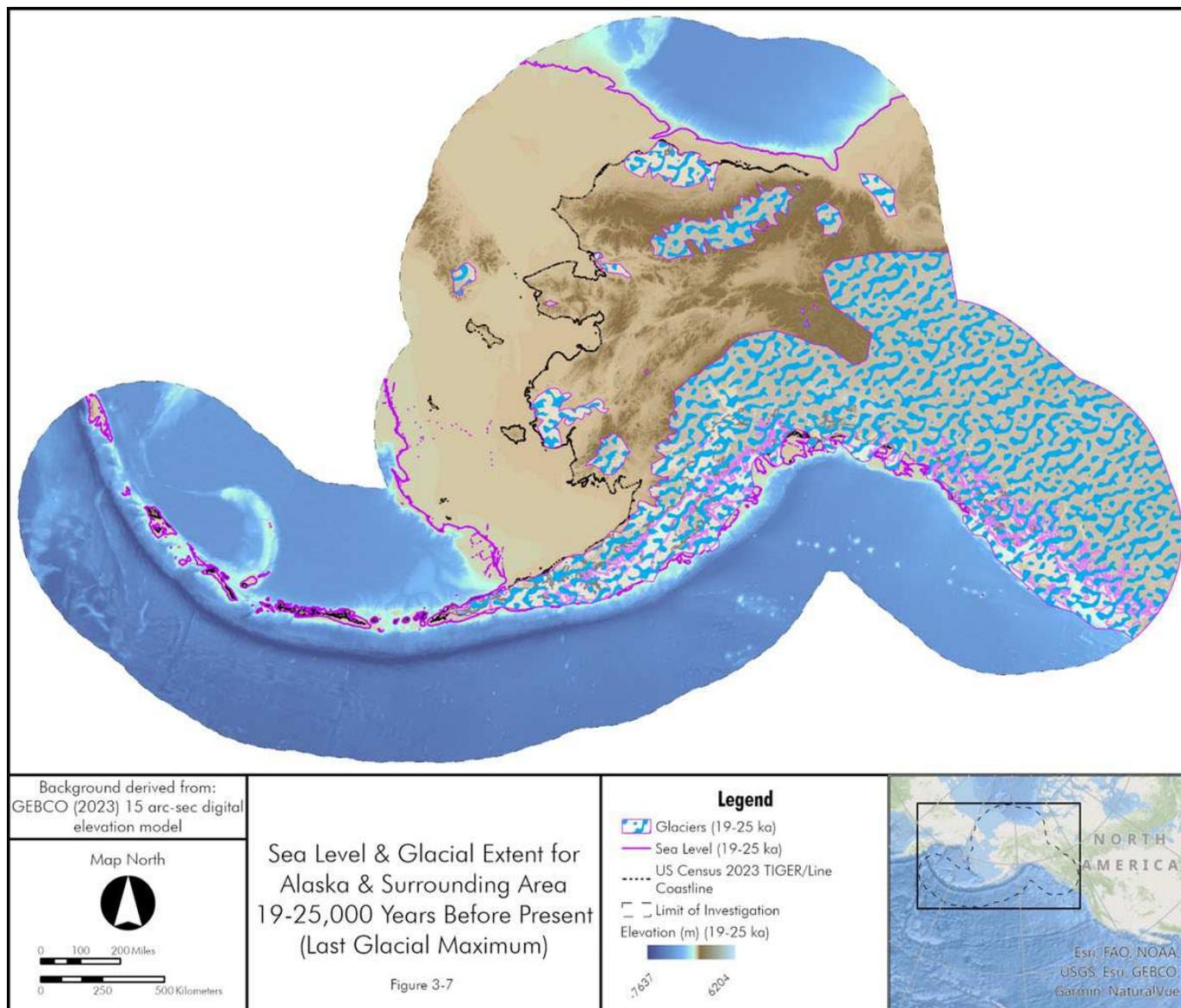


Figure 3-7. Sea level and glacial extent for Alaska and surrounding area 19–25,000 years Before Present (Last Glacial Maximum)

3.2.2.1 North Coast

The greatest sediment thickness occurs off Alaska's northern coast, due to sediment drainage from the myriad northward-flowing rivers and creeks that drain the Canadian Rockies and the Brooks Range, including the Mackenzie, Colville, Canning, Meade, and Sagavanirktok Rivers. Though a wholly Canadian river system, the Mackenzie is second only to the Mississippi River in size and impact on North America. It drains the glaciers of the Canadian Rockies to the Beaufort Sea, so it is the primary influence on that sea in terms of inputs and sedimentation, past and present. The relatively smaller streams of Northern Alaska drained the Brooks Range glaciers while they persisted and greatly impacted sedimentation in the Chukchi Sea. Today ocean currents continue to impact these sediments, though the glaciers have receded, greatly reducing the sediment flux. Generally, as distance from Alaska's northern shore increases, ocean current (especially Beaufort Gyre) influence on these large deposits also increases (Stabeno et al. 2018).

3.2.2.2 West Coast

There are local sediment accumulations in Bristol Bay, Norton Sound, and Kotzebue Sound from the terrestrial drainage to those bodies, though these are small in comparison to those on the north coast. The Bering Strait current flows between Russia and the U.S., which would limit sediment accumulation there (Stabeno et al. 2018, Wang et al. 2021). West of the Bering Strait and north of the Aleutian Islands, the large accumulation of sediment in the Aleutian Basin closely follows the structure of the basin itself.

3.2.2.3 South Coast

Alaska resides at the boundary between the North American and Pacific plates. The subduction of the Pacific plate under North America forms the Aleutian Trench and the many volcanoes that span much of Alaska's southern border. Alaska is tectonically complex, with many microplates occurring at this boundary between major plates and shaping this diverse terrain (Figure 3-8) (Hasterok et al. 2022). While not as thick as those on the northern and western borders, there is a broad sediment accumulation along the west coast of Southeast Alaska from the eastern Gulf of Alaska to Haida Gwaii. This area is adjacent to the Wrangell and Coast Mountains, which continue to support sizable glaciers today, producing sediment-rich drainage (see Figure 3-2).

3.2.3 Ecological Regions

The land mass of modern Alaska represents approximately 1,518,800 km² (586,412 mi²) of area, 54,718 km (34,000 mi) of tidal shoreline, and three million lakes, and multiple rivers and mountain ranges (ADFG 2023b). A total of four Level I, six Level II, and twenty Level III ecological regions (ecoregions) are identified across modern Alaska. These classifications refer to "ecologically distinct areas resulting from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water and human factors," any number of which could be dominant for a given land unit (Gallant et al. 1995:1). The pattern for Alaska's ecoregion distribution is oriented along latitude, though the west coast breaks this pattern (Figure 3-9). From north to south in spatial predominance, the Level I ecoregions include tundra (34%), taiga (28%), northwestern forested mountains (approximately 19%), and marine west coast forest (approximately 19%). The Level I ecoregions are detailed below, with their coastal Level II and III subregions (Gallant et al. 1995, Commission for Environmental Cooperation [CEC] 1997, Environmental Protection Agency [EPA] 2010a, 2010b, 2012). It should be noted that there are multiple valid ecoregion classification systems, but the U.S. EPA ecoregion taxonomy is referenced here.

3.2.3.1 Tundra

Proportionally the largest ecoregion of Alaska, tundra occurs throughout the north, along much of the west coast, and in the Aleutian Islands. These glacially sculpted, rolling landscapes experience short, cool summers with copious light and long, dark, cold winters. Soils here are permafrost, or frozen year-round, with a shallow wet thaw layer in summer (Figure 3-10) (Jorgenson 2022). Waters are ice-fast, though in more southern portions of the ecoregion, waters may open in summer. Snow can fall at any time of year and usually persists on the ground from September to June. Wetlands occur in low-lying areas, though most of this landscape hosts shrubland with scattered trees growing along waterways. Large marine species include seals, walrus, beluga whales, and bowhead whales, with others migrating here in summer (e.g., California gray whales). The coastal Ecoregion level II is identified as Alaska Tundra, while Ecoregion Level III includes Arctic Coastal Plain, Arctic Foothills, Subarctic Coastal Plains, Seward Peninsula, Bristol Bay-Nushagak Lowlands, and Aleutian Islands.

3.2.3.2 Taiga

Though subarctic, the winters across central Alaska are long and cold, while summers are short and bright. Taiga occurs between the tundra areas of the western coast in Kotzebue Sound and Norton Sound. Like tundra, this ecoregion hosts undulating and glacially sculpted landscapes, but with frequent lakes and wetlands in low areas. Soils grade from mostly permafrost in the north to mostly coniferous forest in the south, with peat occurring in the wet depressions. Walrus and seals are common in maritime areas. The coastal Ecoregion level II is identified as Alaska Boreal Interior, and Ecoregion Level III includes Interior Forested Lowlands and Uplands.

3.2.3.3 Northwestern Forested Mountains

These mountainous landscapes occur across south-central Alaska, but only occur in one portion of the coast near Cook Inlet. They're incredibly diverse, ranging from alpine in high elevations to grasslands in the low plains. Though bedrock outcrops are common due to high relief, past glacial activity marks valleys and plains, with some high peaks still hosting glaciers today. Likewise, temperature and precipitation vary with elevation: humid and cold in uplands, dry and mild in lowlands. The coastal Ecoregion level II is identified as Boreal Cordillera, and Ecoregion Level III includes the Alaska Range.

3.2.3.4 Marine West Coast Forest

This ecoregion covers almost the entire southern coast of Alaska, and a portion of the western coast between Kuskokwim Bay and Bristol Bay. Wet, temperate forestland unites the mainland and adjacent islands here. The combination of ocean upwelling along the coast and river inputs lead to high nearshore nutrient loads and, thus, abundant marine life. Whales (including orca), sea lions, seals, Dall's porpoises, and Pacific white-sided dolphins are common. Salmon and steelhead occur in streams throughout this ecoregion. The coastal Ecoregion level II is also identified as Marine West Coast Forest, and Ecoregion Level III includes Ahklun and Kilbuck Mountains, Cook Inlet, Pacific Coastal Mountains, Coastal Western Hemlock-Sitka Spruce Forests, and Alaska Peninsula Mountains.

3.3 GIS

The primary data products for the Submerged Paleolandscapes Database are presented in Figures 3-2 to 3-7. They include polyline contours representing the sea level and polygons representing glacial extents at each point in time depicted in those figures. These files address the entirety of the study area and are not expected to require significant revisions or updates (albeit with the caveat discussed above that sea level is currently changing for Alaska).

The North American Datum 1983 (2011) Alaska Albers (Meters) map projection was used for all maps in this chapter. Each map contains the US Census (2023) TIGER/Line coastline for Alaska as a static reference point. Each location inset map includes graticules for reference, due to Alaska's global position near the arctic. For Figure 3-8, in which the political boundaries were less apparent, the antimeridian is also included as a visual reference.

For each point in time, we produced sea level (line) and glacial extent (polygon) vector shapefiles for the Submerged Paleolandscapes Database. The modern 15-arc-second elevation model is publicly available (GEBCO 2023). The 140 meters below sea level marker (Figure 3-1) is an elevation contour created from the GEBCO (2023) digital elevation model. Likewise, paleosea level contour lines use the following elevations to represent sea level, or 0 meters, for that time-step (Figures 3-2 to 3-7) (Lesnek et al. 2018, Wang et al. 2021). Georeferenced images from reference papers were then used to check the sea level reconstructions visually. The digital elevation models for the past shift the GEBCO (2023) stretch symbology to show the area reported to have been at the land-sea juncture equal to these same elevations.

- 19–25,000 BP: -125 m
- 16,000 BP: -120 m
- 14,000 BP: -80 m
- 12,000 BP: -60 m
- 10,000 BP: -40 m

To create the polygons for glacial extent, glacial recreations from reference material figures were georeferenced and then drawn in the GIS to match (Haeussler et al. 2022, Lesnek et al. 2020, Seguinot et al. 2016, Wang et al. 2021). For reference material recreations occurring between the time-steps presented in Figures 3-2 to 3-7, polygons for our figures were manually interpolated using the closest reference figure dates, local geomorphology, and glacial dynamics. Because the focus is on Alaska, we did not reconstruct glaciation extensively in neighboring landmasses. The limit of investigation for the paleosea level maps includes Alaska and all areas within 500 km (311 mi) of the state boundary. Each paleosea level figure displays 0 meters elevation as a contour (Sea Level) and concurrent glacial extent as polygons (Glaciers), both overlying an elevation raster symbolized to represent the paleolandscape as closely as possible and create a visual reference for the viewer.

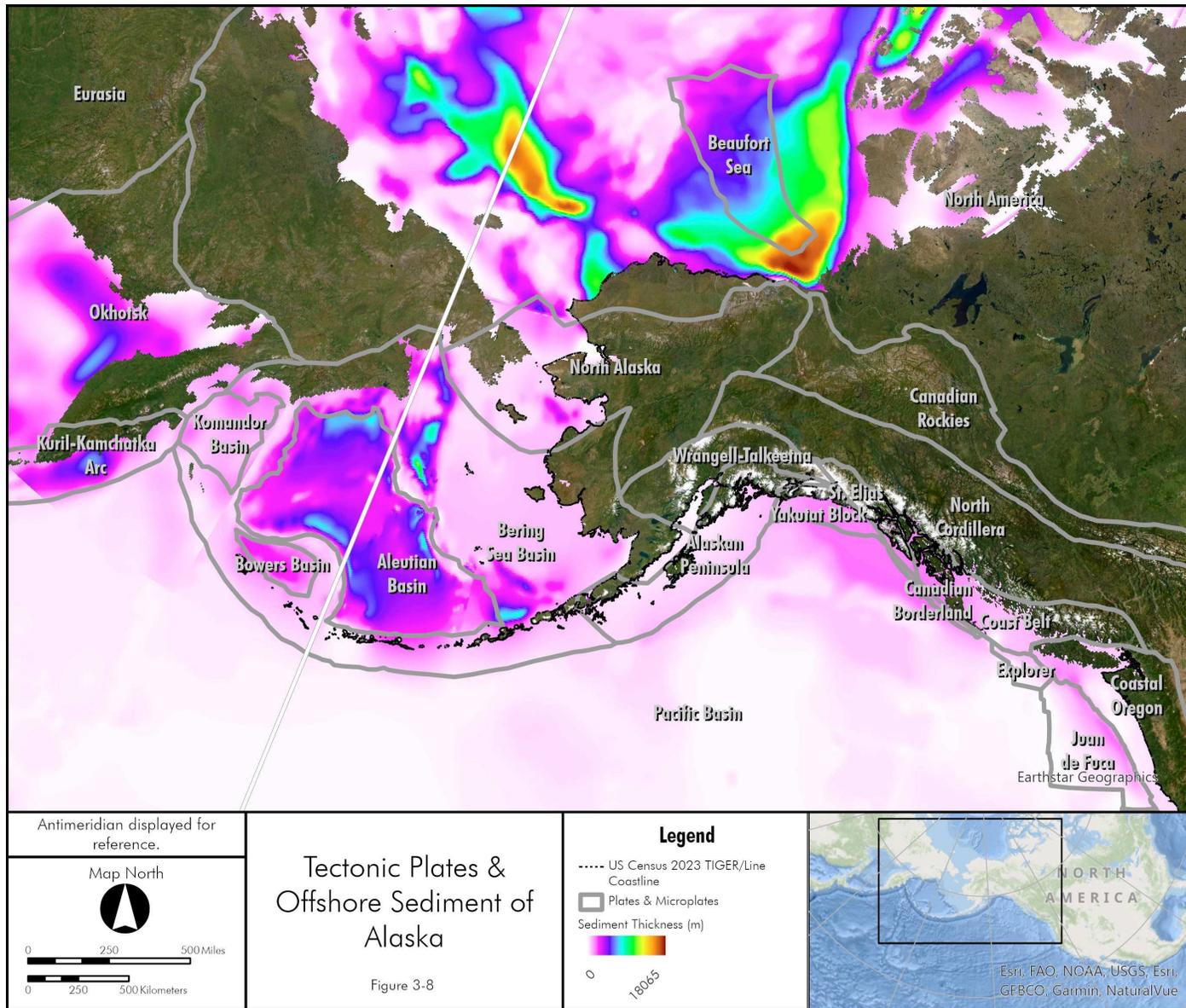


Figure 3-8. Tectonic plates and offshore sediment of Alaska

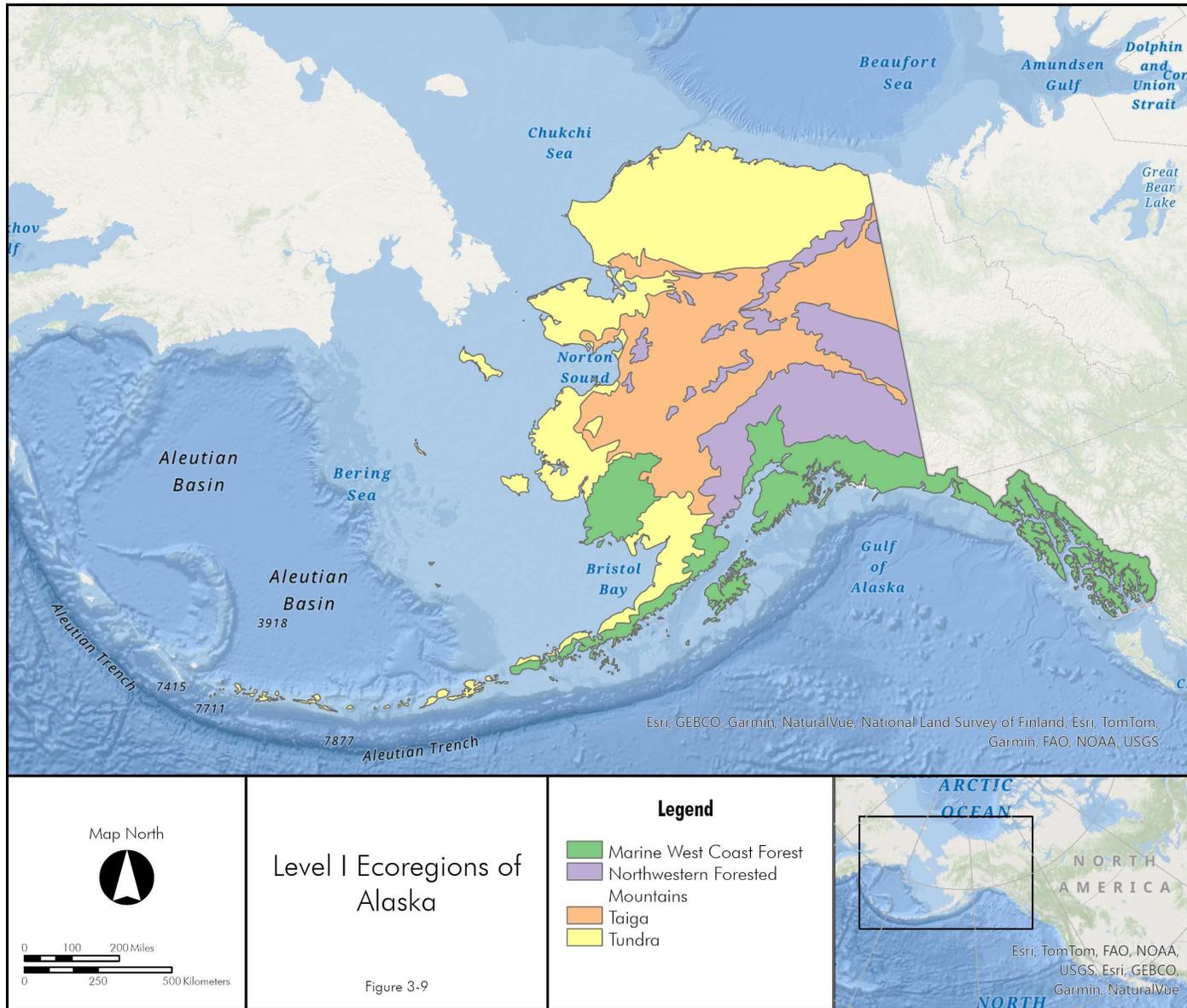


Figure 3-9. Level I ecoregions of Alaska

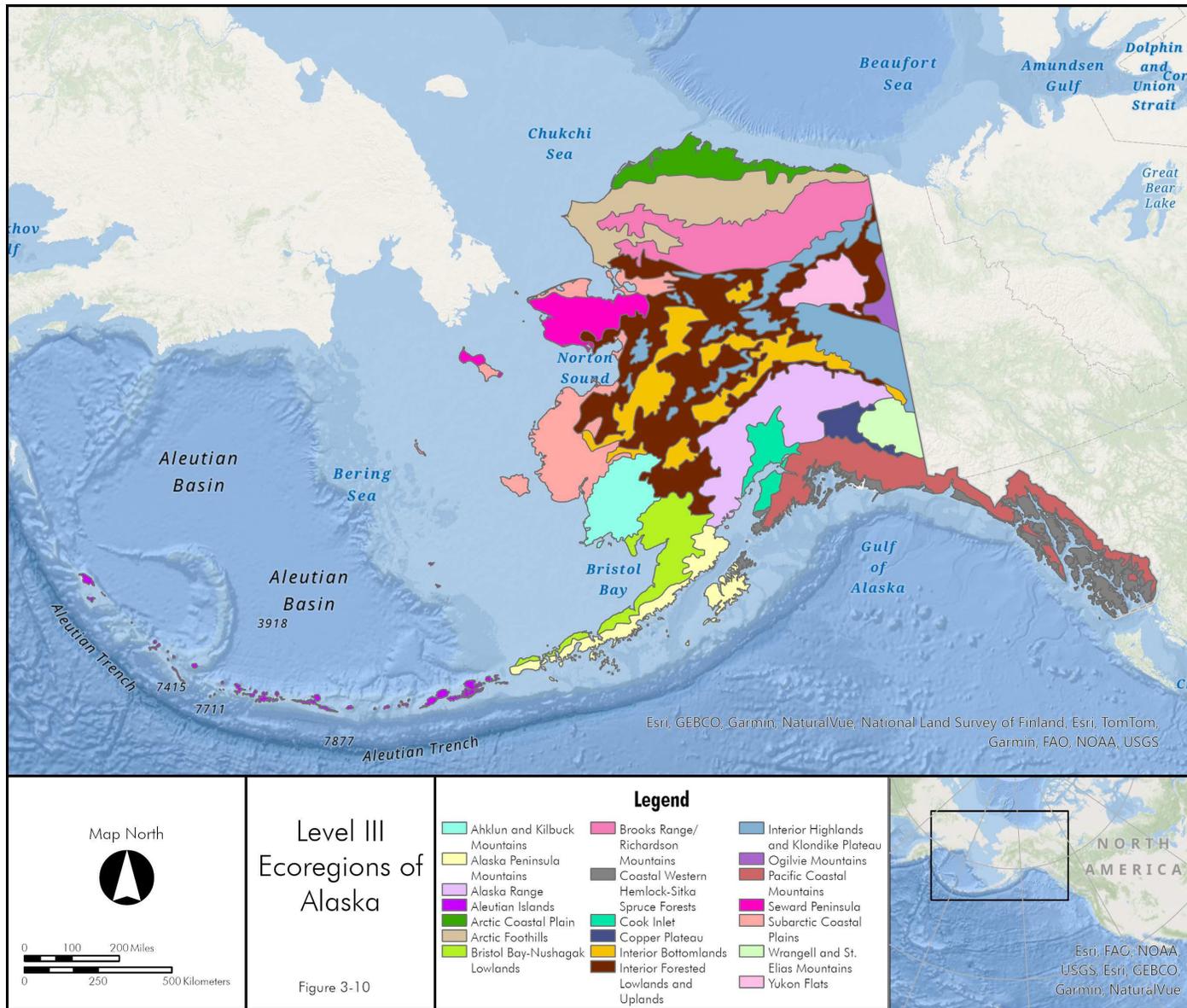


Figure 3-10. Level III ecoregions of Alaska

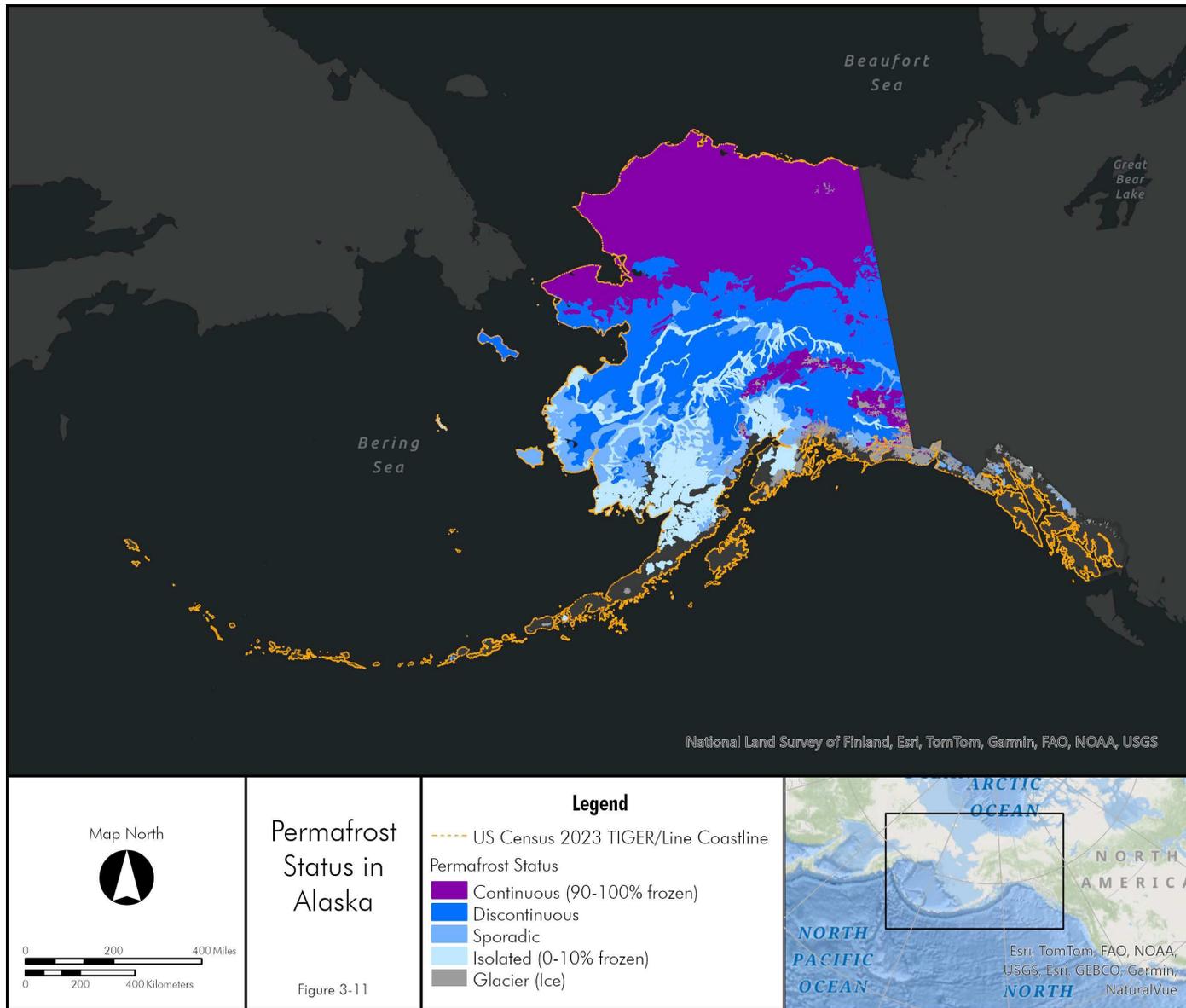


Figure 3-11. Permafrost status in Alaska

4. Coastal Sites and NRHP Database: Coastal Sites Database

The Coastal Sites and NRHP Database is a multipurpose database established to identify and categorize maritime sites related to early Alaska Native populations, help identify clusters where known sites have been identified within state waters, and identify sites listed to and eligible for the NRHP. In Chapter 4, the focus of this database is on Coastal Precontact sites. BOEM has jurisdiction over federal waters of the OCS where the land was subaerially exposed from the LGM until as recently as approximately 10,000 BP (see Chapter 3). Information on known precontact site locations within state waters or along the modern coastal zone may inform the larger discussion of precontact site potential on the OCS. Database development, including methodologies and resources used, are detailed in the following individual sections.

4.1 Historical and Contextual Overview

The peopling of North America is a major question in archaeology, with Alaska playing a key role in answering the question of how and when modern humans first likely entered the western hemisphere. The prevailing theory is that humans emigrated from Asia to the Americas during the most recent LGM via inland and/or coastal routes. The two main theories for the peopling of the American continents concern migration routes through (1) a terrestrial ice-free corridor between the eastern side of the Cordilleran Ice Sheet and (2) along the western side of the Laurentide Ice Sheet or via a Pacific coastal route (Lesnek et al 2018, Zegura 1984). Both theories are compatible on the issue that the Bering Land Bridge (BLB) would have been the initial corridor used by migrating populations. While there is no exact date for the LGM, it is attributed in this report to circa 25,000–19,000 years BP (Chapter 3) when the glaciers began to recede, and sea levels began to rise. It is estimated that the BLB was completely inundated by sea-level rise approximately 11–13,000 BP (Clark et al. 2009); although sea-level rise did not uniformly end, and regional variation likely means that areas were exposed as dry land more recently than 10,000 years BP.

Several authors have considered issues of occupation and migration of the BLB and early migration to the Americas (Masters and Flemming 1983, Dixon 1999). The interior route to people the continents, via a corridor between the Cordilleran and Laurentide Ice Sheets, is outside the scope of the present research, while a proposed Pacific coast route is of direct relevance for coastal precontact site research. Westerly and Dix (2006) examined the possibility of ancient migration routes along coasts relative to the environmental variables in these coastal areas. Recognizing that any coastal settlements of the late-Pleistocene or early Holocene would be inundated, their conclusion is that coastlines were areas of rapid environmental fluctuation not stability and may have played a factor in the use of them by humans as migratory paths. Whether stable or unstable, humans are adaptable species, and the use of coastal routes adds to the potential for submerged precontact sites.

Within Alaskan archaeology, the period of subaerial exposure of the OCS, including the BLB, overlaps with three distinct traditions. The oldest known archaeological complex in Alaska is the Nenana, discovered at several sites in interior Alaska and dating to between 11,600 to 10,000 BP, although its geographic and temporal definitions are loosely defined (Hoffecker 2001:139, Dixon 1999:165). The American Paleoarctic tradition dates from 10,500 BP to after 8,000 BP and is attributed to a microblade technology; it is subdivided regionally into the American Paleoarctic, the Denali complex, and the Northwest Coast microblade tradition (Dixon 1999:165). The third cultural tradition is the Northern Paleoindian, which was concurrent with the Denali complex and occurred between 10,000 and 8,500 BP (Dixon 1999:166). While the oldest sites in Alaska are attributed to the Nenana complex, these sites are all well inland, while sites attributed to the American Paleoarctic have been identified along the coast. Specifically, sites attributed to the American Paleoarctic tradition have been identified along the margins

of the Chukchi and Bering Seas and Arctic Ocean and the tradition is associated with marine mammal hunting and hunting and fishing within the adjacent terrestrial regions (Dixon 1999:173). Sites attributed to the Northwest Coast microblade tradition extend from the Kodiak Archipelago to the southeast, along the Pacific Rim and coastal southeast Alaska, British Columbia, and the Pacific Northwest (Dixon 1999:174). The Northwest Coast microblade tradition is explicitly associated with a maritime economy that included harvesting of salmon, marine mammal hunting, saltwater fishing, and gathering of intertidal and estuarine resources (Dixon 1999:178). According to Dixon (1999:178), “these people were experienced at navigating year-round open water along rugged forested coastlines characterized by fjords, islands, rocky headland, and calving glaciers.” The use of watercraft by these communities has been inferred by the occupation of islands and other sites accessible only by water, the identification of offshore or deeper water fish remains within site assemblages, and a prolific obsidian trade (Dixon 1999:178, Dixon and Monteleone 2013:99).

The BLB is the single largest paleogeographic feature on the Alaska OCS, and while it is the center of attention for initial migration routes, significant sites such as Anangula, Hog Island, Hidden Falls, and Ground Hog Bay II are located from the Aleutian Islands to the Pacific Northwest (Dixon and Monteleone 2013:100). According to Dixon and Monteleone (2013:100):

Data from coastal and interior sites provides strong inferential evidence suggesting that two major types of ancient archaeological sites may be preserved on the continental shelves: (1) artifacts and features left by terrestrial hunters and gatherers who likely occupied the interior regions of the Bering Land Bridge, and (2) the remains of coastal and near coastal sites resulting from maritime subsistence.

The importance of maritime trade, travel, and offshore resource extraction to the peoples of the American Paleoarctic and Northwest coast traditions suggests that the archaeological remains of early watercraft could be present. As discussed in Chapter 2.1.2, the organic materials used in early watercraft construction are unlikely to be preserved, except under certain conditions such as burial within an anoxic environment. Precontact canoes have been investigated archaeologically in the continental U.S., from Florida to Wisconsin, where they tend to be recovered from either active or relict streambanks or lower lake stands. The identification of these canoes has more often the result of accidental finds following an extreme weather event, such as erosion of a streambank or drought that lowers modern water levels. If such features are identified on the OCS, it is possible that watercraft may be preserved if sufficient sediment has resulted in complete burial of the material; however, these resources may be more likely to be uncovered within state waters or from state lands where active erosion is occurring.

Reports of artifacts recovered from the BLB by offshore fisherman or members of the public exist but have not, to date, been verified. Faunal remains, however, have been recovered and accurately documented as having come from the BLB; these remains were further thought to have been in situ or minimally transported (Dixon and Monteleone 2013:101). Archaeological sites consistent with hunter-gatherers and fishers are unlikely to be identified through remote sensing techniques, while “larger features such as semisubterranean house pits, middens, or fish weirs may be more visible” (Dixon and Monteleone 2013:100). Despite the interest and potential for submerged archaeological site discovery on the Alaska OCS, few underwater surveys for non-shipwreck archaeological sites have been conducted explicitly for paleolandscape mapping or archaeological research. As summarized by Dixon and Monteleone (2013:97), no survey work had occurred in western Beringia, while one survey had been completed in central Beringia with two more having been conducted in eastern Beringia. A fourth underwater survey was initiated in 2010 in southeast Alaska (Dixon and Monteleone 2013:105–107).

The timing of final marine inundation of the federal waters portion of the OCS coincides with the persistence of the American Paleoarctic, tradition, the Denali complex, and the Northwest Coast tradition. Following transition to a fully marine environment, the federal waters portion of the OCS, while no

longer available for occupation, remained available to Alaska Native Peoples throughout the precontact period (prior to circa 1741). Alaska Native Peoples traveled across the open waters and exploited marine resources for thousands of years, and it is probable that archaeological materials associated with fishing, hunting, or watercraft may have been lost or deposited on the seabed. However, unless these materials, which are organic in nature, have been buried within sediments they are less likely to be preserved and identified.

4.2 Methodology

The development of the Coastal Sites Database was a new undertaking, beginning with shapefiles and tables on record with the State of Alaska via AHRS and ending with a single centroid point entry for each AHRS site number. The attribute table uses the original AHRS data wherever possible (see Chapter 5). Information from the AHRS used in this data table appears directly as provided from OHA and has not been manually edited or reformatted. While there are inconsistencies in the way that some data are entered in the AHRS (e.g., the use of capitalization is not standardized), the database is consistent with the State’s data. Data issued from AHRS contained a table with site data and shapefiles with location data for each site. There were four different shapefile types: point, multipoint, polygon, and line. To facilitate this portion of the project, centroids and their geometry were calculated for each site, the location data were merged, and the site data were joined to the resulting shapefile.

The following is a description of how the database was established, starting with the most pertinent information at the beginning of the table, and more contextual information as the reader moves left to right. The data entry columns are further detailed in Appendix A, including the types and format of data to be entered and listings of any pick list variables. Of note, if data is missing within the database, such as left blank or listed as “null” within GIS, this information was not present in the original record. If a cell within the database is labeled “unknown”, or “unidentified”, it is indicative of a researcher inputting information to that effect, and such information has been sought out and not found or identified. This is a distinction that carries across all databases.

The basic tenet and design of the dataset was envisioned to provide locational information to the reader at the beginning of the dataset. Of note, a full description of column headers and content descriptions is included in the attached document, BOEM Coastal Sites and NRHP Database Definitions (Appendix A). A description of each column will be included in this section. As one starts looking at the table, the first two columns on the left are the X and Y coordinates, labeled “CentroidX” and “CentroidY”. These values enable creation of shapefile from the database. For this database, and to ensure coordinates and projection were universal for all of Alaska, The North American Datum 1983 (2011) Alaska Albers (Meters) coordinate system is used (EPSG 2024). Centroid point geometry was calculated in the GIS using the original AHRS multipoint, polygon, and line shapefiles. For items that were points in the original source, CentroidX and CentroidY are the original point location.

Following the XY coordinates, the attribute “MERGE_SRC” indicates the original file and file type issued from AHRS, the company and user to whom they were issued, and the date of issue. The entries in this attribute are generated by the GIS during the table export and merge process that generates the database shapefile from the original AHRS shapefiles. Entries take the following form: AHRS Data [company] [user] [YYYYMMDD]_[geometry abbreviation]_ExportTable. The geometry abbreviation is pt (point), mp (multipoint), ln (line), or py (polygon). For the database at the time of this report, the company is GP (Gray and Pape), the user is CFadem (Cynthia Fadem), and the date is 20240521 (May 21st, 2024). If more than one set of data is issued to the same company and user on the same day, there is also a Group notation to indicate the dataset issued (in the case of the current database: Group A and Group B).

The next two columns are identifiers used by AHRS. The first is “AhrsID”, a relate key in the AHRS database. The second is “AhrsNo,” a unique ID number for cultural resources as recorded by the State of Alaska. Each entry includes a three-letter designation corresponding to the USGS quadrangle on which the resource is located and a unique sequential number within that quadrangle (e.g., SIT-01234). Perhaps more vitally than for each of the other data tables, coordination with the State of Alaska, specifically OHA and AHRS, are imperative for maintaining an up-to-date cultural dataset.

Following AHRS number is “Site Name,” which is the common name of the resource. If there is no common name, the default site name is the AHRS number. Figure 4-1 displays the first four column headers of the database with examples.

MERGE_SRC	AhrsID	AhrsNo	SiteName
AHRS Data GP CFadem Group A 20240521_In_ExportTable	48	KEN-00764	Bridge Access Road
AHRS Data GP CFadem Group A 20240521_In_ExportTable	95	YAK-00030	Yakutat and Southern Railway Alignment
AHRS Data GP CFadem Group A 20240521_In_ExportTable	95	YAK-00030	Yakutat and Southern Railway Alignment
AHRS Data GP CFadem Group A 20240521_In_ExportTable	95	YAK-00030	Yakutat and Southern Railway Alignment
AHRS Data GP CFadem Group A 20240521_In_ExportTable	231	SEW-00256	Canyon Creek Trail

Figure 4-1. Image of first four non-locational column headers and five entries of the Coastal Sites and NRHP Data (Source: Gray & Pape, Inc.).

A description of the location of the site and how to get there is in the next column, titled “LocationDe.” The location description often includes natural features, landforms, or street addresses. “ResourceDe,” “ResourceNa,” and ”Resource_1” follow the location description. These headers refer to the resource description and name, which include keywords and the type and sub-type of resource from picklists. “AssignedTo” refers to the agency or person that requested the site number – this entity would have submitted the original data on the resource.

The following six columns are “Cultures,” “Ownership,” “OtherNumbe,” “Condition,” “CardStatus,” “OccupancyD,” and “Destructio.” These data provide information on the cultural and temporal affiliation of each resource, as well as the current ownership and condition of the resource. “Cultures” pertains to any cultural identities related to the resource or associated with recovered materials. The term Euroamerican has typically been used for historic and modern American cultural resources. “OccupancyD” includes any dates related to the resource. Information on the current status of the resource includes private or institutional landowners, any additional numbers associated with the resource, the current condition of the site (including weathering and investigation status), the status of the data record (card) in the AHRS system, and the year the site was destroyed (if applicable).

The following columns contain data on the reliability of the source and location information of the resource. “SourceReli” is a picklist choice referring to the nature and quality of information leading to the site entry. “LocationRe” is a picklist choice referring to whether the site has been found and is still in existence.

Next are columns referring to the nature of the resource and any broader significance. “Descriptio” offers a brief synopsis of the physical aspects of the cultural resource at the time of investigation. These aspects may include topography, viewshed, ground cover, artifacts, buildings, etc. “Significan” is a description of the cultural significance of the resource, if available. “Associatio” indicates whether the resource is part of or contributing to a larger group of sites (e.g., historic landmark or district). “Area” is the site area, usually in acres.

The next column, “PeriodCode” includes a picklist from which multiple choices are made if appropriate: Prehistoric, Historic, Protohistoric, Paleontological, Modern. All sites within the buffer were included in

the table, regardless of time period; however, the GIS can be set to symbolize by time period or to selectively display only those sites with precontact (prehistoric) components. It was determined, through discussions with ACES, that the term ‘precontact’ is preferred to define sites that predate the historic period. Throughout the source data in this database, this period was referred to as prehistoric but in recent years, the archaeological community has moved away from that term, as it unintentionally indicates there was no history prior to European contact. According to Steven Langdon of the University of Alaska Anchorage, the contact period in Alaska began in the mid-eighteenth century (Sandberg 2013). For this study, circa 1741 is used to the year delineating the transition from the precontact to the historic period.

Time period is followed by attributes defining the function and modern disposition. “CurrentFun” and “HistoricFu” are picklists from many categories and subcategories relating to the current and historic function of the resource. “Destruct_1” is a picklist choice referring to activities that are adversely affecting the resource. “BiaNumbers” are any Bureau of Indian Affairs numbers associated with the resource. Any secondary common names for the site are listed in “OtherNames.”

Next are attributes related the site data entry. “Modified” is the date and time of site form completion or update. “IsApproxim” indicates whether the date and time of modification is approximate with a true or false entry. “SourceSRID” is the coordinate system code for the original site form coordinates. “SurveyYear” is the year(s) site survey was completed, if applicable. “GpsGrade” indicates the type of GPS used to acquire site coordinates, if any. The portion of the parcel or section in which the resource is located is listed in “AliquotPar.” The entry is in the form of 1/4 1/4 1/4 section in cardinal directional abbreviations only (e.g., SNENW). “GeometryTy” is the geometry type of the original AHS shapefile: point, multipoint, line, or polygon.

Lastly, the NRHP identification number, also known as the NRIS reference number, is in “NRHPNo.” The number listed is the reference number of the resource itself, or of the district of which the resource is a part (if the resource itself is not independently listed). If the resource is neither listed nor part of a district or landmark, this attribute is left blank or shows as 0.

4.3 Data Sources

This database is one way of cataloging culturally important sites from an archaeological or anthropological perspective. It is important to ask for input from Alaska Native Peoples and Tribes. The next section details interactions and collaborative efforts to document sites that are culturally important for Alaska Native Peoples and Tribes.

4.3.1 Alaska Native Tribal Sites

Several databases provide historical and cultural information about Alaska’s rich and diverse history. The State of Alaska’s universities, museums, and the AOHA provide various expertise to ensure Alaska’s heritage is preserved and passed on to future generations. These institutions work with local governments, the public, and educational and not-for-profit organizations to identify, preserve, protect, and interpret Alaska’s cultural, historical, and archaeological resources (AHS 2023). Additionally, NPS manages various units, including multiple National Parks, in Alaska and works closely with Alaska Native regional and community leadership in conducting archaeological surveys, excavations, and ethnographies (AK NPS 2023). Over the years, these institutional and regional/community collaborations have created updated research guidelines to improve the collaborative effort and focus projects to benefit the Alaska Native regions and their communities.

The history of Alaska research guidelines is rooted in the Alaska Indigenous People’s relationships and knowledges of their ancestral homelands. Their applied knowledges and perspectives in working with Western institutions on land decisions and management over time has yielded guidelines on how to

conduct various types of work on Alaska Native lands, which includes scientific research. Early examples of applying Indigenous knowledge with land tenure include the North Slope Iñupiat. Applying their knowledge and position on protecting cultural areas from potential impacts from activities guided the Iñupiat to create their cultural database known as the Traditional Land Use Inventory (TLUI) (ICAS 1976) which is still in use today. In time, Alaska Native leadership, through their largest advocacy organization, the Alaska Federation of Natives (AFN), created guidelines for conducting research among Alaska Natives and their communities. The AFN listed principles that included data gathering techniques, protecting cultural knowledge, and collaborating with Indigenous communities (AFN 1993). Over time, Alaska universities have improved these guidelines and created required research procedures when conducting research with Alaska Natives.

The Alaska university guidelines attempt to comply with Tribal rules, policies, and procedures for conducting research with their respective peoples. The guidelines follow agreed-upon definitions and guiding principles. These guidelines have changed to ensure that research benefits the Alaska Native regions and their communities (University of Alaska Fairbanks [UAF] 2023). The recent Inuit Circumpolar Council (ICC) report “Circumpolar Inuit Protocols for Equitable and Ethical Engagement” (EEE), reinforce collaboration between researchers and Inuit communities. The eight protocols are directives needed to move toward equitable and ethical engagement. One protocol is information and data sharing, ownership, and permissions (ICC 2022). Acknowledging the history and improvement on research guidelines with the Alaska Native community is essential with all projects, including this database project for the Alaska OCS.

The database project collects information from various organizations with different information types. Inviting and acknowledging the perspectives of Alaska Native Indigenous knowledge holders to the project is essential to successfully bring together multiple ways of knowing while ensuring that Indigenous knowledge is protected and valued as a unique knowledge system with its own evaluation and validation process. Indigenous knowledge is a systemic way of thinking applied to phenomena across many systems (i.e., cultural, biological, and spiritual). It includes insights based on evidence acquired through direct and long-term experiences and broad, multigenerational observations, lessons, and skills. Indigenous knowledge is a way of life (ICC 2022). By making space for and working with Indigenous knowledge holders, the Alaska BOEM OCS database can address a more diverse set of resources that are considered culturally significant and may even identify sources of cultural and historical importance that cannot be identified through traditional archaeological survey.

A provision of the Alaska Native Claims Settlement Act (ANCSA) divided the state into 12 regions defined by the common heritage of the Indigenous peoples within each geographic area. The boundaries do not represent land ownership, but rather which ANCSA regional corporation serves the people and villages in that region. Each region has a landscape of governance, land ownership, roles, and relationships that may display similarities with other regions, while still specifically defining each region. A key difference between some areas is the level of government, such as organized and unorganized boroughs (ARA 2023). Alaska has over 200 Tribes federally recognized by the U.S. Bureau of Indian Affairs as holding a government-to-government relationship with the U.S. federal government. Federal agencies have an ethical and legal obligation to conduct formal consultations with tribal governments outside and separate from public involvement. Applying their trust responsibility, also known as the trust relationship, agencies have a responsibility to act in the best interest of Tribes. To understand their best interests, agencies must consult Tribes to properly represent those interests in decisions and environmental governance (Brooks 2022).

When introducing the Alaska BOEM OCS database project, informal meetings were conducted with regional ANCSA and Tribal leadership who could guide best practices to present the project, along with recommended contacts with specific knowledge on submerged historical and cultural resources on the Alaska OCS. Many ANCSA corporations and Tribes have a similar organizational structure, including a

Lands and Natural Resources Department while some also have cultural resource departments. Additionally, some regional governments have cultural resources departments. These departments were first engaged in the project, and we acknowledge and thank these organizations and departments that helped guide the project's engagement process with their knowledge and recommendations. Further information on the project stakeholder engagement summary, stakeholders, and project recommendations are in Chapter 8.

4.4 GIS

The main source of content is the AHRS database, which was used with permission from the State of Alaska. Listings from the NRHP are also included. Due to the confidential nature of this specific database, the GIS products created for this report cannot be shared publicly and represent a static view of known sites from the AHRS and NRHP. Information provided through engagement activities with Alaska Native communities or entities will be kept confidential. It is recommended that BOEM and the State of Alaska work toward a collaborative agreement to share locational and contextual information contained in the database for precontact coastal sites, as the data will become outdated as soon as new information is entered into the AHRS. Once information permissions have been acknowledged between BOEM and the State of Alaska, locational information will be administered by BOEM and will not be publicly available without request. These data will be restricted for BOEM planning purposes and held in confidence by the Department of the Interior.

Any changes to text entering from the original source would need to be replicated in future entries and a system created to ensure new entries did not duplicate existing entries (if they had been edited and no longer matched the original source). To prevent this issue, this database presents text and information in their form in the original sources. Data pertaining to this database (e.g., Coordinate System, X and Y coordinates, public outreach potential, entry data) are newly added. Sites were projected from their original coordinates and their geometry was calculated to provide the current X, Y coordinates. After projection, they were clipped to a polygon including Alaska state and U.S. federal waters, and a 160 km (99.4 mi) buffer of the US Census 2023 TIGER/Line coastline. Locations were spot-checked for accuracy. Finally, the database was added to a blank map and converted to a shape directly from the XY coordinates from Excel to ensure future updates would return the same GIS dataset.

5. Historic Shipwreck and Downed Aircraft Databases

The Shipwreck and Downed Aircraft databases capture data relative to the most common types of submerged cultural resources encountered in federal waters. The protection of cultural resources is dependent on the identification of potentially significant resources. The ability to plot known or reported shipwrecks and downed aircraft is critical to safeguarding them from adverse effects of development. The content within the Shipwreck and Downed Aircraft databases developed for BOEM were cultivated through an extensive research process. This chapter explains the methodologies, resources used, and potential opportunities for further research resulting from the process.

5.1 Historical and Contextual Overview

The following discussion presents broad information and suggested research themes to be considered in conjunction with the historical shipwreck and downed aircraft databases. Also, it outlines the methodology for obtaining high-resolution historical maps as JPG or TIFF files and the process followed for georeferencing and digitization of cultural resources from the historical maps. Historical research discussed in this section was completed by Gray & Pape staff and by Dr. Heather Lee Miller of Historical Research Associates, Inc. (HRA), under subcontract to NLURA; HRA and Gray & Pape jointly owned NLURA at the time the work was conducted (Miller 2023). Georeferencing and digitization tasks were completed by GIS staff from Gray & Pape.

5.1.1 Shipwrecks and Downed Aircraft– Historical Context

The Alaskan shoreline and the surrounding offshore waters have been traversed by countless numbers of ships and sailing vessels over the millennia, from Indigenous craft prior to Russian and EuroAmerican exploration to modern commercial and tourist vessels. Since the early twentieth century, a diversity of aircraft has been used and subsequently lost within these same waters. This historical context is presented as companion to the subsequent discussion of the shipwreck and submerged aircraft databases developed for the current project. Mirroring the temporal period of the 2011 BOEM Alaskan Shipwreck Table, this discussion explores the period from the earliest Russian exploration and colonization (circa 1741) to the mid-twentieth century.

Initial forays by Russians along what would become the Alaskan coastline may have occurred as early as 1647 (Gibbs 1977:10). However, it wasn't until 1741 that Vitus Bering was charged by Peter the First of Russia to actively explore the lands beyond known Russian/Siberian waters. Two ships, the *St. Peter* and the *St. Paul*, first encountered Mount Saint Elias and subsequently skirted what became known as Kodiak Island, Chirikof Island, and the Semidi Islands. The first permanent settlement was established in 1773, possibly at Captain's Harbor on Unalaska Island. By 1792, Kodiak had become the capital of Russian America, which was eventually surpassed by New Archangel (eventually known as Sitka) by 1808 (Library of Congress [LOC] 2023a). Much of the settlement of coastal Alaska by Russian explorers and traders focused on the search for additional hunting grounds for seal and sea otter, among other mammals. The increase in the fur trade from these outer Russian reaches led to the arrival of missionaries, explorers, and trappers to support the growing commercial industries being established.

As word of the rich hunting grounds and abundant resources spread, additional explorers from Spain, Britain, and Russia ventured as far as the Cook Inlet area and along the coastal zones of southwestern Alaska (NLURA 2016). The first recorded interaction between European explorers and Indigenous inhabitants occurred in 1778, when Captain James Cook of the Royal British Navy arrived in what is today called Cook Inlet in search of a Northwest Passage. Cook indicated that current inhabitants of the area already had European trade goods in their possession, indicating that active trade between Alaska Native groups and Russian explorers and traders was already occurring (Rogers 2017). The establishment

of trading posts and growing settlements brought increasingly large quantities of European trade goods and cultural practices into the area. The Russian American Company (RAC) chartered in 1799, created a state-sanctioned monopoly of the exploitation of natural resources and the fur trade along the Alaskan coastline. The RAC actively encouraged settlement through agriculture and animal husbandry, opening the door for Russian Orthodox missionaries as these settlements became more established. The expansion of trading posts and settlements, combined with the harsh weather and expanding pressure from British, Spanish, and eventually American explorers and commercial interests, led to increasing tensions between Alaska Native populations and the various groups of settlers. As these populations expanded, bringing with them diseases that most affected Alaska Native groups (including a smallpox epidemic from 1836 to 1840), Russia came to realize that it overextended itself in the push for more fur and recognized that few Russians showed interest in relocating to expand Russian settlements. This eventually led to the sale of Russian America to the U.S. in 1867, marking a shift in the dominance of trade and settlement within the region (NLURA 2016, Rogers 2017).

The Alaska Purchase, negotiated by then U.S. Secretary of State William Seward for a purchase price of 7.2 million dollars (approximately 151 million in 2022 dollars), transferred 1,518,800 m² (586,412 mi²) to the full control of the U.S. (Wikipedia 2023). Many met the purchase with skepticism, referring to it as “Seward’s Folly,” leading to a general population decline in the immediate aftermath of the transfer of power (Gibbons 2007:22). Hunting, whaling, and commercial trade did continue, eventually experiencing one of the worst whaling disasters of all time (Chapter 2). Despite stark weather warnings by the local Iñupiat people, in 1871 a fleet of 33 whaling ships set sail off the north coast of Alaska only to be trapped by shifting winds and ice floes. Over the course of more than two weeks, it became clear that crews would have to abandon the ships where they were trapped in the ice. While all survived, the loss of ships and cargo was a huge economic blow to the whaling industry (NOAA 2023l). Clearly a visible and well documented loss, it is indicative of the risks taken by ships and sailing vessels of the period.

By the 1880s, abundant salmon fisheries developed throughout the Alaskan coasts. From roughly 9,000 cases of salmon produced in 1881 to approximately 714,000 by 1888, production continued to expand. By 1900, 55 canneries were packing 1.5 million cases of salmon annually, and by 1917, the Alaskan salmon industry produced approximately half of the canned salmon distributed globally (LOC 2023b). Export of such a quantity, combined with continued hunting of other Alaskan sources such as seal, otter, and whales, meant an exponential increase in the transport of goods out of Alaska. While the fur industry continued to decline, the fishing industry became increasingly well established (LOC 2023c). With the increase in fishing, canning, and export from Alaska came a directly correlated increase in the numbers of Americans heading into the territory for jobs and access to land. By the turn of the century, the discovery of gold in Canada’s Yukon Territory, led to thousands of prospectors flooding into the Pacific Northwest and Alaska. The establishment of gold-mining camps led to an increased demand in goods and services, initially brought in by boat, and eventually brought in by a combination of shipping and rail. Major gold strikes in Nome (1898) and near Fairbanks (1902) led to the rapid growth of small settlements into major towns. With the linking of coastal ports and twentieth-century rail lines, continued settlement in this previously sparsely populated area continued to increase (LOC 2023d). The gold rush in Alaska, and the influx of people, goods, and services that supported it, led to the development of tourism as many Americans became increasingly curious about the allure of the frontier. Luxury steamships traveled through the Inside Passage from Portland or Puget Sound as far north as Muir Glacier in Glacier Bay, eventually travelling further up the coast and along the Gulf of Alaska. The Alaska-Yukon-Pacific Exposition of 1909, a World’s Fair that took place on the grounds of the University of Washington in Seattle, promoted the development of the Pacific Northwest, including its cultural richness and economic potential (LOC 2023e).

With the advent of flight, air transportation around the coast and into the Alaskan interior was the best option for moving goods and people across vast distances. The first flight in Alaska took place in 1913

when a group of Fairbanks merchants organized to ship a biplane from Seattle to Alaska by steamboat and then sold tickets for spectators to witness the new technology fly at approximately 61 m (200 ft) over ground at roughly 45 miles per hour. A decade later, land was cleared in Anchorage for the city's airstrip, a seemingly small beginning to what would become the dominant form of transportation within the state. Commercial air service in Alaska began with the foundation of Wien Air Alaska in 1927, with a series of smaller airlines to follow. Subsequent mergers formed the core of Alaska Airlines, which began operation in 1944 and is now the fifth-largest airline in North America. James Pepper Henry, CEO of the Anchorage Museum, described the importance of flight to the development of Alaska as follows in the foreword to the book *Alaska and the Airplane: A Century of Flight*,

It is a land so vast that approximately 83 percent of Alaskan communities are isolated from road service. Many of these communities rely upon small aircraft as a lifeline for supplies, mail, and emergency services. A unique 'bush pilot' culture has evolved in Alaska as a result of the heavy reliance on rural aviation as the only practical means of transportation and connection to and from the outside world" (Decker and Kinney 2013: foreword).

The growing prominence of flight in Alaska has continued to increase through time. The Alaska Aviation Museum, located on the south shore of Lake Hood is home to the busiest seaplane base in the world, with more than 87,000 takeoffs and landings annually (Alaska Aviation Museum 2023). The below discussion in Section 5.1.4.2 notes that Alaska has more than 750 landing sites (Infogram 2023, Plane Talk 2019). The importance of aviation to Alaska cannot be understated.

5.1.2 Possible Future Research Themes

During archival research (discussed in more detail in Section 5.1.2.2) and in consideration of the above historic context, a list of potential research themes was developed, which intersect with shipping and aviation history in Alaska. Some are consistent over time (e.g., ocean resource gathering), while others are more temporal-period specific (e.g., Russian exploration and settlement). While this is a long list, undoubtedly more themes exist (Miller 2023). All these themes have a nexus to cultural and historic resources in marine waters and coastal areas of Alaska.

- Precontact Indigenous resource gathering at sea and along the shore.
- Early exploration and trading (Spanish, French, British, Russian, U.S., etc.); Hudson's Bay Company, Russian-American Company.
- Japanese "junks" caught in the Kuroshio current and wrecked along the Alaskan shore.
- Whaling (fleet from the Northeast).
- U.S. purchase of Alaska from Russia and statehood.
- Siberian trade, both before and after Alaska purchase.
- "Yankee Traders."
- Fisheries and associated facilities and structures: fish traps, floating and onshore canneries, salteries and flake yards, docks/wharves, moorage/mooring buoys, etc. (Indigenous and non-Indigenous).
- Regulation of fishing industry.
- Poaching, illegal trade, piracy, looting.
- Sealing and associated facilities and structures.
- Fur farming (e.g., fox).
- Mining (e.g., gold at Nome, sailing routes to ports with access to the Klondike).
- Timber industry and sawmills.
- Religious missions and Indigenous education/indoctrination.
- Nineteenth- and twentieth-century sailing and steamship travel (pleasure, employment, merchandise, and other goods) to, from, and within Alaska.

- Ferries and barges to, from, and within Alaska.
- Coal, oil, gasoline, diesel, wheat transport.
- Communications: mail delivery/postal routes, telegraph cable laying.
- Charting and surveying ocean bottom and navigational routes (esp. USGS and U.S. Navy), coast piloting, tugboat services.
- Shipwrecks (causes of and attempts to save the ship or save lives), experiences of survivors stranded in remote locations, derelicts and wreckage, ships lost at sea, mutinies.
- Indigenous responses to non-Indigenous shipwreck survivors.
- Lighthouses, lightships, and lifesaving stations.
- Search and rescue (ship, airplane, and helicopter).
- Customs and immigration.
- Salvage operations (marine), FAA boats/barge for recovery of wreckage.
- Onshore development for military and civilian ships and seaplanes (e.g., wharves, docks, airports/airstrips).
- BIA, Alaska Resupply Program.
- Marine safety programs.
- Early twentieth-century resource “reservations.”
- Transportation routes in Alaska (ship, rail, air).
- Tidelands (surveys/mapping).
- Research and scientific expeditions (e.g., North Pole expeditions, National Oceanic and Atmospheric Administration).
- Alaska boosterism (e.g., Seattle Chamber of Commerce).
- Recreational boating and aviation (facilities, destinations).
- Military facilities (barracks, forts, bases, outstations) and operations (ship, airplane, and helicopter); investigation into the sinking of multiple Liberty ships during World War II.
- Other federal or state entities/facilities (e.g., parks and monuments).
- Aviation and the rise of “bush piloting” and seaplane bases, using airplanes to locate sea and land resources for harvesting (fisheries, elk herds, etc.).
- Environmental disasters (e.g., Exxon Valdez and Selendang Ayu oil spills).

5.1.3 Historical Map Research and Digitization

Extensive online research for historical maps was completed as part of the current investigation beginning with the NOAA Historical Map and Chart Collection (NOAA Collection) (<https://historicalcharts.noaa.gov/>) and the LOC Map Collection (LOC Collection) (<https://www.loc.gov/maps/>) websites. In both instances, a variety of keyword searches was utilized and high-resolution versions of all maps showing cultural sites and navigation routes of cultural and/or historical significance were downloaded. For the NOAA maps, a series of pins were dropped on the interactive website map around the Alaskan coastline to search for maps tied to those locations. A tracking spreadsheet in Microsoft Excel was developed for both datasets, with the LOC maps on the first tab of the workbook and the NOAA maps on the second tab. A third tab was added for six maps identified during broader historical research, which were from other databases/website locations. The tracker includes columns for the following: original website link; the location origin (i.e., LOC drawer, pin location for NOAA collection); date the online link was last checked to confirm the file path had not changed; the map file name as it was downloaded; primary thematic collection assignment; and descriptions of the types of cultural resources shown on the map. It also includes a text column at the end of each worksheet with notes about broad descriptions and map content. In total, 266 maps were downloaded from the LOC collection, 78 from the NOAA Collection, and 6 maps from other locations, bringing the total number of maps downloaded for the current project to 350.

The historical research team reviewed all the maps, in conjunction with the tracker. A ranking of 1 to 4 was assigned to each map. Ranking was based on the content of the map, including the types and numbers of cultural resources or historical shipping routes noted. All maps ranked from 1 to 3 have been imported into the project GIS, georeferenced, and cultural resources of note have been fully digitized. Cultural resources marked in red text in the tracker column named “Cultural Resources Shown on Map” were digitized. Black text in this column indicates the presence of the type of resource shown on the map but also indicates that these resources were not digitized. Maps with a rank of 4 were not georeferenced or digitized. In many instances, these maps are historical topographic maps, are maps showing duplicate information from other maps that were georeferenced and digitized, or they show cultural sites well outside of the project area. A small number of maps were georeferenced prior to the finalization of the ranking hierarchy. In these cases, no further GIS work was undertaken; this has been noted on the tracker.

High-resolution TIFF files of all LOC maps will be transmitted to BOEM upon project completion. Similarly, high-resolution JPG files of all NOAA maps will be transmitted to BOEM upon project completion. Currently, it is only possible to download JPG files from the NOAA map website. Files from the LOC were downloaded as high-resolution JPG2000 files and converted in Photoshop to the high-resolution TIFF maps included with the final project deliverables. All map files will be sorted into their thematic relevance for transmission; some maps were considered “uncollected” as they didn’t tie-in directly with the themes of the project.

The original project description called for all mapping to be completed in ArcGIS Desktop 10.8.1. Subsequent discussion with BOEM staff, confirmed that it was acceptable for Gray & Pape GIS staff to complete georeferencing and digitizing in ArcGIS Pro 3.0.3, as software support for ArcGIS Desktop is being phased out by the developer (ESRI 2023). All historical maps were made available to the GIS team for processing once the ranking discussed above was completed. An internal version of the Excel tracker was used by the GIS staff to track georeferencing and digitization tasks and completion, including which staff member completed each task. Due to the size of the TIFF and JPG files, historical maps were downloaded to local drives for processing. Each GIS team member created an ArcGIS Pro project file for the project and worked independently to complete the georeferencing and digitization. When georeferencing historical maps, this was completed using as many spatial points of commonality as was feasible for each map to ensure accuracy. Subsequent digitization followed the priority ranking (from 1 to 4) and then concentrated on those items shown in red in the tracker column named “Cultural Resources Shown on Map.” Once all digitization was completed, all GIS data were combined into a single geodatabase for transfer to BOEM.

5.1.4 Additional Reference Materials Obtained

5.1.4.1 Historical Research

During the research conducted by Gray & Pape staff to source high-resolution historical maps, additional related research was undertaken into published histories, U.S. government reports, surveyors reports and other map-related reference materials. These additional materials are organized based on whether the research was conducted during searches into LOC or NOAA maps and includes PDF and JPG image files. Some of this material will be of subsequent use in the development of the public-facing story map. Similar to the historical maps, materials gathered as part of this research will be provided to BOEM at the conclusion of the current project. Brief examples of materials gathered are listed below. Most of these materials are from the mid-nineteenth to early twentieth centuries, and gathering these materials was tangential to our research of historical maps. The collection is not comprehensive but does provide insight into the materials that could be obtained with additional research based on content related to the historical mapping.

- LOF Sample Reference Materials
 - *Thirteen Years of Travel and Exploration in Alaska*, by W. H. Pierce, edited by Professor and Mrs. J.H. Carruth. Published in Lawrence, Kansas, 1890.
 - *Introduction to Domestic Reindeer, 1890-1894: Preliminary Report of the General Agent of Education for Alaska to the Commissioner of Education*, by Sheldon Jackson. Published in Washington, D. C., Government Printing Office, 1891.
 - *Mineral Resources of Alaska: Report on Progress of Investigations in 1925*, by F. H. Moffit and Others. Published in Washington, D. C., Government Printing Office, 1927.
- NOAA Sample Reference Materials
 - Records related to the Pacific Steam Whaling Company, including JPG images, and a map and brochure related to the route. A map of this route was included for georeferencing and digitizing.
 - Images and PDFs related to surveys completed by Ian Petroff, including the volume, *Report on the Populations, Industries, and Resources of Alaska*. Published in Washington, D. C., Government Printing Office, 1882.
 - *A Reconnaissance in Northern Alaska, Across the Rocky Mountains, along Koyukuk, John, Anaktuvik, and Colville Rivers, and the Arctic Coast to Cape Lisburne, in 1901*, by Frank Charles Schrader, with notes by W. J. Peters. Washington, D. C., Government Printing Office, 1904.

Gray & Pape staff also gathered scans of several books related to cultural resources in Alaska and a variety of magazine and peer-reviewed journal articles related to terrestrial and maritime history and archaeology, including shipwrecks and downed aircraft. A number of these articles were downloaded from Academic.edu and, while not always individually related to the current project, PDFs of these articles can be provided to BOEM as supplemental materials related to the current project.

5.1.4.2 Archival Research

Additional targeted historical research was undertaken by Dr. Heather Lee Miller, of HRA, during May and June 2023 at the National Archives in Seattle, which holds collections for Alaska and is local to HRA's office. The following is excerpted from Miller (2023), the summary memo of her research. In addition to identifying research themes noted above in Section 5.1.3, HRA also uploaded 284 files that correspond to file names found in the research log (247 PDFs and 37 JPGs) (Miller 2023); the research log and complete copy of the summary memo were provided to BOEM as a separate deliverable.

Gray & Pape tasked HRA with researching and documenting shipwrecks and plane crashes in Alaskan waters from records held by the National Archives. The overall goal was to research and gather documents, images, and other materials that would be used to update BOEM's Alaska shipwrecks and Alaska downed aircraft databases and from which to develop a list of thematic contexts, provide data (coordinates, maps, or other descriptive locational information) for the GIS/mapping effort, and identify potential themes for the public outreach story map about various incidents. Initially, HRA intended to update the extant BOEM database with data gathered in the field, but due to the overwhelming volume of data identified, the project team agreed to prioritize a written synthesis of the results. The records for data entry will be provided to BOEM.

The archival research focused on documenting specific shipwrecks/plane crashes and sought to establish connections between shipping and aviation as a means of transportation with themes, times, and physical locations both onshore and offshore. Archival queries were expansive, searching for archaeological, ethnographical, and historical evidence of these connections. Many examples exist to demonstrate the connections among seagoing vessels and shore facilities. For example, over the millennia, Indigenous and later, non-Indigenous peoples living in or visiting Alaska have relied on ocean resources, such as whales, seals, fish, and shellfish, for both food and income. And, although vessel types, harvesting technologies,

and methods have changed over time, people have always used boats to go to and from land to gather resources from the sea and return them to shore. Thus, correlated with boats are the numerous and varied structures people have built along the shoreline, from early fish traps and weirs to the large wharves and canneries that exist today. Over the past few centuries, humans involved in marine resource gathering developed networks of shore facilities and have been (and still are) charting what they hoped were safe routes to those facilities.

Archival research also addressed connections between overwater aviation and affiliated structures onshore. Although a more recent invention than boats, almost as soon as humans took to the sky in a reliable manner, airplanes took on a significant role in transporting people and goods to and within Alaska. Both commercial and private aviation increased exponentially over the course of the twentieth century. Today, for every 1,000 Alaskan residents, there are 10 pilots—six times more than the U.S. national average—and 12 airplanes. As previously stated in Chapter 5.1.1, the state has more than 750 landing sites (as of 2019, 394 public airports and 363 informal landing areas)—the fourth highest in the country (Infogram 2023, Plane Talk 2019). Although many flights occur over Alaska’s vast interior, the fact that most people live along the coast (currently, 83 percent) and/or on an island has necessitated overwater aviation (NOAA 2023m). With 1,800 named islands, and surrounded by water to the north, west, and south, Alaska has by far the most shoreline of any state in the U.S. (10,686 km [6,640 mi] of general coastline and an estimated 76,122 km [47,300 mi] of tidal shoreline, including islands, inlets, and shoreline to head of tidewater). Alaska has more coastline and shoreline than all other states combined (NOAA 2023m, State of Alaska 2023). Given the length of coastline and shoreline and the numerous islands that comprise both the Aleutian chain and hug the southeast coast, many flights in Alaska are overwater, linking communities on both the mainland and the islands. Not surprisingly, many of Alaska’s airports and airstrips are located on or near the coast; additionally, Alaska has numerous seaplane bases along its ocean coasts (Ourairports.com 2023, Seaplanebase.com 2023).

Before visiting collections in person, HRA completed a desktop review (via keyword searching) of the holdings of known local repositories and ArchivesWest.org (direct link: <https://archiveswest.orbiscascade.org/>), which provides the locations of and descriptions of digital and physical collections in the Pacific and Intermountain Northwest (Idaho, Montana, Oregon, Utah, Washington, and Wyoming). Staff looked closely at finding aids and communicated with librarians and archivists to narrow results and create a targeted list of collections known, or anticipated to hold, relevant materials. Additionally, keyword searches in the University of Washington and University of Montana search engines were completed, which are powerful tools that link to online, full-text materials in such databases as JSTOR, HathiTrust, HeinOnline, and ProQuest (to name a few).

Upon completion of the desktop reconnaissance, the following list of repositories holding collections with materials relevant to the research goals were reviewed with the project team to identify research priorities:

- National Archives and Records Administration–Seattle (NARA)
- University of Washington Library and Special Collections (Seattle) (UW)
- Museum of History and Industry (Seattle) (MOHAI)
- Pacific Northwest Maritime Historical Society (Seattle) (PNMHS)
- Seattle Public Library
- Washington State Archives, Center for Pacific Northwest Studies (Bellingham) (CPNWS)

After confirmation of the research plan, HRA moved forward with scheduling and executing visits to each of the above repositories, with the exception of PNMHS. Repeated attempts to call and email PNMHS were unsuccessful. According to the MOHAI archivist, PNMHS currently has no staff and no one regularly monitoring email. This collection could hold additional materials of interest if future access can be gained.

Dr. Miller conducted all onsite research for the BOEM project between May 1 and June 20, 2023. Restricted hours and lack of appointments hampered HRA’s ability to conduct research in the most efficient way possible (i.e., full eight-hours days at a given location). MOHAI, for example, only offered two appointments per week between the hours of 1 and 4 p.m., whereas NARA was open full time but also required appointments. Despite this somewhat limited access, Dr. Miller was ultimately able to spend meaningful time in each repository. However, she was not able to complete all desired research at every location.

The archival research unearthed more documents, images, and contextual material related to shipping than to aviation (both in terms of casualties and associated structures). This is likely because aviation’s “newness” as a transportation method has simply meant there has been less time within which to accrue a historical record that has made it to an archive. (This is not to say such materials do not exist—indeed, especially in a region so dominated by the aviation industry, more sources about aviation likely exist, just apparently not in the collections that were visited.) People from coastal communities along the entire West Coast of North America (along with Japan, Russia, and even South America and the Pacific Islands) traveled to and from Alaska by boat for centuries, engaged in whaling, sealing, and other types of fishing and resource extraction (for example, furs or minerals); exploration and settlement; commercial shipping (for example, shipping tools, machinery, or general merchandise to and from both outside and inside Alaska); recreational boating; military missions, and so on. What is now the state of Washington has a long maritime history, with both Indigenous and non-Indigenous people establishing and maintaining Tribal, familial, commercial, and recreational connections between locations along Washington’s coasts and those farther north. These connections have fostered the existence of large collections in local repositories of private and public materials related to shipping.

5.2 Shipwreck Database

The Shipwreck Database is a standalone collection of information pertaining to lost vessels, of all types, near or off the coast of Alaska. It is formatted in a Microsoft Excel file and is separate from other databases, including the Downed Aircraft Database. The completed data entry table is the result of a collaborative effort to identify locational, historical, and physical contextual information of vessels lost or sunk off the coast of Alaska, extending out to the EEZ. This database is meant to be continually updated as additional information becomes available. This chapter describes the methodology for the Shipwreck Database creation, the data sources researched and used to populate the database, and GIS-related productions based off the data collected. The data entry columns are detailed in Appendix B, including the types and format of data to be entered and listings of any pick list variables.

5.2.1 Methodology

The Alaska Shipwreck Database was originally created by BOEM as a Microsoft Access database, updated through 2007. Additionally, BOEM has a similar Alaskan Shipwreck Table available online that is updated through May 2011. One of the main goals of this project was to simplify the earlier database and convert it from Access to Excel and to mirror the data fields that are currently in the BOEM Atlantic OCS, Pacific OCS, and Gulf of Mexico OCS shipwreck databases. The following is a description of how the database was converted from Access to Excel (incorporating data from the May 2011 Alaskan Shipwreck Table) and how it is designed to give certain information at the beginning of the table, and more contextual information as the reader moves left to right. Given the project team’s experience working with data from other BOEM regional databases, deliberate steps were taken to avoid known issues or problems. A detailed listing of all data entry columns, definitions of prepopulated attribute options, and the intent behind each value are detailed in Appendix B and can be used to help follow along as column information is described below. Of note, if data is missing within the database, such as left blank or listed as “null” within GIS, this information has either not been researched or still outstanding

and needs to be further researched. If a cell within the database is labeled “unknown”, or “unidentified”, it is indicative of a researcher inputting information to that end, and such information has been sought out and not found or identified. This is a distinction that carries across all databases.

The basic design of the Shipwreck Database (also referred to as data entry table intermittently throughout report) was envisioned to provide locational information of the shipwreck to the reader at the beginning of the dataset, with more historical and physical contextual information as the reader moved from left to right. Of note, a full description of column headers and content descriptions is included in the attached document, BOEM Alaska Shipwreck Database Definitions, located within Appendix B, and a description of the columns is included below. As mentioned previously, the Shipwreck Database was originally formatted in Microsoft Access and needed to be converted into Microsoft Excel, per the scope of work provided by BOEM. The data from the original Access database was kept in this transfer, with certain column headings kept or updated, and incorporated into the new Excel table. This conversion and modification of attributes as the database transferred from Access to Excel was the first major part of the Shipwreck Database development. What follows next is a description of the column information (added and updated) that make up the content of this database.

Reading from left to right, the first column on the left provides is the “BOEM 2011 ID” which refers to the identification number attributed to the shipwreck in the previous 2007 and 2011 datasets. The retention of this information was done to prevent the loss of any contextual data and allows for cross-reference between the old and new tables. Next to “BOEM 2011 ID” is the “AHRS ID”, which indicates if there is a corresponding AHRS ID for that shipwreck. As with each of the other data tables, coordination and data sharing with the State of Alaska is imperative to maintaining an up-to-date database. Alaska SHPO and DNR staff communicated to project team members that they receive and inventory information on verified and potential cultural resources in both state and federal waters and may contain references to possible submerged cultural resources that have not been reported to BOEM. Currently, there is no formal mechanism that requires coordinated reporting of submerged cultural resources (verified or reported) between BOEM and the State of Alaska.

Moving right along the column headers, “Vessel Name” is next. This is the most common way of referencing a shipwreck, by its name. Some entries specify that a vessel’s name is “unknown” while others reference an “unnamed” vessel. Some documentary sources may refer to a vessel that is unnamed, meaning that it was not registered or documented with a name, while “unknown” refers to a report of a wreck that is not identified by a specific name. The next data column is for “Registration ID,” which is the official number for documented vessels. Where the “Registration ID” was not located the column is left blank. The image (Figure 5-1) below shows the first column headers of the database, illustrating the identification system of each shipwreck within the database.

The following sections of the table focus on specific locational information, as BOEM reviewers (who represent the most active users of the database) are likely to need to look up resources within a specific location. Flowing left to right, column headings start with BOEM “Planning Area Name”, “Protraction ID”, “Protraction Name” (if available), and “Lease Block”. This focuses areas from large to small, reading left to right, within BOEM OCS planning areas. Following this column grouping, specific coordinate location information is set, with header attributes “Coordinate System”, and “X” (horizontal) and “Y” (vertical). For this database and to ensure coordinates and projection were universal for all of Alaska, The North American Datum 1983 (2011) Alaska Albers (Meters) coordinate system is used (EPSG 2024). Point geometry was calculated within the GIS after points were entered and projected from their original source coordinates.

Following this section are the column headings “Original Coordinate System”, “Original X” (or Latitude), “Original Y” (or Longitude) The inclusion of the originally reported coordinate or location data is intended to serve as a backup; in cases where coordinates of one datum need to be converted to the

project-specified datum, any errors in the conversion process can be queried if the original coordinates and corresponding datum are included in the database. The use of a primary coordinate system will also avoid situations where a shapefile may draw from one of multiple sets of coordinates within an entry, which may or may not be complete, resulting in database entries that are not displayed within GIS shapefiles. Data are often presented in a Lat/Long format, so both systems are included within the dataset/table. Depth is also included for known wreck sites, where information is available, listed in meters (m). Of note, if an entry reads “Outside Planning Area,” but has a “Protraction ID,” this is due to a wreck site evidently inland or on an island, whose location may be within a Protraction but outside of the maritime boundary of the Planning Area.

Moving right along the column headers, additional location information for where the vessel was lost is listed. The column “Loss Location” gives contextual, descriptive information, rather than numerical GIS information, to where a vessel was lost. The “Location Reliability” column provides a numerical attribute, based on a scale of 1–5, to the accuracy of the location of the shipwreck, and is adapted from the reliability rankings developed by Pearson et al. 2003 and used in other BOEM regional databases. For example, if a site has a rating of 1, this means locational information is much more accurate, and the site is verified to have evidence of remains at that specific location. A rating between 3–5 means there is less reliable locational information, however, the GIS coordinates provided fit within the description using data collected and provided within the “Loss Location” section. Column headers “Loss Type” and “Loss Type Other” provide additional contextual information as to how and where the vessel sank, which when viewed in terms of site formation processes may provide information as to the size, shape, and extent of the wreck site.

BOEM 2011 ID	AHRS ID	Vessel Name	Registration ID
1		Sv. Petr	
2		Sv. Ieremiia	
3		Sv. Kapiton	
4		Sv. Petr i Pavel	

Figure 5-1. Image taken of first four column headers with example data of the Shipwreck Database displaying BOEM 2011 ID, AHRS ID, Vessel Name, and Registration ID as the main identifying features for individual wreck sites within the database (Source: Gray & Pape, Inc.)

Moving to the right in the table, the data fields become more specific to the vessel, and this information may or may not be available for individual records. Column headers include “Vessel Use”, “Vessel Type”, and “Vessel Type Other”. This type of information describes the vessel itself, in particular, what service the vessel was in and what makeup or design the vessel was. To the extent possible, these columns and their corresponding attributes correlate with data fields used in other BOEM regional databases. A typical string of information would look like the following image below (Figure 5-2).

Vessel Use	Vessel Type	Vessel Type Other
OTH - Other	OTH - Other	Russian shitik
COM - Commercial	SHP - Ship	Russian vessel
COM - Commercial	SHP - Ship	Small Russian ship

Figure 5-2. Image taken of column headers with example data of the Shipwreck Database displaying Vessel Use, Vessel Type, and Vessel Type Other (Source: Gray & Pape, Inc.)

The next portion of the database focuses on the vessel itself, such as when it was built, manufacturer, who owned the vessel at the time of its loss, and physical attributes of the vessel such as length, beam, depth of hold, gross and net tonnage, hull material, propulsion, and engine type (or other engine details). Having this type of information at hand can be helpful in determining the extent of a shipwreck site and possible identification in the event of future survey work. The next section of data that is a specific carryover from the Access database focuses on vessel and cargo value and the type of cargo a ship was carrying. It should be noted that the content collected within this database is by no means a full exhaustive account of all the details of a shipwreck, but enough to provide a thorough accounting of the site; alternately it is understood that not all records will include this high level of detail. By including similar column headers between similar cultural resources, such as downed aircraft, consistency in reporting for BOEM can be attained. This is important and improves upon an issue identified in the BOEM GOMR regional database, which was explicitly created as a shipwreck database but has, over time, come to include records for downed helicopters, submerged precontact targets, artificial reefs, downed/toppled platforms, and side scan sonar targets and magnetic anomalies.

After these headers, date information follows to give context of when the vessel was lost. “Loss Year”, “Loss Month”, and “Loss Date” are each individual column headers, meant to account for varying levels of specificity without forcing all data into a single format that can introduce errors. While the date fields may seem excessive, the intent is to avoid a known problem with other regional databases that require a strict date format. For example, records that only indicate a year of loss, presented as YYYY, will not function properly in a required MM/DD/YYYY format; the formatted column will convert the YYYY entries to all show the same January 01 date of loss. By allowing for various degrees of specificity, the individual dates can be accurately entered and displayed at the level of detail indicated through research.

The next section of data columns is used to record information about the vessel’s last voyage, including its point of origin, planned destination, number of crew, number of passengers, number of lives lost in the

wrecking event, cargo weight, cargo type, and cargo value. There are also data columns to record information related to any known salvage of the wreck or its cargo. The “Other Research” column is used to capture the sources of information for the entry. Most sources were transferred from the 2007 Access database and 2011 Alaskan Shipwreck Table, using the attached document, Shipwreck Sources and Notes, located in Appendix E. In the conversion between Excel and Access formatting, extensive review of entries into the “Other Research” column was necessary. If information was missing or incomplete, this is noted, but the goal was to expand upon the abbreviations used and provide a more complete reference. The “Sources” column is meant to cite the primary source, such as the AHRS or BOEM.

One of the new attribute columns included in the table is simply a “Yes” or “No” determination of whether that specific shipwreck could have any public outreach potential. This column, “Public Outreach Potential,” was created so that if a shipwreck had a larger historically or culturally relevant story attributed to its loss, or available imagery, there could be additional avenues for BOEM to engage directly with the public in highlighting this vessel. This column is also used within the Coastal Precontact and NRHP, and Downed Aircraft databases.

The final sections of the database refer to sources used and information about who created each entry, and when it was updated. This is an important aspect of the database and makes it very easy to determine when the last update was made or if new information has been added.

Once the structure for the data entry table was finalized, again, focusing on locational information at the outset of the database and moving toward more historical and physical attribute data from left to right, it was imperative to begin reviewing and updating the database with newly reported or identified shipwrecks. Transferring data from Access to Excel and updating locational information were the most time-consuming tasks associated with this data entry table, and this last aspect will be discussed within the GIS section (Section 5.2.3). In addition to reviewing the transferred content, supplemental historical information was located and will be discussed in the next section.

5.2.2 Data Sources

Once the structure of the Shipwreck Database was established in Excel and updated, it was then necessary to start reviewing content and adding additional information. A preliminary review of sites within 61 m (200 ft) of the modern Alaska coastline indicated over 7,700 known or reported cultural resources. This initial search area was expanded to include Federal and State waters and coastal sites within 160 km (99.4 mi) of the shoreline.

The original 2007 Access database and 2011 Alaskan Shipwreck Table included references to sources that are likely to have been revised since the last update, such as publicly available databases, and these sources were rechecked for newer entries; new sources of information were also reviewed and are described below. Research included review of NOAA Electric Navigational Chart (ENC) information and data from NOAA’s office of Coast Survey’s Automated Wreck and Obstruction Information System (AWOIS). ENC and AWOIS data provides a level of locational information that is not necessarily as accurate as others, however, it does provide contextual data that can be expanded upon. Additional NOAA data could be located within NOAA’s Office of Exploration (OE). NOAA’s OE supports research expeditions to explore previously unvisited areas of the ocean (NOAA 2023n). At the time of report preparation (May through September 2023) NOAA was conducting an expedition in Alaska, utilizing the NOAA vessel, Okeanos Explorer, to conduct a series of telepresence-enabled ocean exploration expeditions to improve knowledge about unexplored and poorly understood deepwater areas offshore Alaska, with a particular focus on the Aleutian Islands, Gulf of Alaska, and Aleutian Trench (NOAA 2023o). An image of where Okeanos Explorer was (29 August 2023) conducting survey work is seen in Figure 5-3 below.

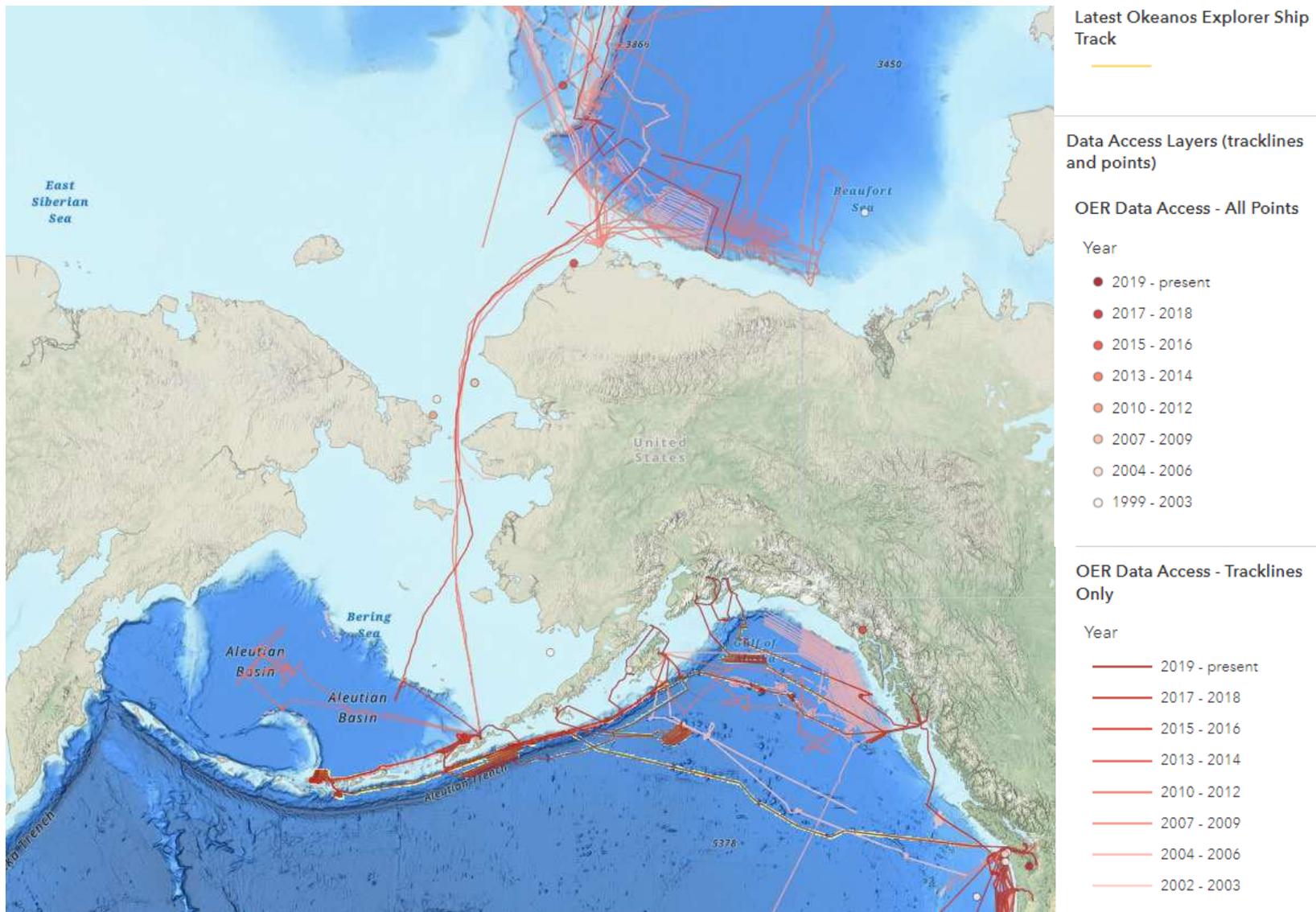


Figure 5-3. Map image of Alaska with track lines indicating survey routes of NOAA Ocean Exploration Research data as of 25 January 2024. (Source: NOAA Office of Exploration)

It is anticipated that information regarding cultural sites, including downed aircraft and shipwrecks, could be located because of this expedition. This aspect will be reviewed again in the recommendations section; however, it is important to point out projects NOAA OE has funded in Alaska, both past and future, that provide information to populate the Shipwrecks and Downed Aircraft Databases.

Information on NOAA OE funded investigations in Alaska can be accessed through the NOAA Ocean Exploration Data Atlas (NOAA 2023o). One of these expeditions is of the famous 1871 whaling fleet in the Western Arctic, previously discussed in this chapter (Barr and Delgado 2016). In 2015, NOAA ONMS, with assistance of NOAA OE, led a systematic seabed mapping survey along the Arctic coast of Alaska in search of whaling ships abandoned in 1871 due to freezing and ice conditions (Barr and Delgado 2016). The results of this survey are located both with the State of Alaska DNR and the AHRS database and are accessible in the NOAA Ocean Exploration Data Atlas (NOAA 2023o). Information from this survey was used to update the Shipwreck Database and to add contextual data to sections lacking content.

Military conflict in Alaska comprises a thematic portion of the Shipwreck Database. To account for these losses, two main entities were contacted, USCG and the U.S. NHHHC. In consulting with NHHHC in reference to this project, it was mentioned that there are naval assets offshore of Alaska, both from the U.S. and Japan, but specific details were not given. NHHHC requested BOEM work directly with NHHHC on any specific data requests, and that in the upcoming year, a new GIS information sharing system will be available for agencies to directly work and request data from NHHHC. USCG was another source of information. USCG was consulted to determine if assets, both vessel and aircraft, had been lost off the coast of Alaska. In confirming with individuals from USCG, this was the case, and information was included and referenced within the Shipwreck Database and in the Downed Aircraft Database.

Research was conducted using a combination of primary archival data and online database research, to acquire and cultivate information for the Shipwreck Database. This research was supplemented with additional content from the State of Alaska AHRS database and information from USCG, NHHHC, and NOAA. BOEM should continue to collaborate with these agencies to update and add to the data collected for this project (Chapter 8).

5.2.3 GIS

The Shipwreck Database is set up in an Excel format that was used to create the corresponding shapefiles used in ArcGIS Pro. As mentioned in previous sections, individual specific locational data collected for the Shipwreck Database is administered by BOEM and is not publicly available without request by qualified researchers. These data are restricted for BOEM planning purposes and held in confidence by the Department of the Interior.

Additional contextual information that was generated as a product of this study from historical map research, however, is available for public use, as the data were pulled directly from published government repositories, primarily NOAA and Library of Congress (LOC). Historical maps provide content, such as shipping routes for commercial shipping, postal, or whaling vessels, that in turn help to inform areas of high probability for potential shipwreck locations. For instance, a GIS recreation of the main commercial shipping routes of the Pacific Steam Whaling Company from 1901 was completed, using data from the historical map. Both images can be seen below (Figures 5-4 and 5-5).

The use of these historical maps greatly informed the identification of higher probability areas for potential remains of shipwrecks. Knowing that a certain area was traversed more frequently as opposed to others is an important tool for BOEM when considering the likelihood that a project may adversely affect historic resources. Other information pulled from historic map data included submerged cable lines.

This information does not necessarily fit in any single database, but it is important to include such information from historical maps to help alert BOEM to potential sub-bottom obstructions. This information can be seen below in Figures 5-6 through 5-8. Additionally, maps are important for continued interpretation for both planning and, in the event of a survey anomaly, aid in determining a potential identification.

This database presents text and information in its form from its original source. Data pertaining to this database (e.g., Coordinate System, X and Y coordinates, public outreach potential, entry data) are newly added. Sites were projected from their original coordinates and their geometry was calculated to provide the current X, Y coordinates. After projection, they were clipped to a polygon including Alaska state and U.S. federal waters, and a 160 km (99.4 mi) buffer of the US Census 2023 TIGER/Line coastline. Locations were spot-checked for accuracy. Finally, the database was added to a blank map and converted to a shape directly from the XY coordinates from Excel to ensure future updates would return the same GIS dataset.

As new information presents itself, there are two methods that could be used to update the database. The first, data could be added manually to the Excel spreadsheet. XY coordinates in the database coordinate system would need to be calculated to complete the entry. To maintain an up-to-date shapefile, the Excel sheet would need to be converted to a new shapefile in GIS. In this case, the user would also need to regenerate or apply the metadata to the new shapefile to maintain completed metadata status for the database. For the second method for updates, data could be added to the spreadsheet and shapefile concurrently. The user would need to add the point to the shapefile manually using “Create” in the Edit menu of ArcGIS Pro. XY geometry could then be calculated within the attribute table of the shapefile and copied and pasted back to the Excel spreadsheet to complete the database entry.

Due to the additional metadata work and the potential for error or difficulty placing the new point correctly using calculated coordinates, the first method is not recommended.

5.3 Downed Aircraft Database

The Downed Aircraft Database is a standalone collection of information pertaining to lost aircraft, of all types, near or off the coast of Alaska. A deliberate decision was made to separate shipwrecks and downed aircraft into unique databases because, while they share many of the same data columns (e.g., name, location, location reliability), the specific aircraft details require specialized attributes. Rather than create a single data entry table with multiple columns of unrelated information for all resource types, the databases were tailored to the specific resources being entered.

The Downed Aircraft Database was formatted as a Microsoft Excel file and is the result of a collaborative effort to identify locational, historical, and contextual information of aircraft crashed or lost off the coast of Alaska, extending out to the EEZ. This database is meant to be continually updated as additional information is identified. This section describes the methodology for the Downed Aircraft Database creation, the data sources researched and used to populate the database, and GIS related productions based off the collected data.

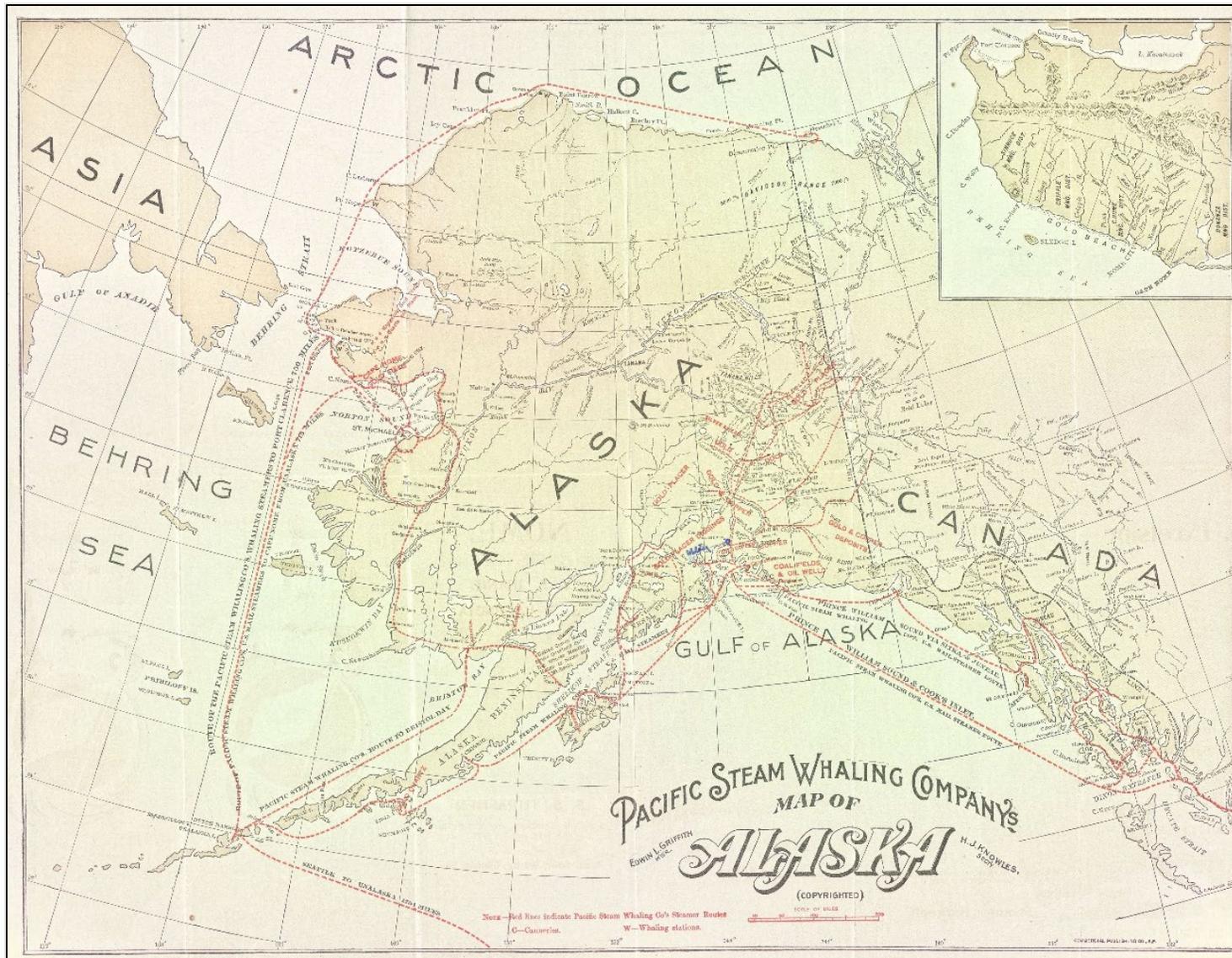


Figure 5-4. Historic map from the Pacific Steam Whaling Company, dated 1901, indicating shipping routes in dotted red lines (Courtesy: Rare Maps Collection, Elmer E. Rasmuson Library, APRCA, University of Alaska Fairbanks)

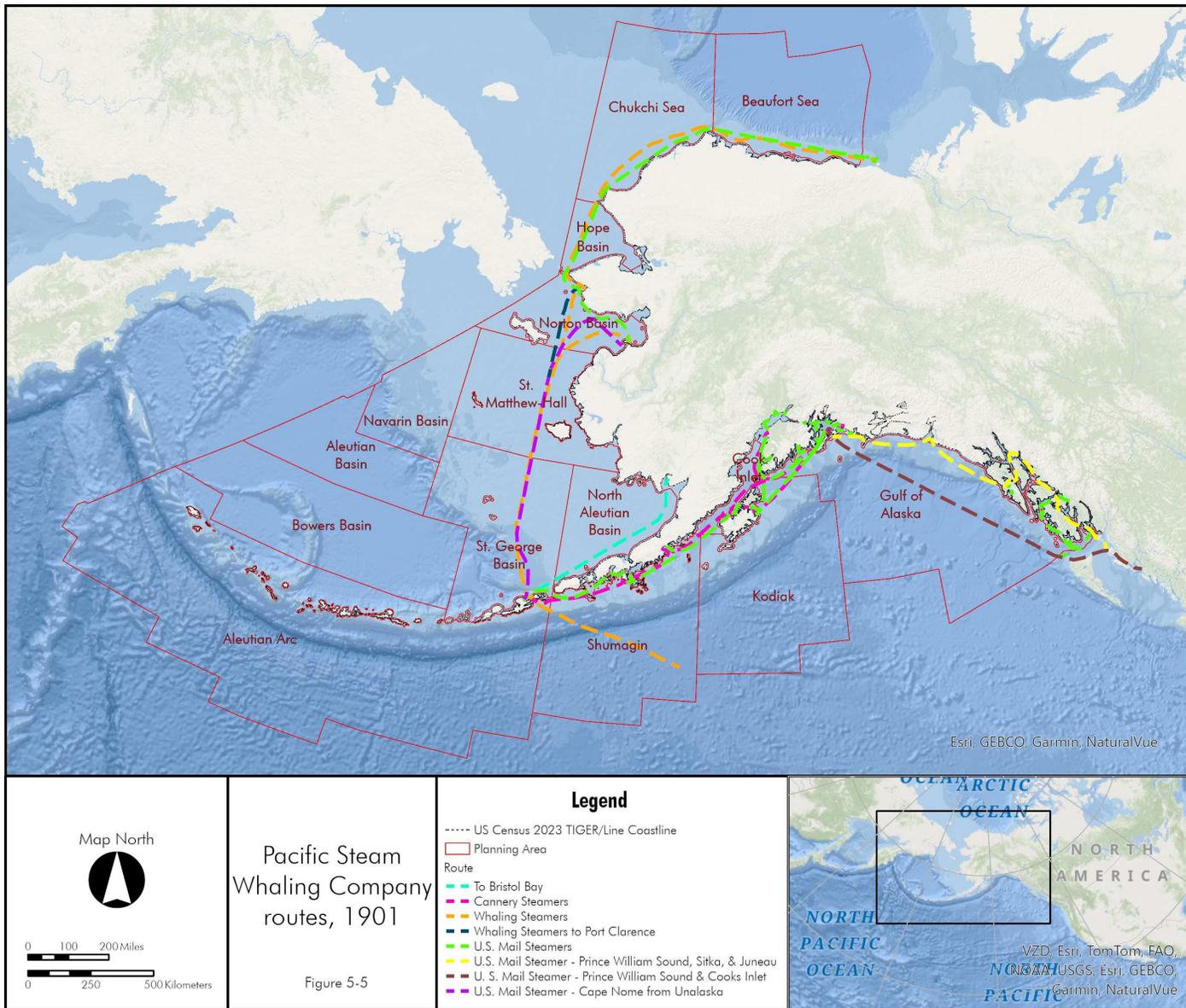
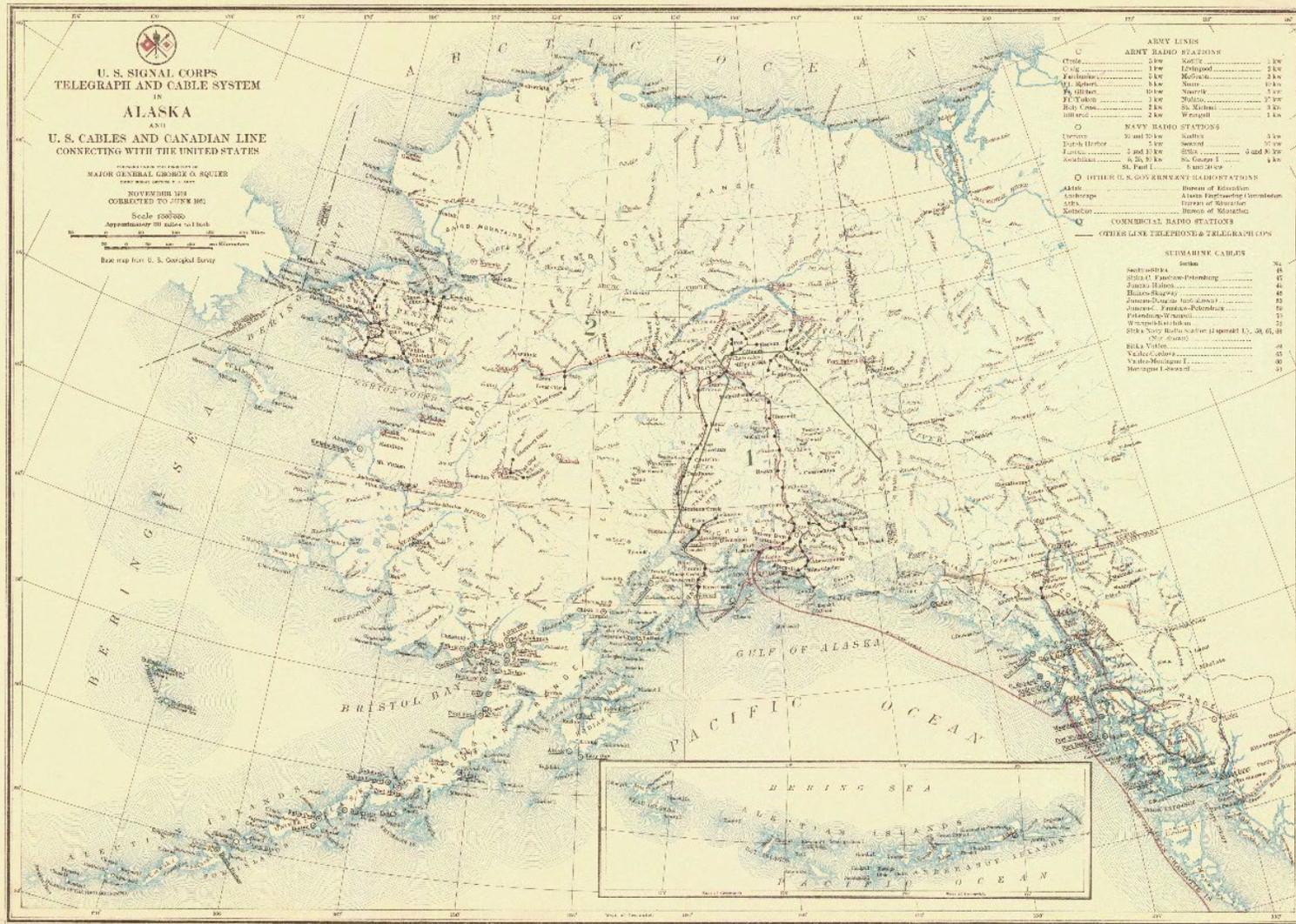


Figure 5-5. Pacific Steam Whaling Company routes, 1901



945

Figure 5-6. Large image of map created by the U.S. Signal Corps illustrating the telegraph and cable system in Alaska and Canadian line connecting with the U.S. Dated June 1921 (Source: NOAA Office of Coast Survey, Historical Map & Chart Collection [2023n])



Figure 5-7. Close up image of previous map displaying red line indicating a military cable located in the Gulf of Alaska, connecting Fort Liscom and Sitka, Alaska (Source: NOAA Office of Coast Survey, Historical Map & Chart Collection, edited by Gray & Pape, Inc.)

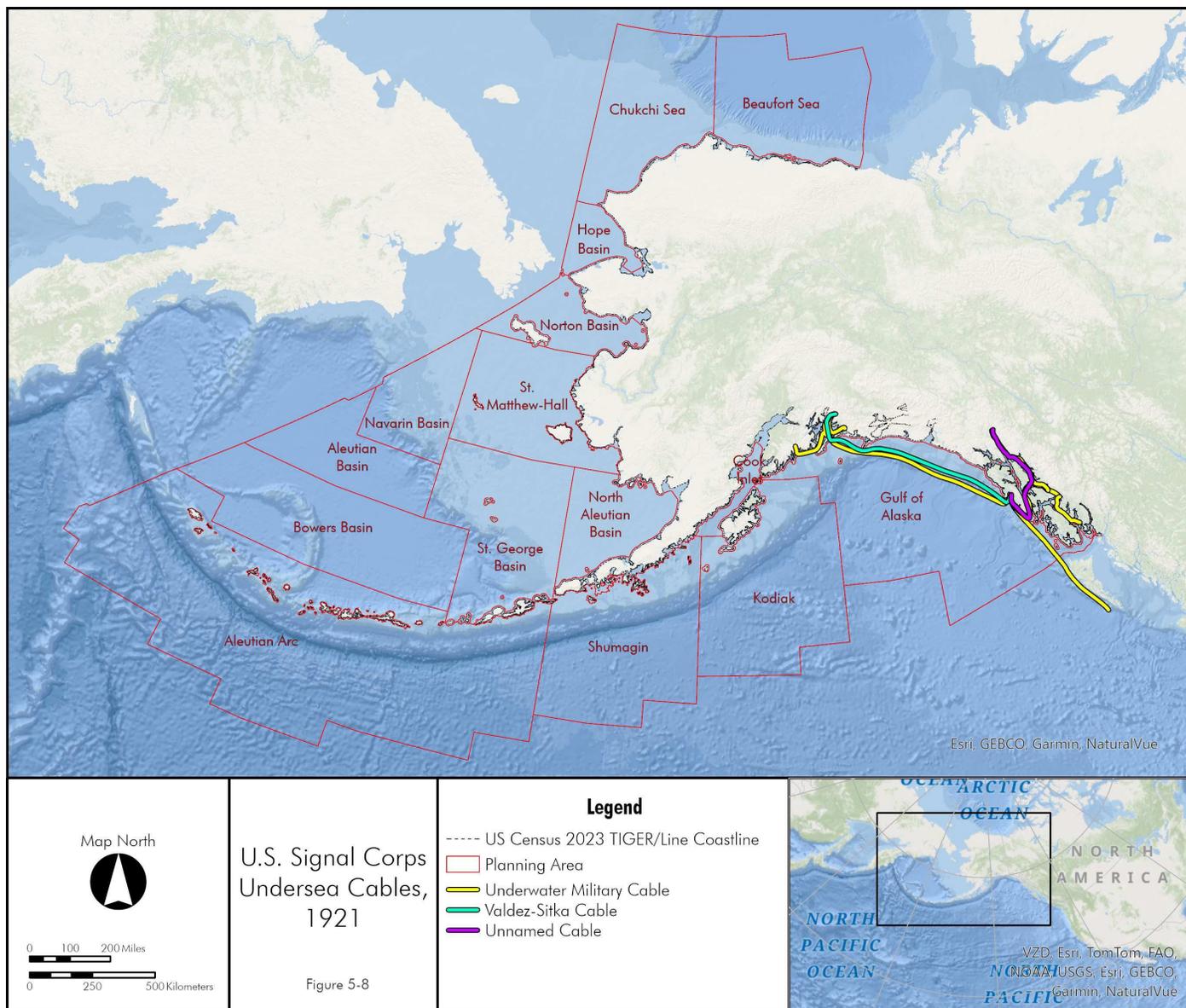


Figure 5-8. Undersea cable routes from the 1921 U.S. Signal Corps

5.3.1 Methodology

Unlike the Shipwreck Database, the Downed Aircraft Database did not have a previously collected data set to work from and required creation of an attribute data table from the ground up. Much of the formatting for this table was borrowed from the Shipwreck Database, with similarities in column headings and attribute content organized left to right within the database itself. The following is a description of how the database was established and, like the Shipwreck Database, the Downed Aircraft Database is designed to give the most used information at the beginning of the table, and more contextual information as the reader moves left to right. A detailed listing of all data entry columns, definitions of prepopulated attribute options, and the intent behind each value of the Downed Aircraft Database are detailed in Appendix C and can be used to help follow along as column information is described below. Of note, if data is missing within the database, such as left blank or listed as “null” within GIS, this information has either not been researched or still outstanding and needs to be further researched. If a cell within the database is labeled “unknown”, or “unidentified”, it is indicative of a researcher inputting information to that end, and such information has been sought out and not found or identified. This is a distinction that carries across all databases.

The basic design of the table was envisioned to provide locational information to the reader at the beginning of the dataset, similar to the Shipwreck Database. The first column header is the “AHRS ID”. As with the other databases, if there is a corresponding AHRS ID for a downed aircraft entry, historical, archaeological, and contextual information is available and has been identified by the State of Alaska. Coordination and data sharing with the State of Alaska is imperative to maintaining an up-to-date database, especially given the current lack of formal requirement for data sharing between BOEM and the State of Alaska.

Moving right along the column headers, “Registration ID” is next. This column is used to identify the aircraft itself. Unlike ships, aircraft do not necessarily have a name attributed, but rather an ID or serial number or tail number used to identify the aircraft. Depending on if the aircraft is commercial or military, those serial/registration numbers will look different in the column. A naval aircraft, for instance, will have a “BuNo” or “Bureau Number” assigned to the aircraft (example, USN PBV-5A) (BuNo 7280). This number is used for identification and record-keeping purposes and remains with the aircraft until it is retired or stricken from the Navy inventory. The number is not reused or reissued to another aircraft (Baugher 2023). The U.S. Army Air Forces will have an identifying serial number. Other registration numbers, in particular commercial flights, are identified by the airline and the flight number (example, Northwest Airlines 285), within this ID column. Additionally, this column may also include an aircraft's “N-number”, which is the registration ID given by the FAA (example, N4747U). The image (Figure 5-9) below shows these first three column headers of the database.

The location information for the Downed Aircraft Database shares the same layout and design as the corresponding columns in the Shipwreck Database. Continuing left to right, column headings start with BOEM “Planning Area ID”, “Planning Area Name”, “Protraction ID”, “Protraction Name” (if available), and “Lease Block”. This focuses areas from large to small, reading left to right, within BOEM OCS planning areas. Next, specific location information is in the attributes “Coordinate System”, and “X” (horizontal) and “Y” (vertical). For this database, and to ensure coordinates and projection were universal for all of Alaska, The North American Datum 1983 (2011) Alaska Albers (Meters) coordinate system is used (EPSG 2024). Point geometry was calculated within the GIS after points were entered and projected from their original source coordinates.

1	AHRS ID	Registration ID
2	ADK-00226	Unidentified Aircraft Wreckage
3	ATK-00036	USAAF B-24D (40-2367)
4	ATU-00275	USCG HC-130H Hercules
5	KET-00982	N64T
6	KIS-00006	A-20 and PBY Aircraft
7	NOM-00260	Unidentified
8	TYO-00354	USAAF P-51H (Unidentified)

Figure 5-9. Image taken of first two columns with example data of the Downed Aircraft Database displaying AHRS ID and Registration ID, as the main identifying features for individual aircraft sites within the database (Source: Gray & Pape, Inc.)

Source data often presented locations with latitude longitude, and with various datums. In case of errors in projection, but also to preserve references, original coordinate data (Latitude and Longitude) is included as well. This information is included in column headings “Original Coordinate System”, “Original X” (or Latitude), and “Original Y” (or Longitude). Depth is also included for known wreck sites, where information is available, listed in meters (m).

As mentioned in the previous section, if data within the database reads “Outside Planning Area,” but has a “Protraction ID,” this is due to a downed aircraft site that is located above the water, either inland or on islands where those provenience layers do not extend.

After this section of the database that focuses on GIS locational information, the following sections of the Downed Aircraft Database help contextualize the individual lost aircraft. Column headers include “Airframe”, “Aircraft Use”, “Manufacturer”, and “Model”. This type of information describes the aircraft itself, if it was an aircraft or helicopter, or another type of aircraft, who was using it when it was lost, and what specific type of model it was. A typical string of information would look like the image below (Figure 5-10).

Airframe	Aircraft Use	Manufacturer	Model
AIR - Airplane	OTH - Other		
AIR - Airplane	MIL - Military		B-24D Liberator
AIR - Airplane	MIL - Military	Lockheed	HC-130H Hercules
AIR - Airplane	CIV - Civilian/Commuter	Consolidated	PBY-5A

Figure 5-10. Image taken of column headers of the Downed Aircraft Database displaying Airframe, Aircraft Use, Manufacturer, and Model (Source: Gray & Pape, Inc.)

After these headers, date information follows to give context of when the aircraft was lost. “Loss Year”, “Loss Month”, and “Loss Day” are each individual column headers, with a fourth date column, “Loss Date” created to put all three into a full MM/DD/YYYY format. A “Date Specificity” column provides detail on the level of accuracy or indicates if no date was attributed to the record. Again, the use of multiple date format options allows for the accurate inclusion of variably detailed entries (see Chapter 5.2.1). Moving right along the column headers, additional locational information for where the aircraft was lost is listed. The column “Lost Location” gives contextual information, rather than numerical GIS information, to where an aircraft was lost. The “Location Reliability” column provides a numerical attribute, based on a scale of 1–5, to the accuracy of the location of the downed aircraft and is adapted from Pearson et al. 2003 (see Chapter 5.2.1). Column headers “Loss Type” and “Loss Type Other” provide additional contextual information as to how and where the aircraft went down. An “Origination” and “Destination” column track the proposed flight path of the aircraft. All of this information should be considered when evaluating any locational data provided.

The next large portion of the database focuses on the aircraft itself, such as when it was built, who owned the aircraft at the time of its loss, and physical attributes of the aircraft such as length, wingspan, tail height, wheelbase, physical class, and the number, and type, of engines. The aircraft’s nationality is recorded, as well as information on possible salvage of the site or materials. Having this type of information at hand can be helpful in determining the extent of a downed aircraft site and possible identification in the event of future survey work. Further columns include whether a loss report was filed and by what agency. Individual report numbers are identified, where available, within the database and can be used to further examine specifics of the conditions of a downed aircraft event. Many of these reports account for the number of crew, passengers, and any loss of life due to the aircraft loss.

One section of data that is a specific carryover from the Shipwreck Database is the next section dealing with aircraft and cargo value, and the type of cargo an aircraft was carrying. This is taken almost directly from the previously constructed BOEM 2007 Shipwreck Access Database, which provided the base structure for both the Shipwreck and Downed Aircraft Databases. The intent was to construct a database that maintained a significant range and variety of information for each downed aircraft, and to mirror the Shipwreck Database in size and scope. As mentioned in the Shipwreck Database section above, the content collected is by no means a fully exhaustive account of all the details of a downed aircraft (or shipwreck), but enough to provide a thorough accounting of the site. By including similar column headers between these cultural resources, consistency in reporting for BOEM can be attained. Space is provided for “Other Research” and “Sources”.

The final sections of the database refer to sources used and specific references to entry and update dates and authors, consistent with the Shipwreck database. Additionally, the authors decided to add a column that was simply a “Yes” or “No” determination of whether that specific downed aircraft could have any public outreach potential. This column, “Public Outreach Potential”, was created so that if a specific site had available imagery or a larger historical or culturally relevant story attributed to its loss, there could be additional avenues for BOEM to engage directly with the public in highlighting this aircraft. This column is also used within the Coastal Sites and NRHP and Shipwreck databases.

Once the data entry table structure was finalized, again, focusing on locational information at the outset of the database and moving toward more historical and physical attribute data, it was imperative to begin populating the database with individual aircraft losses. The next section will describe the sources used, and how they were used to identify sites that fit within the context of the Downed Aircraft Database. One important aspect that differentiates the Shipwreck Database and the Downed Aircraft Database is that most of the identified shipwrecks lay within a marine environment, there are downed aircraft that are included within the database that were lost on land. This specific aspect, along with identifying search criteria, will be further discussed in the next section.

5.3.2 Data Sources

Once the structure of the Downed Aircraft Database was established, it was then necessary to start populating it with content. As mentioned in previous sections, the AHRS database was one of many resources queried to acquire content for the Downed Aircraft Database and used with the permission of the State of Alaska. The AHRS search was based on identifying all potential aircraft sites near the shoreline, as defined by the US Census (2023) TIGER/Line, in addition to those in State and Federal waters. If research determined that a downed aircraft site was salvaged and there are currently no remains present, that site was not included within the database. Only locations that are known to or potentially have remains are included within the database.

The main sources of content came from the following locations, each of which will be detailed further in this section: the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA); the Flight Safety Foundation and the corresponding Aviation Safety Network (ASN) database; DPAA; NHHHC; the USCG; NARA; and the AFHRA. Additionally, as mentioned in the previous chapter, archival research was completed at the National Archives in Seattle. In addition to these sources, a combination of primary archival data and online database research was undertaken to identify additional records for inclusion. Various source information is included within the “Sources” column within the Downed Aircraft Database itself but is also listed within the references section of this report (Chapter 9).

The FAA and NTSB provide an online database for searches of commercial and private aircraft incidents, as reported by these Federal agencies. The link for this database is located within the references (NTSB 2023). Accident/incident data could be searched for according to location, year, and by “Highest Injury Level” severity of the accident (Fatal, Serious, Minor, All, or None), and other attributes. Each incident had a corresponding accident report or “NTSB #” that was available as a PDF download, which provided contextual information for that aircraft incident. Detailed information included where the accident occurred (often latitude and longitude were provided), when it occurred, who was involved, how the incident occurred, and additional aircraft details.

For the purposes of this project, a search of the NTSB database began with a wide-reaching scope, using limited criteria to gain the maximum number of reviewable incidents. For this search, the criteria began by including all types of aircraft, lost in Alaska, with the “Highest Injury Level” severity set to “All”. This resulted in a return of 9,479 cases. Refined searches included changing the “Highest Injury Level” severity to “Fatal” produced a smaller return of 1,082 items. It was determined by the authors that a “Fatal” crash would likely produce a physical site that would either still have remains located there, or were later salvaged, but minor injuries may not produce a physical crash site for archaeological/historical consideration. Within the 1,082 fatality reports, location and contextual information was reviewed and if an incident fit within the proximity of search parameters (offshore and/or not to exceed 4.8 km [3 mi] inland), the incident could have potential to be included within the Downed Aircraft Database. Further analysis of the incidents, such as whether accident remains were salvaged, helped to determine if such a listing could be included. Locational accuracy varied depending on location (near or far offshore, or along shoreline), and was attributed in the database where appropriate.

Along with commercial, commuter, and private aircraft, military aircraft are influential in the Alaskan region. Historically, with World War II action and the Cold War incidents, military aircraft losses comprise a portion of the overall Downed Aircraft Database entries. To account for these losses, two main entities were contacted, DPAA and NHHHC. In consulting with NHHHC in reference to this project, it was mentioned that there are probably 30–50 known aircraft losses offshore of Alaska, but specific details were not given. NHHHC requested BOEM work directly with NHHHC on any specific data requests, and that in the upcoming year (2024), a new GIS information sharing system is planned to be available for agencies to directly work and request data from NHHHC.

Working with DPAA, Gray & Pape signed a Memorandum of Understanding (MOU) to share data and collaborate on this, and other DPAA organized projects. As a result of this collaboration numerous avenues for potential aircraft losses were identified. Online databases, including the Aviation Archaeological Investigation & Research (AAIR) database, were shared with the project team and detail military aircraft losses, both USN and USAF (AAIR 2023). Additionally, information was shared about the “U.S. – Russia Joint Commission on POW/MIAs”. Of note, “Through its Joint Commission Support Division (JCSD), Defense POW/MIA Accounting Agency (DPAA) provides administrative and analytic support to the U.S. Side of the U.S.-Russia Joint Commission on POW/MIAs (USRJC) and conducts research in Russia on missing U.S. service personnel. JCSD also assists the Government of Russia with efforts to account for its missing” (DPAA - USRJC 2023). The reasoning for this will be discussed more within the GIS section (5.3.3), but briefly, Alaska served as a major location for Lend-Lease material to flow into the Soviet Union (Russia) during World War II. Close to 8,000 aircraft alone were transferred from Montana, through Canada, and into Alaska, to be picked up and flown back to the Soviet Union by Soviet pilots (Figure 5-11). This was referred to as the Alaska to Siberia (ALSIB) route and, “Between September 1942 and September 1945, 133 planes were lost in North America, and 44 in Siberia, along the Northwest and ALSIB air routes, due to severe weather conditions, mechanical problems, and pilot error—a total of 2.22 percent of the 7,983 planes that were delivered to the Soviets from Great Falls,” (Dolitsky 2016:14). There is the potential for American made aircraft piloted by Soviet pilots, to be lost along this route, specifically in the Hope or Norton Basin Planning Areas.



Figure 5-11. Statue of two pilots, a memorial in Fairbanks, Alaska commemorating the shipment of U.S. aircraft to the Soviet Union (Photo by Air Force Staff Sgt. D. Myles Cullen, Department of Defense [2023])

During consultation with DPAA, data pertaining to downed aircraft in Alaska was limited to American losses only, but DPAA made the determination that any aircraft located that had been piloted by Russian/Soviet pilots, would be considered property of Russia, even if the aircraft itself was built by the

U.S. Additionally, the AFHRA was contacted to provide additional ALSIB contextual information and provided multiple documents containing hundreds of pages of information pertaining to this event. AFHRA provided an important resource for ALSIB research, but also became important in establishing a working relationship for future archival information requests.

The information located within the ASN online database did, however, include military aircraft losses. Searching this database, in a similar search manner as with the NTSB database, produced a listing of 409 flight cases to be reviewed. Combining information from the ASN database, another online database was also used to help identify military aircraft losses. The AAIR database includes military losses from the U.S. Air Force, U.S. Navy, U.S. Civil, and Vietnam losses. Using both the ASN database and the AAIR database information together helped refine the number of corroborated incidents. Further analysis of the incidents, such as whether accident remains were salvaged, helped to determine if such a listing could be included within the Downed Aircraft Database. Locational accuracy varied depending on location (near or far offshore, or along shoreline), and was attributed in the database where appropriate.

The USCG was another source of information. As discussed previously, USCG was consulted to determine if assets, both vessel and aircraft, had been lost off the coast of Alaska. In confirming with individuals from USCG, if that was indeed the case, the relevant information was included and referenced within the Downed Aircraft Database and in the Shipwreck Database.

In summary, the Downed Aircraft Database was populated with data identified following comprehensive research and engagement with multiple agencies. As will be discussed in the recommendations chapter, updating this data and adding content will be necessary. Each of these online databases are highlighted and linked within the references section of the report.

5.3.3 GIS

The Downed Aircraft Database is set up in an Excel format that allows for information to be pulled to plot locational data in ArcGIS Pro. As mentioned in previous sections, individual specific locational data collected for the Downed Aircraft Database is administered by BOEM and is not publicly available without request. These data are restricted for BOEM planning purposes and held in confidence by the Department of the Interior.

Additional contextual information that was used through map research, however, is available for public use, as these data were pulled directly from published government repositories, primarily NOAA and LOC. Historical maps provide content, such as commercial airplane routes or the Lend-Lease “ALSIB” route, that help define areas of high probability for potential downed aircraft. An example of this process is illustrated by extrapolating specific route data directly from the historic map to then create GIS line data that can be used for predictive modeling. Figures 5-12 through 5-14 illustrate the process of pulling map data, in this instance certified air routes from 30 June 1961, for further research purposes and predictive modeling for high probability of downed aircraft; note that the routes are annotated as “certificated air routes” in Figure 5-12. Of note, this map has three main sources of line information, including “mail routes,” “non-mail routes,” and “interstate routes,” but each line displays a route in which an aircraft travels. Of the three images of this set of information, the GIS image (Figure 5-14) is an interpretation of the data acquired from this certificated air route map. Another example of data being used for predictive modeling comes from the World War II route taken by American/Canadian, and ultimately Soviet, pilots transferring Lend-Lease aircraft from the U.S. to the Soviet Union (Russia) is displayed in Figures 5-15 and 5-16. Again, close to 8,000 aircraft were transferred from Montana, through Canada, and into Alaska, to be picked up and flown back to the Soviet Union by Soviet pilots. In the event of poor weather, or any number of issues, there was the potential for an aircraft to crash anywhere in between Nome, AK and Uelkal, Soviet Union (Russia). As mentioned, the historical maps were used to identify areas where there is a higher probability of encountering remains of downed aircraft due to the

increased presence and/or persistence of air traffic. Knowing that a certain area was traversed more frequently, as opposed to others, is an important historical contextual tool for BOEM to use. These maps are important for continued interpretation for both planning and in the event of a survey anomaly, aid in determining a potential identification.

As with the Shipwreck database, as new information presents itself, there are two methods that could be used to update the database. The first, data could be added manually to the Excel spreadsheet. XY coordinates in the database coordinate system would need to be calculated to complete the entry. To maintain an up-to-date shapefile, the Excel sheet would need to be converted to a new shapefile in GIS. In this case, the user would also need to regenerate or apply the metadata to the new shapefile to maintain completed metadata status for the database. For the second method for updates, data could be added to the spreadsheet and shapefile concurrently. The user would need to add the point to the shapefile manually using “Create” in the Edit menu of ArcGIS Pro. XY geometry could then be calculated within the attribute table of the shapefile and copied and pasted back to the Excel spreadsheet to complete the database entry.

Due to the additional metadata work and the potential for error or difficulty placing the new point correctly using calculated coordinates, the first method is not recommended.

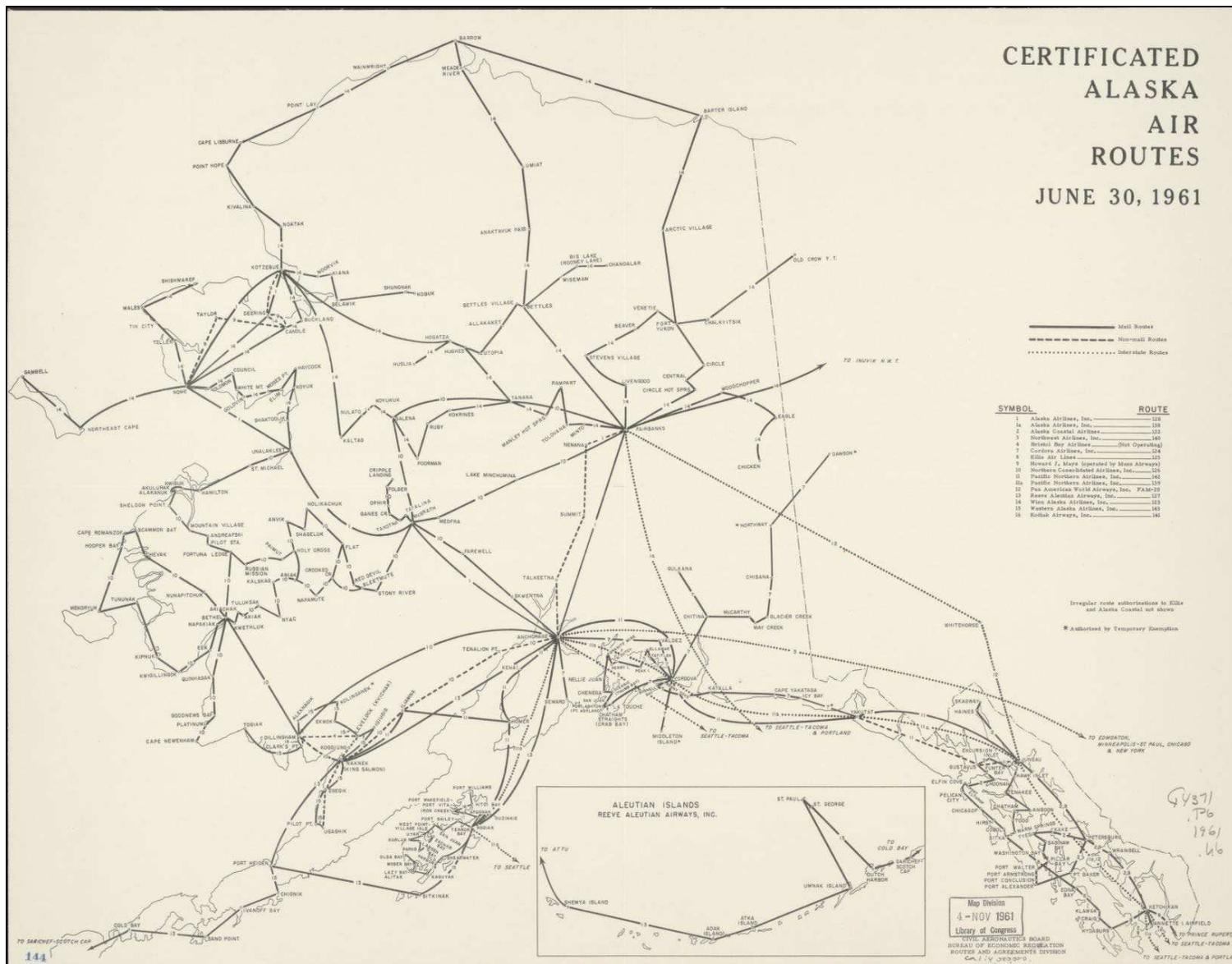


Figure 5-12. Main map of certificated air routes in Alaska, dated 30 June 1961 (Source: Library of Congress)

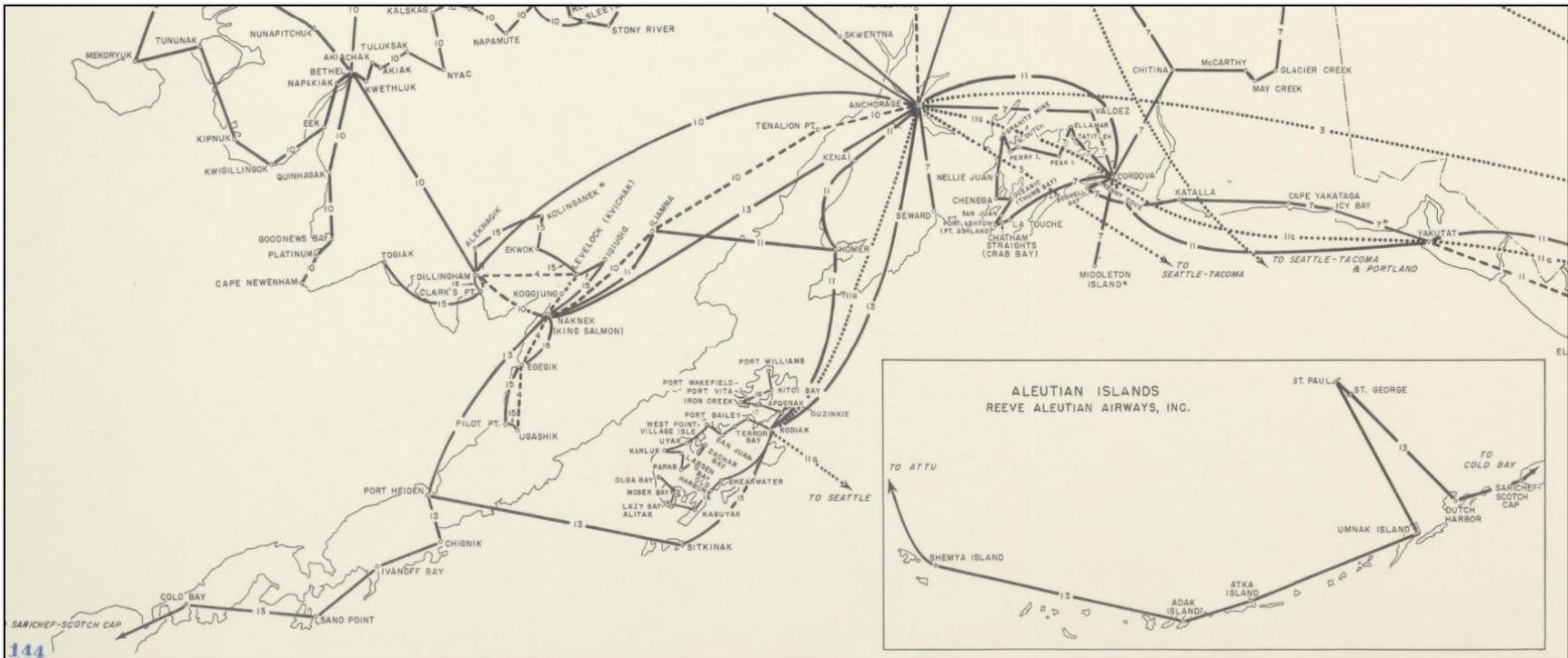


Figure 5-13. Close up of map of certificated air routes in Alaska, dated 30 June 1961, illustrating more detailed routes aircraft traveled throughout Alaska (Source: Library of Congress)

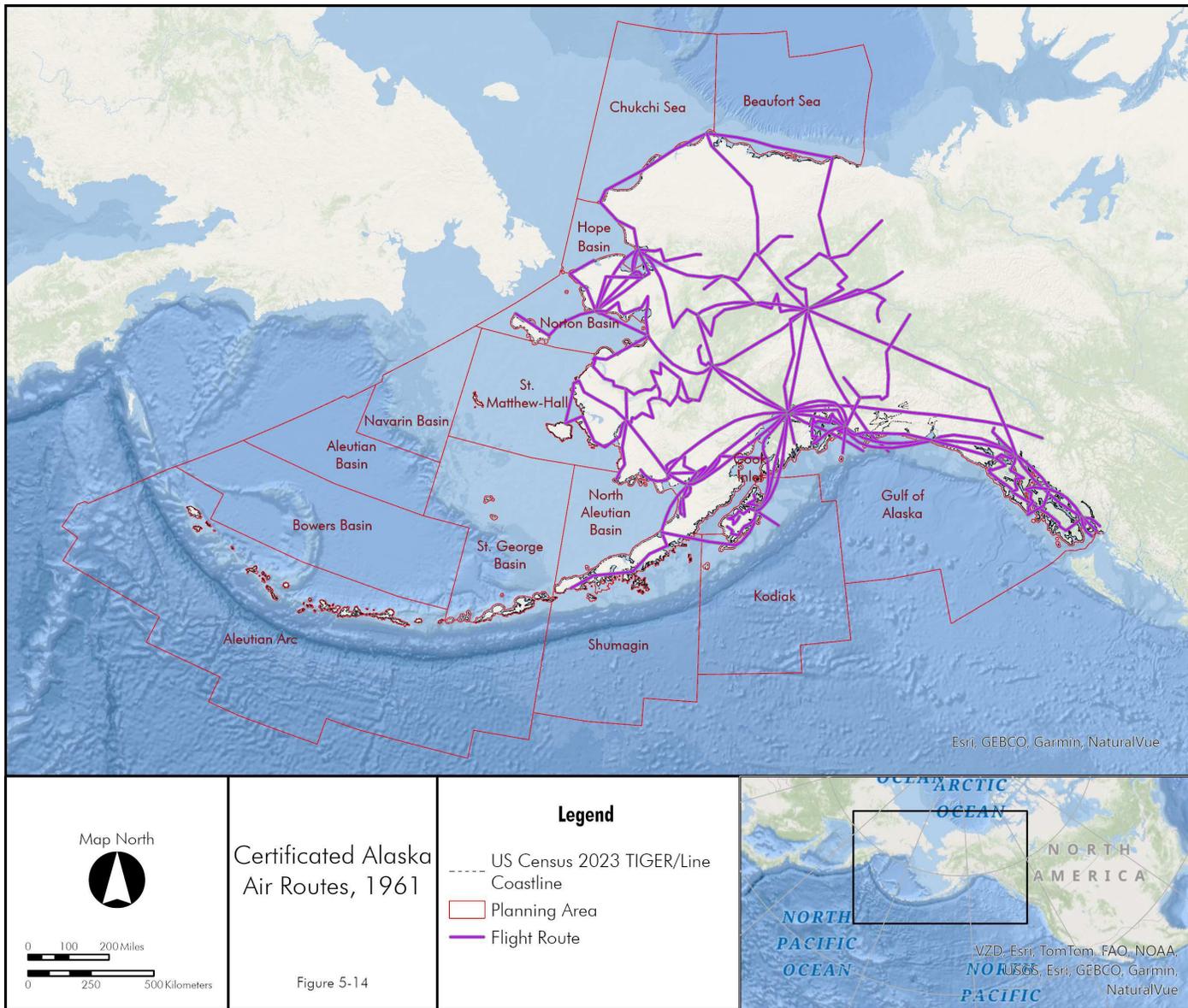


Figure 5-14. Certificated Alaska air routes, June 30, 1961

**WWII Alaska-Siberia
Lend-Lease Airway
1942-1945**

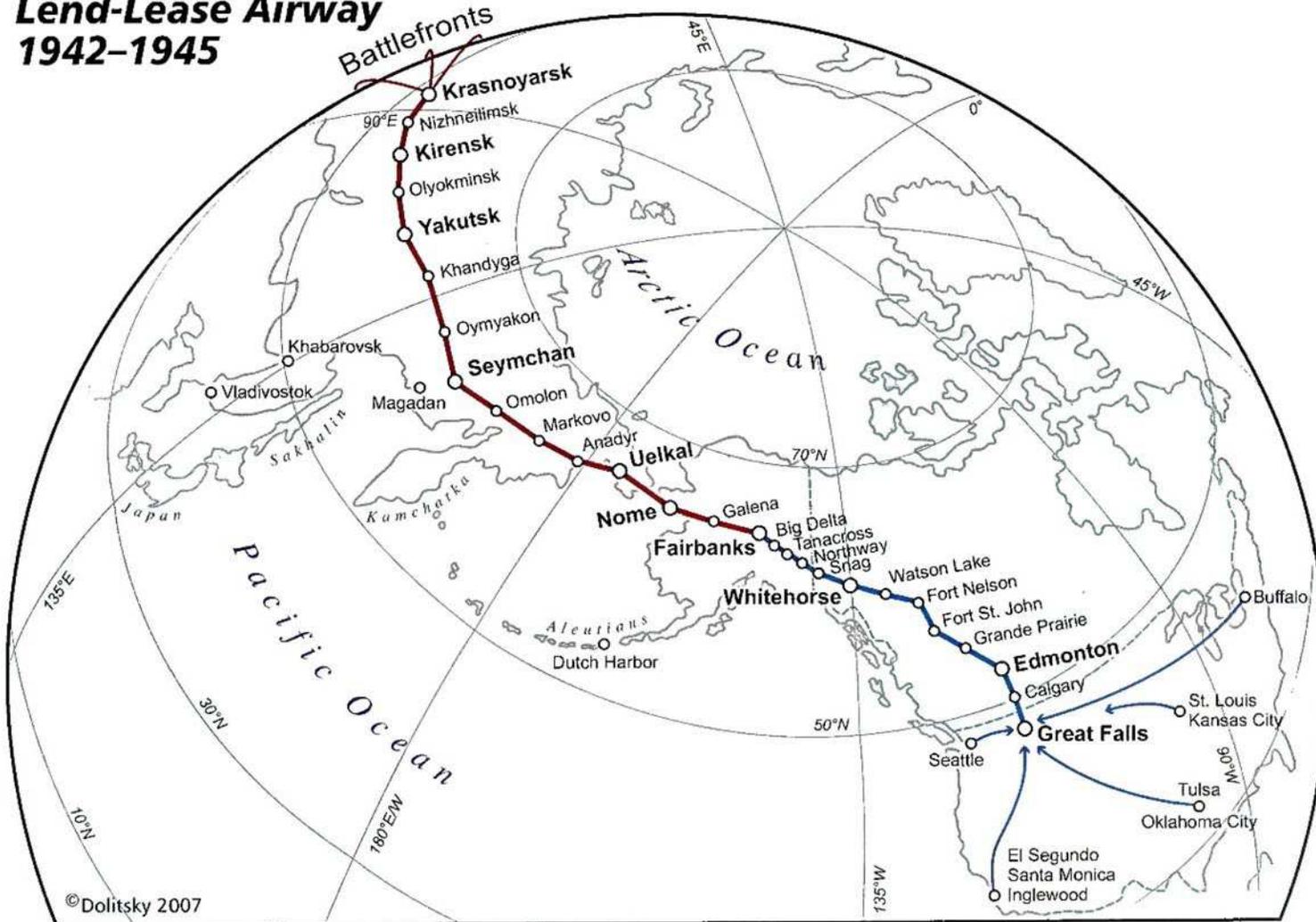


Figure 5-15. Map illustrating the route from Great Falls, MT through the Soviet Union (Russia) of Lend-Lease aircraft being transferred from the U.S. during World War II (Source: Dolitsky 2016:9)

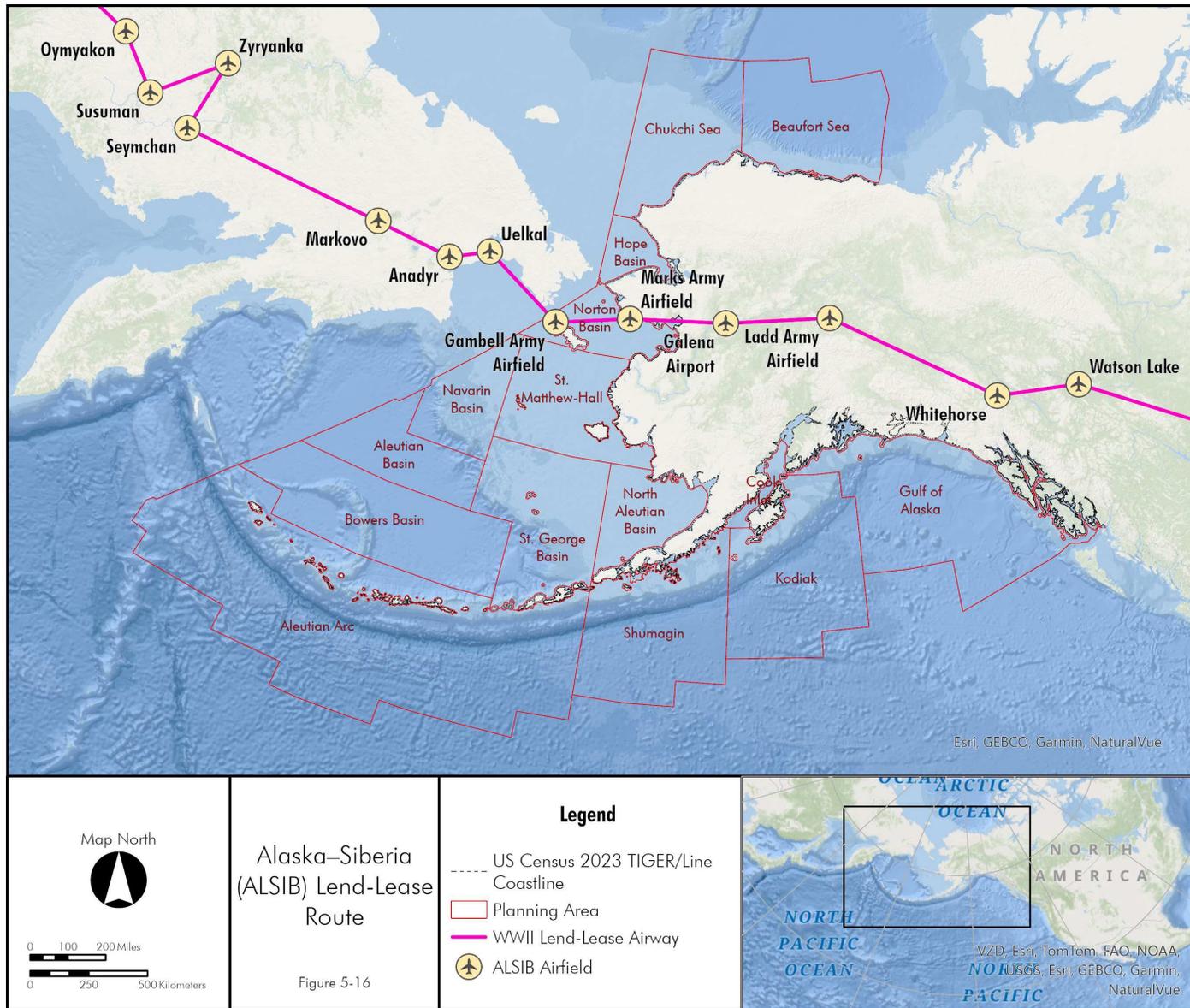


Figure 5-16. Alaska – Siberia (ALSIB) Lend-Lease Route

6. Coastal Sites and NRHP Database: NRHP Database

BOEM has a regulatory responsibility to protect historically significant cultural resources as part of the Section 106 process. The act of issuing a federal permit to conduct activities on federal lands (the OCS) is the trigger for compliance with the NHPA. Under the auspices of the NHPA, historical significance is defined using the eligibility criteria for nominations to the NRHP. To date, there are more than 96,000 places across the U.S. listed to the Register (NPS 2023a). The Coastal Sites and NRHP Database was therefore established to identify and categorize those sites either offshore or within the research area that have been determined to be eligible or have already been listed to the NRHP. As stated by NPS, the NRHP is the official list of the Nation's historic places worthy of preservation. This component of the overall database, previously discussed in Chapter 4, was developed to provide additional context for project reviews by identifying those places where historical significance has already been determined or places where determinations are lacking and should be promoted. The data entry table is populated with information from the AHRS database for each site located within a 160-km (99.4-mi) shoreline buffer and cross-referenced with the NRHP database maintained by NPS to identify listed resources. Eligibility determinations were not consistently available for all data entries; therefore, the data entry table includes only those listed resources. Both the AHRS and the NPS NHRP lists are subject to frequent updates. The data entry tables will need to be updated periodically to maintain the most current information. Database development, including methodologies and resources used, are detailed in the following individual sections.

6.1 Historical and Contextual Overview

The NRHP Database includes both precontact and historical period sites, whose historical contexts have been addressed in Chapters 4 and 5; therefore, Section 6.1 will provide a brief overview of how Sections 106 and 110 of the NHPA influence the preservation and identification of sites on the OCS and the NRHP eligibility criteria used to determine their potential significance. Finally, the discussion will address Traditional Cultural Places and other culturally significant places that may or may not be identified through survey alone.

Multiple federal laws enacted to protect archaeological resources are applicable to sites and activities on the OCS, including the NHPA (1966), Executive Order 11593, and the Sunken Military Craft Act (2005). Applicability to the OCS is an important distinction, as some preservation laws such as the Archaeological Resources Protection Act (1979) explicitly exclude authority over the OCS. As BOEM is tasked with regulating activities associated with mineral extraction (including oil & gas, sand and gravel, and offshore renewable energies) on the OCS, permit applications under their review must comply with Section 106 of the NHPA, while BOEM as a federal agency has a responsibility to inventory historic resources on their managed lands under Section 110. In support of Section 106 activities, BOEM's Alaska region has issued NTLs that provide guidance to operators on how to comply with permitting and operational conditions. The most current archaeological survey and reporting guidance for the Alaska OCS region is published in *Archaeological Survey and Evaluation for Exploration and Development Activities NTL 2005-A03* (reissued June 24, 2020). Potentially historically significant sites that are identified through surveys must be either avoided by project impacts or investigated to determine their significance. Although not explicitly referenced in NTL 2005-A03, "significance" is defined as meeting the eligibility criteria for nomination or listing to the NRHP within Section 106, and in other BOEM regional guidance, for example in *Diver Evaluation of Unidentified Magnetic Anomalies and/or Side-Scan Sonar Targets: Search and Methodological Requirements* as issued by BOEM GOMR and

Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585) as issued by BOEM Office of Renewable Energy Programs (OREP).

The requirements for determining NRHP eligibility are published in National Register Bulletin 15 (NPS 1990), and in 36 CFR 60.4. To meet National Register eligibility criteria, an archaeological site that is 50 years or older must meet at least one of the following criteria:

- A. Be associated with events that have made a significant contribution to the broad patterns of our history.
- B. Be associated with the lives of persons significant in our past.
- C. Embody distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic value, or represent a significant and distinguishable entity whose components may lack individual distinction.
- D. Have yielded, or be likely to yield, information important in prehistory or history.

Supplemental guidance is provided for specific resource types, including historic vessels and aircraft, in National Register Bulletins 20 (NPS 1992) and 43 (NPS 1998a) that already meet the minimum age requirements and satisfy at least one of criteria A–D, above. Historic vessels must retain integrity of location, design, setting, materials, workmanship, feeling, and association. Determining the significance of a historic vessel depends on establishing whether the vessel is: 1) the sole, best, or a good representation of a specific vessel type; 2) associated with a significant designer or builder; 3) involved in important maritime trade, naval, recreational, government, or commercial activities (NPS 1992). Five distinct categories of vessels may be eligible for listing on the NRHP, including shipwrecks, which are defined as “a submerged or buried vessel that has foundered, stranded, or wrecked. This includes vessels that exist as intact or scattered components on or in the seabed, lakebed, riverbed, mud flats, beaches, or other shorelines ...” (NPS 1992:3). Similarly, the guidance for listing Historic Aviation resources defines eight types, including aviation wrecks.

An aviation wreck is any aircraft that has been crashed, ditched, damaged, stranded, or abandoned. The wreck may be intact or scattered, may be on land or in water, may be in National Register terms a structure or a site. A "structure" remains relatively intact, while a wreck "site" lacks the structural integrity of an aircraft although the site may contain the structural elements of the aircraft. (NPS 1998a:20).

For submerged sites, information used to develop NRHP nominations may be developed from any combination of remote sensing survey data, historical and archival research, diver or remotely operated vehicle investigation, but most of these methods for data collection assume that there is a tangible object that can be identified and assessed. The NRHP also recognizes additional categories including traditional cultural places (TCPs). At the time of this report, the existing NPS National Register Bulletin 38, which previously referred to “Traditional Cultural Property” was pending an update that includes a name change to Traditional Cultural Places (NPS 2023b). TCPs are defined as physical places associated with the cultural practices, traditions, beliefs, arts, crafts, or social institutions of a living community (NPS 1998b). However, unlike the previously discussed shipwrecks and aviation wrecks, TCPs do not need to retain evidence of the activities or events associated with them. TCPs are best identified by consulting directly with members of a traditional community, Indigenous community or organization, or Tribal government. In fact, the guidelines for documenting TCPs state outright that they may not be identifiable to people outside of the community.

Traditional cultural properties (sic) are often hard to recognize, however. A traditional ceremonial location may look like merely a mountaintop, a lake, or a stretch of river; a

culturally important neighborhood may look like any other aggregation of houses, and an area where culturally important economic or artistic activities have been carried out may look like any other building, field of grass, or piece of forest in the area. As a result, such places may not necessarily come to light through the conduct of archeological, historical, or architectural surveys (NPS 1998b).

A single TCP is listed on the NRHP in Alaska, at the time of this report, and is within the coastal area as used in this report. In the summer of 2016, NPS recognized a decades long effort to list the sacred *X'unaxi* in Juneau, AK, in the NRHP (AHRs Number JUN-00701). This would constitute the first traditional cultural place in Southeast Alaska to be placed on the register. *X'unaxi*, also known locally as Indian Point, is a traditional cultural place that is the original habitation site of the Auk Kwáan in the Juneau area. Archeological evidence and oral testimony indicated use of the site from over 800 years ago through the 1970s, and in the early 2000s, following a dispute with NOAA over a proposal for use of the land for new facilities, efforts began to gain protection of the area under the National Historic Preservation Act. In 2016, following years of work to gain listing, the area was recognized and placed on the Register. "After all these years, we are extremely happy that the government has finally recognized that this site is a sacred site to us and its sacredness must be protected," said Auk Clan Leader Rosa Miller," (Anchorage Daily News 2016, Sealaska Heritage 2016, Forest Service 2023).

The intent of the Coastal Sites and NRHP Database is to aid BOEM in identifying those places where significance has already been determined but must be coupled with information from Alaska Native communities/Tribal Councils to identify additional areas of cultural significance and potential NRHP eligibility that cannot be identified through traditional archaeological surveys.

6.2 Methodology

The creation of the Coastal Sites and NRHP Database was previously discussed in Chapter 4, however, additional context for potential and listed NRHP sites is included here. The addition of column headers "NRHP Status", and "NRHP ID" easily identify those data entries that have received a status determination and, for listed properties, include the official NRHP number.

Data were identified from the AHRs site database for each site located within a 160-km (99.4-mi) shoreline buffer and cross referenced with those places included in the NPS NRHP database. The purpose of this task is to provide the study with the types of archaeological resources that have already been listed and may be adversely affected by future proposed developments. While these sites are not located in BOEM lease blocks, they merit discussion due to their proximity to the shoreline and the potential for ancillary development activities. It also provides a spatial tool for identifying places where NRHP listings should be encouraged. A total of 32,876 previously recorded sites are located within the 160-km (99.4-mi) shoreline buffer, of which 442 are listed or are part of listings on the NRHP.

6.2.1 Summary of Site Distribution

There are many sites across all coastal study areas in this database, 32,876 sites total. Of the recorded coastal sites, only 4 centroid points occur within or intersect federal waters (Table 6-1). The coastal sites intersecting federal waters include 2 shipwrecks that also appear on the Shipwrecks data entry table. A total of 4,802 coastal site centroids intersect or are within state waters, and the remaining 28,070 are located within the coastal buffer on land, and do not currently intersect either state or federal waters.

Table 6-1. Coastal Sites Intersecting or Within Federal Waters, offshore Alaska

Alaska OCS Area	AHRS Number	Site Name	Time Period	Cultural Affiliation
Aleutian Arc	ADK-00002	Kagalaska 4	Prehistoric	Aleut
Aleutian Arc	KIS-00080	USS <i>Grunion</i>	Historic	Euroamerican
Cook Inlet	SEL-00389	Possible Shipwreck	unspecified	Unspecified
St. George Basin	XPI-00002	Seal Islands Historic District-Fur Seal Rookeries NHL	Historic	Russian, Aleut

To assess site distribution quantitatively, Figures 6-1 and 6-2 present the distribution of sites as point density. Note that this density measurement does not take site area into account, as there is one point per resource in the database, regardless of the site’s size or perceived importance. Density is measured in sites per m² within a circular radius equal to 1/30th the vertical extent (65,390.66 m). Figure 6-1 displays site density spatially, with 0 sites per m² in transparent white for clarity. The GIS calculates density for the entire spatial extent of the database in the form of a rectangle; that raster was then clipped to the project study extent of Alaska state and Federal waters, plus a 160–km (99.4-mi) buffer of the US Census TIGER/Line coastline. Figure 6-2 shows the count of sites by their density in the clipped raster over 10 bins and with the mean marked with a dark blue line.

Most notably, the vast majority of the study area has 0 sites per m², due to the bias against documented cultural resources in the ocean. Within Alaska, there is also a highly variable distribution of land across the map space, so there is a mathematical bias toward mainland Alaska over solitary islands and the Aleutian chain. Across mainland Alaska, there are somewhat high site concentrations in the southeast and northwest. The highest site density is in the south-central region in and surrounding Anchorage and Kodiak Island, corresponding to the shoreward portions of the Cook Inlet, Kodiak, and Gulf of Alaska Planning Areas. Conversely, very few sites are documented along the shoreline or offshore of the Beaufort Sea and Chukchi Sea Planning Areas, along the northern coast of Alaska, despite having the majority of active and former BOEM leases. Based on GIS information available through BOEM, 1,829 (or 75%) of the total 2,446 active and inactive lease numbers are located within the Beaufort Sea and Chukchi Sea Planning Areas. Based on current NTL 2005-A05. The Beaufort Sea and Chukchi Planning Area leases were effective as of 1980 to 2008; all are currently listed as “expired”.

The Coastal Sites and NRHP database entries can be classified by time-period, as well as location. The ability to sort and analyze the GIS data are somewhat limited by the consistency of the source information. For example, of the 26,902 Coastal Sites and NRHP Database entries, 3,151 do not have a recorded time period. Of those that do, 11,462 have a recorded “Prehistoric” component, 18,809 are identified as “Protohistoric” or “Historic”, and 1,198 are identified as “Modern”. Similar issues exist when attempting to sort by cultural affiliation. A total of 13,718 entries do not have a recorded cultural affiliation. Those that do contain uncertain or subjective notations, and varied spellings of similar terms (e.g., ‘Mixed,’ ‘Probably early,’ ‘Alutiiq?’).

Among locations of NRHP-listed sites (Figure 6-3), there is a similar coastal concentration distribution corresponding with the shoreward portions of the Cook Inlet, Kodiak, and Gulf of Alaska Planning Areas. None of the NRHP listed sites intersect with or are located in federal waters. In discernment of cultural resource impacts of marine or coastal development, existing resources must be considered, but there is, currently, no assessment mechanism here that can predict what survey would reveal in any given area. Lack of existing resources is no measure for the presence of resources in an area without thorough survey.

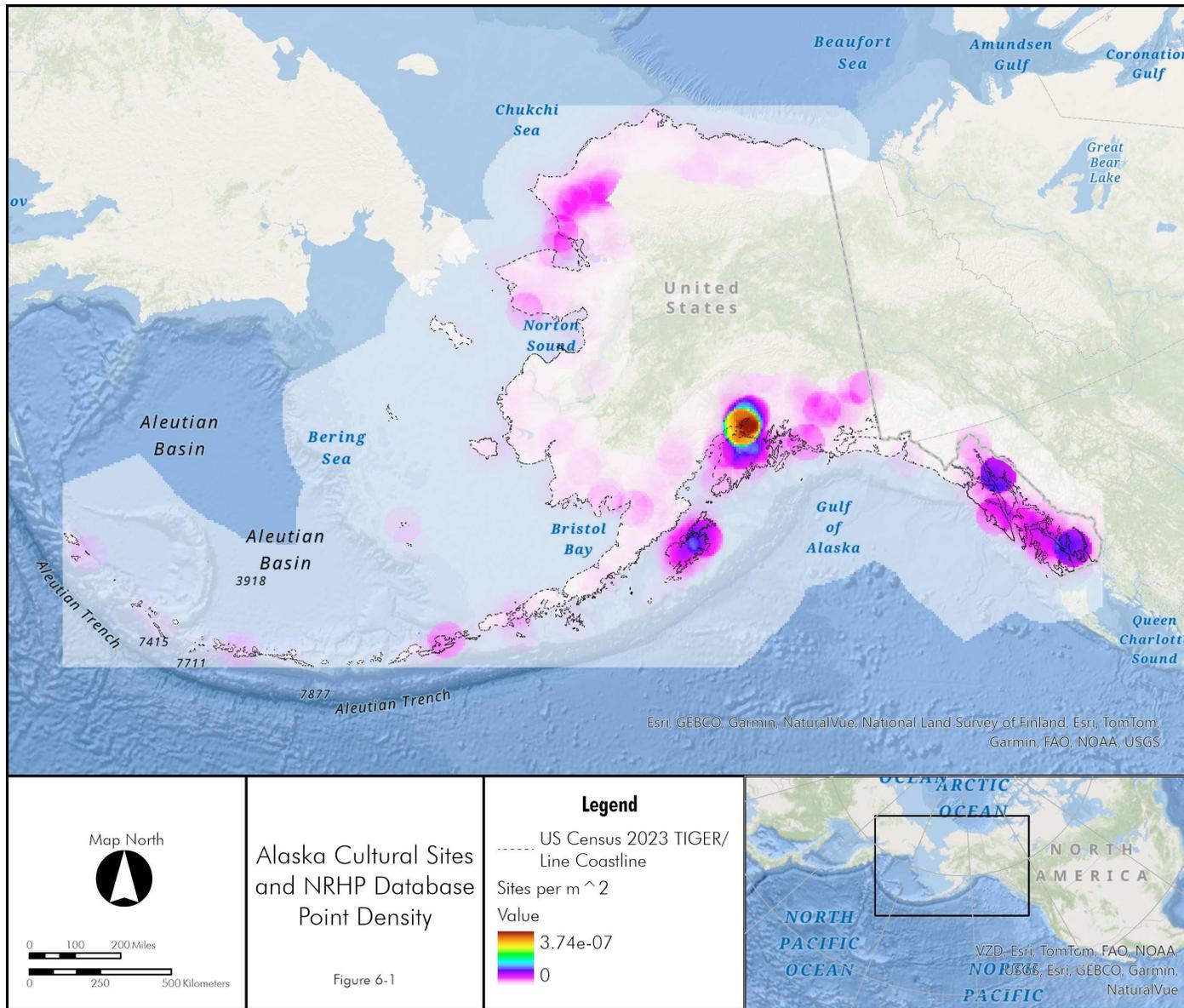


Figure 6-1. Alaska Cultural Sites and NRHP Database Point Density

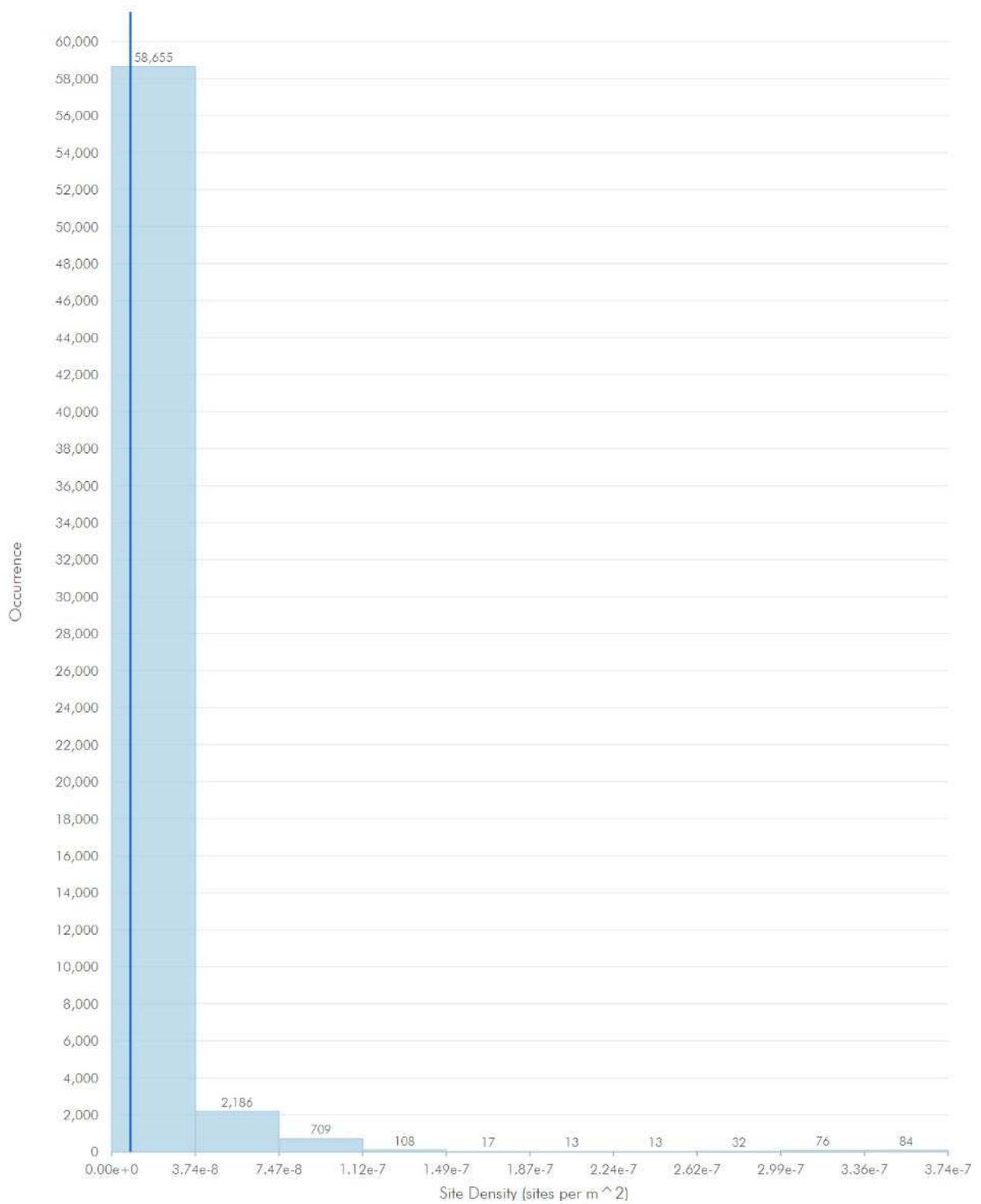


Figure 6-2. Mathematic distribution of sites per m², including mean indicator (dark blue line) and bin counts

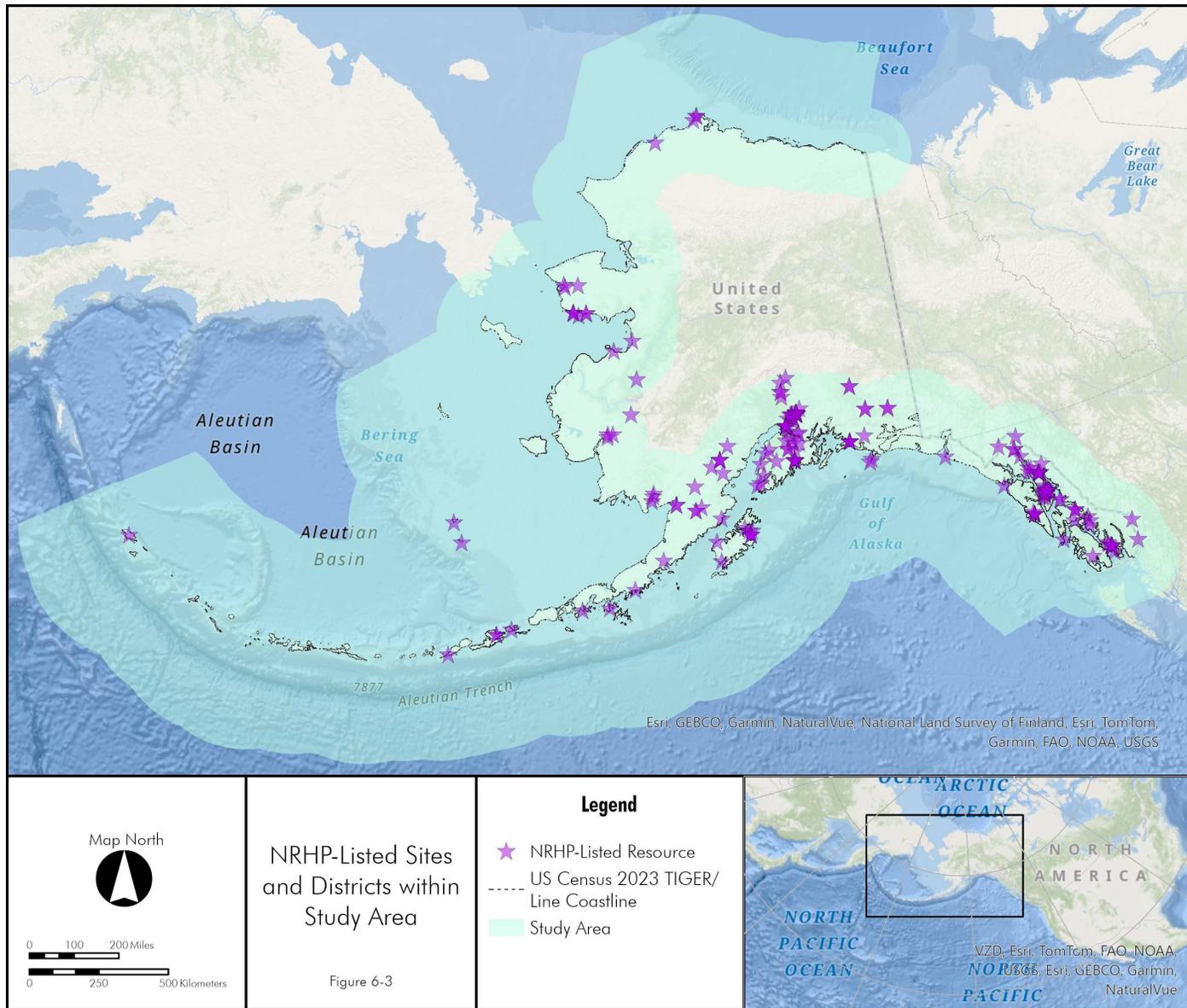


Figure 6-3. NRHP-Listed Sites and Districts within Study Area

6.3 Data Sources

The main source of content to review came from the AHRS (used with permission from the State of Alaska) and NRHP databases. Sites located in Alaska state or US federal waters, or within a 160-km (99.4-mi) buffer of the US Census TIGER/Line coastline were included in the Alaska Coastal Sites and NRHP Data table. Additionally, AHRS data were cross-referenced with the NPS NRHP database (available to the public and listed online), such that NRHP and AHRS IDs are concatenated, rather than repeated, for like sites. The information from AHRS was entered directly as provided in the data entry table and has not been manually edited or reformatted. While there are inconsistencies in the way some data are entered in the AHRS (e.g., the use of capitalization is not standardized), the BOEM data entry table is intentionally consistent with the State's data to maintain data integrity during future updates.

6.4 GIS

Information on NRHP-listed places in this database is publicly available from the NPS (excluding NRHP resources that are specifically restricted). Location information from the AHRS is confidential as a condition of database use. Sites, places, and information provided by Alaska Native communities or entities are kept confidential at the request of the participants. The resulting table and GIS shapefile provide a static view of resources as of spring 2024 and will require updates to remain current.

As AHRS entries are made or updated within the study area, updates to the BOEM Alaska Coastal Sites and NRHP Data shapefile and table should follow these steps:

1. Add Data to add the AHRS shapefiles to the map.
2. Add two fields to each AHRS shapefile: **CentroidX** and **CentroidY** (*Data type: double; Number format: numeric*).
3. Calculate geometry for each **CentroidX** and **CentroidY** using the property *Centroid x-coordinate* and *Centroid y-coordinate*; or for points, *Point x-coordinate* and *Point y-coordinate* (*Coordinate format: same as input; Coordinate system: NAD_1983_2011_Alaska Albers*).
4. Use Data → Export Table from each shapefile and Merge the tables. All the fields should align, but you can use Edit fields to make sure. You should get a table that has the same number of entries as the shapefiles combined.
5. From your merged table, Create Points from Table → XY Table to Point (*X Field: CentroidX; Y field: CentroidY; Coordinate system: NAD_1983_2011_Alaska_Albers*). You should now have a point shapefile with one point for each site.
6. Add Data to add the AHRS csv file to the map.
7. Join Field using your new point shapefile as the *Input table* and the AHRS csv table as the *Join table* (*Input Field: MapLabel; Join Field: AHRSNo*). Use *field mapping* to *Transfer fields*. Edit Fields and Delete NumberIssuedDate, because this field will not function properly in the join. You can Validate the join if you like (there should be the exact same number of records in the two tables), then Run. Your shapefile table should now contain all the site data from the AHRS csv table, but it should have the same number of records it did before. Delete the *Field MapLabel*, *RelateKey*, and *RelateKe_1–MapLabel* should be identical to *AhrsNo*; and *RelateKey* and *RelateKe_1* to *AhrsID*.
8. You can now Merge this shapefile to any existing data in the same format. Use Edit fields to make sure each attribute aligns properly.
9. If any of the new data update older entries, the older entries should be deleted to maintain the nature of the dataset as containing one point per cultural resource identifier.
The updated shapefile is now complete, and the updated data table can be generated by the GIS using Data → Export Table.

7. Anomalies Database

The Anomalies Database is a formatted data structure intended for BOEM to use as a center for collecting and storing anomaly data into one resource. Putting information about unidentified targets and anomalies of potential historical significance in one place will help serve BOEM to quickly locate and identify locations for potential avoidance or research. Details of the creation of this database, methodologies, and terminologies, are detailed in the following individual sections.

7.1 Historical and Contextual Overview

As part of BOEM’s environmental impact assessment review for proposed lease development activities, each region or program provides guidance on archaeological survey methods and the preparation of reports. The most recent archaeological guidance for the Alaska region was issued in 2005 as Notice to Lessees (NTL) 2005-A03, *Archaeological Survey and Evaluation for Exploration and Development Activities*. NTL 2005-A03 was reissued in 2020 and clarifies that an archaeological resource report may be required when the Regional Director has a reason to believe that archaeological resources may be present in the lease activity area (BOEM 2020). The current guidance states that submerged precontact sites may occur in areas that were subaerially exposed during low sea level stands approximately 13,000 years before present, which generally correlates with those areas up to 60 m below modern sea level on the Alaska OCS.

When requested, archaeological surveys are required to represent a “reasonable and good faith effort” (BOEM 2020:3). Equipment specifications are provided for bathymetry, side scan sonar, magnetometer, and sub-bottom data, although alternate systems may be proposed. Supplemental information on geophysical survey instrumentation and the analysis and interpretation of remote sensing data is provided in Appendix D.

As specified in the NTL, singlebeam bathymetry data should be acquired at 12 kHz or higher, although multibeam data may be required as needed in areas of complicated seafloor (BOEM 2020:10). Side scan sonar data should provide a minimum of 150% coverage of the seafloor (BOEM 2020:10). Sub-bottom profilers should be able to record at least 30 m below the seafloor and may include a combination of low frequency (e.g., 3.5 - 7 kHz) systems and medium penetration systems (e.g., boomer) to achieve the desired depth (BOEM 2020:11). Magnetometer data is not consistently required and instead, if magnetometer data is required, NTL 2005-A03 states that BOEM will address survey requirements on a case-by-case basis (BOEM 2020:11).

Archaeological resource survey reports submitted in compliance with NTL 2005-A03 contain information on anomalies, targets, and features that may represent historically significant resources. Side scan target reporting includes coordinates, dimensions, descriptions, and imagery, while magnetometer anomaly reports must detail their coordinates, intensity, lateral extent, and tow depth (BOEM 2020:7). Relict geomorphological features that may correlate with the occurrence and preservation of precontact sites may be mapped from the sub-bottom or bathymetry data (BOEM 2020:5).

7.2 Methodology

The Anomaly Database was conceptualized and developed to be a singular location to collect all forms of anomaly data for the BOEM Alaska OCS Region, into one Excel table. Much like the Shipwreck and Downed Aircraft databases, the Anomaly Database has a similar arrangement of data columns, providing basic identifying and location information at the beginning of the table, and more contextual information as the reader moves left to right.

The design of the Anomaly Database (also referred to as a “table,” intermittently throughout report) was envisioned to provide basic information regarding anomalies located during survey work, that have not been confirmed to be a certain cultural or historic resource (i.e., shipwreck, downed aircraft, etc.). Utilizing different survey methods such as side scan, multibeam, or magnetometer, anomalies are added to this database as a collection point for further planning use. For context, a series of anomaly examples were provided to Gray & Pape to create this database for BOEM. A description of what this database includes is listed below, using these examples as placeholders that can be updated by BOEM with results from previously submitted and future NTL compliant surveys.

The first column header on the left is the unique identifier for the entry. The next column header, “Source Survey Report Citation”, is a textual reference to the survey report in which the anomaly was located. If there is a project review number associated within that report, that ID number is added to this database under the next column header, “Unique Project ID.” Additional information regarding the survey information associated with the anomaly is also captured in the table, starting with the survey line it was recorded from in the column “Line Name.” The image (Figure 7-1) below shows these first four column headers of the database, illustrating the identification system of each anomaly.

ID	Source_Survey_Report_Citation	Unique_Project_ID	Line_Name
1	BBN 1976 Survey of the [redacted]		Line 133
2	BBN 1976 Survey of the [redacted]		Line 122
3	BBN 1976 Survey of the [redacted]		Line 122

Figure 7-1. Image taken of first four column headers of the Anomaly Database displaying ID, Source Survey Report Citation, Unique Project ID, and Line Name (Source: Gray & Pape, Inc.)

More information about when the anomaly or target was identified follows in the next four columns. Those columns are “Year of Acquisition,” “Month of Acquisition,” “Day of Acquisition,” and “Data Auto Generated.” After this, moving left to right, column headings continue with BOEM “Planning Areas”, “Protraction ID”, “Protraction Name” (if available), and “Lease Block”. This focuses areas from large to small, reading left to right, within BOEM OCS planning areas. Following this column grouping, specific location information is in the attributes “Coordinate System”, and “X” (horizontal) and “Y” (vertical). For this database and to ensure coordinates and projection were universal for all of Alaska, The North American Datum 1983 (2011) Alaska Albers (Meters) coordinate system is used (EPSG 2024). Point geometry was calculated within the GIS after points were entered and projected from their original source coordinates. As previously discussed in other chapters, the original coordinates and datum are captured and the coordinates are converted, where necessary, for this report.

After this section of the database, the following sections of the Anomaly Database focus on the instrument used and the corresponding information of the anomaly itself. The column header, “Sensor,” provides information for which type of equipment was used, such as side scan sonar, magnetometer, and sub-bottom profiler. Following this is the “Depth,” of the located anomaly, listed in meters, followed by, “Fish Height” and “Water Depth”. These are critical pieces of information when analyzing and interpreting survey data to know where the equipment is located within the water column and provide context for the recorded size and shape of the interpreted feature.

The next three columns, “Length,” “Height,” and, “Width” all correspond to the anomaly or target itself, measured in meters. As referenced in the above section, anomaly characteristics can be described in both a length and width, and for side scan sonar anomalies, height is determined by the shadow cast in the image. A longer shadow is indicative of higher relief, or height off bottom, of a potential object. Following these column headers, a column for “Depth Below Bottom” is available to collect sub-bottom profiler data. As a reminder to the users of this database, not every column will be utilized or contain information, as this database is designed to collect all types of survey data, not just a particular methodology. The next three column headers, “Intensity (nT),” “Duration (m),” and, “Signature,” correspond to magnetometer survey data.

The next series of column sections, as displayed in Figure 7-2 below, help organize context for the anomaly. A column for “Description” allows for additional context to be provided about the anomaly as descriptive text, not captured in other columns. Additionally, a column for any “Corresponding Features,” can be used to provide context to the surrounding survey area and the anomaly in question, such as correlating anomalies or targets. Finally, if there is an image of the anomaly and where it is located within BOEM data, the last two columns help organize this information.

The final sections of the database refer to information about who created each entry, and when it was updated. This is an important aspect of the database, in that it is a static collection of information at any given time but allows for latest information to be added or updated, and an acknowledgement of that update, to be referenced. With the structure of the database complete, again, focusing on locational information at the outset of the database and moving toward more physical attribute data from left to right, BOEM could input anomalies from previous reports and add newly discovered ones, all in the same location. If, or as unidentified targets and anomalies are investigated, they can be moved to the appropriate resource database, or text added to the Anomaly database to indicate that the target or anomaly has been confirmed as something other than a historical resource (e.g., modern debris).

Description	Corresponding_Features	Image_Available	Image_Location
EXAMPLE from BOEM. Object protruding to significant height above bottom. "Attachment 4" document.			
EXAMPLE from BOEM. Possible sunken aircraft in the Gulf of Alaska identified in 1977 in a USGS Review of cultural resource analysis of the side scan sonar data collected by BBN in 1976 for the [redacted]. "Attachment 3" document.		Yes	

Figure 7-2. Image taken of column headers of the Anomaly Database displaying Description, Corresponding Features, Image Available, and Image Location (Source: Gray & Pape, Inc.)

7.3 Data Sources

Two examples of previous survey data and reports were provided to Gray & Pape by BOEM for use in developing this database and supplemented by guidance in NTL 2005-A03, and data columns specified for anomaly and target tables as published in GOMR NTL 2005-G07 and OREP *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*). Supplemental columns have been added by Gray & Pape based on experience and best practice. Location information for possible cultural resources from survey reports is confidential and restricted for BOEM planning purposes and held in confidence by the Department of the Interior.

7.4 GIS

The Anomaly Database is a product to be populated by BOEM moving forward; therefore, there are currently no GIS products created for this report.

8. Alaska Native Engagement

BOEM is tasked with protecting the natural and cultural environment regarding energy development on the OCS through application of the NHPA. As part of its cultural resources responsibilities, BOEM has a need to identify potential and existing submerged cultural resources on the OCS and an obligation to engage in meaningful consultation with Tribes and ANCSA Corporations regarding adverse impacts that may result from permitted activities. Although most of the report focuses on the types of resources that may be present and preserved in federal waters of the Alaska OCS, engagement and outreach efforts were conducted to enhance the identification of places of significance that may not be detected through traditional survey.

8.1 Stakeholder Engagement

Stakeholder engagement is a dynamic process through which the BOEM Alaska OCS Regional staff may build and maintain relationships with all pertinent stakeholders in the effective preservation of Alaska's submerged cultural heritage. We outline the methods employed for this effort, and further identify issues that should be addressed. This section also includes recommended actions to increase the potential for developing positive working relationships with all the Alaska Tribes and ANCSA leadership for the Alaska OCS. Specific strategies to build essential relationships and communication venues with Tribal and ANCSA regional and local leadership are outlined, as they will vary from recommended coordination and information sharing with state and federal agencies referenced in Chapter 9.

8.2 Engagement Timeline and Methods

The engagement throughout the Alaska BOEM OCS database project timeline has been through emails, phone calls, oral presentations, and video conferencing when connectivity allowed. Consistent engagement and messaging were key, especially during certain times of the year specified for seasonal subsistence harvesting for specific regions of Alaska (i.e., fishing, whaling, hunting, gathering). Below are descriptions of the types of engagements that were conducted during the project:

- Introductory meetings:
 - These types of meetings were conducted first with an introductory email that introduced the project's engagement specialist (Inuuteq Stotts, with ASRC Consulting and Environmental) and his role in the project, the project description, and setting up an opportunity to discuss the project and learn best engagement practices for their region. Attached to the introductory emails were more specific project descriptions. When meetings were scheduled, they were conducted either on the phone or via video conference (e.g., Microsoft Teams). The style of discussions was "coffee meetings," which were informal and consisted of questions and answers and taking notes on engagement best practices (e.g., contacts, organizations, coordinating timing).
- Official notification/invitation (Initial Planning Stage):
 - Following federal policy on consultation with Tribes and ANCSA regional corporations, an official email letter notification was sent. The notice provided details for tribal leaders to fully engage in the review process. The information included in the letter was a project description, a process timeline, and possible outcomes. Additionally, the notice allowed tribal leadership to provide feedback before commenting, including time to request technical assistance and clarify how the process conforms to consultation requirements.

Initial feedback indicated that invited participants did not want to comment on the project or the proposed databases while these were in progress, but instead preferred to review and comment on the draft deliverables. In deference to this request, and with consideration of seasonal subsistence schedules, the bulk of the substantive engagement is occurring simultaneous to BOEM’s review of the draft deliverables. Scheduling notifications and meetings during the fall and winter benefits the project, Tribes, and ANCSA corporations. For example, avoiding periods in the year when people are harvesting their traditional foods, practicing their culture, and other ways of life offers better assurance that their leadership will be available to meet. Comments and changes resulting from engagement were incorporated into all final project deliverables. Table 8-1 shows the timeline of introductory meetings and official notification letters.

Table 8-1. Engagement Timeline

Region	Engagement Type	Timing
Aleut	Introductory	Summer-Fall 2022; Winter 2023
Arctic Slope	Introductory	Summer 2022
Bering Straits	Introductory	Summer 2022
Bristol Bay	Introductory	Summer 2022
Calista	Introductory	Summer 2022
Chugach	Introductory	Summer 2022
Cook Inlet	Introductory	Summer 2022
Koniag	Introductory	Summer 2022
NANA	Introductory	Summer-Fall 2022; Winter 2023
Southeast	Introductory	Summer 2022
Aleut	Official notification	Fall 2023
Arctic Slope	Official notification	Fall 2023
Bering Straits	Official notification	Fall 2023
Bristol Bay	Official notification	Fall 2023
Calista	Official notification	Fall 2023
Chugach	Official notification	Fall 2023
Cook Inlet	Official notification	Fall 2023
Koniag	Official notification	Fall 2023
NANA	Official notification	Fall 2023
Southeast	Official notification	Fall 2023

8.3 Identified Stakeholders

Alaska is divided into 12 ANCSA regions (Figure 8-1). Each region includes an ANCSA regional corporation, ANCSA village corporations, federally recognized tribes, city and borough governments, and Alaska Native regional non-profit organizations. Each organization plays a distinct role, although there is overlap within the leadership network. It is common to have regional and community leadership in multiple positions.

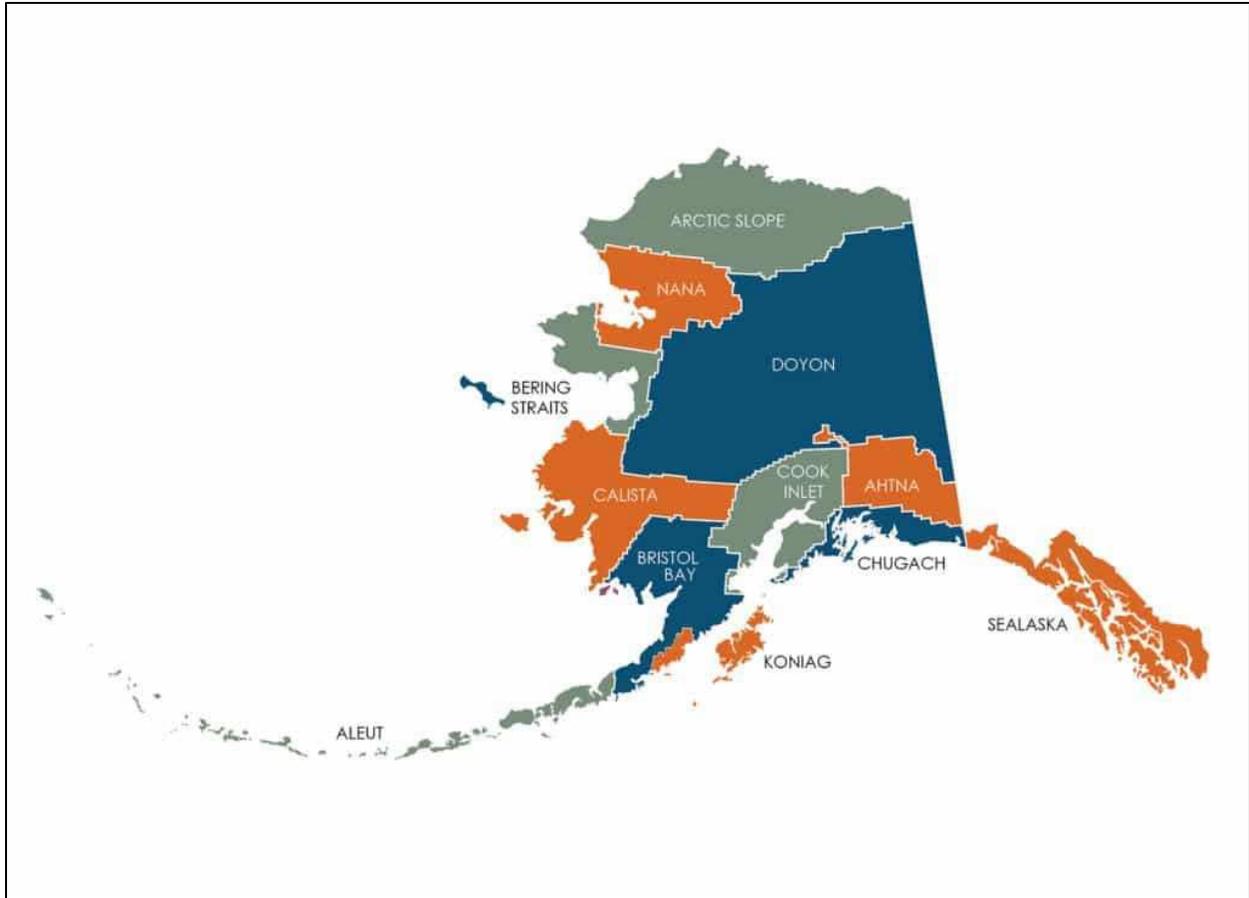


Figure 8-1. ANCSA Regions in Alaska (image source ARA 2023)

Informal and formal communications were conducted with Tribes and ANCSA corporations. For each region, contacting the regional tribal organization and ANCSA regional corporation was the initial step taken to introduce the BOEM Alaska OCS database project. Informal communication was conducted with regional governments to present the project and learn their recommendations on suggested local knowledge holders. For the Tribes and ANCSA corporations, contacting their Lands or Natural Resources department was conducted first to listen to their suggestions for future regional and local engagement processes. The following subsections, presented in alphabetical order, describe each region’s organizations and potentially interested entities.

8.3.1 Unangaġ Region

Unalaska is the largest settlement in the Aleutian Islands region. The region is split into organized (East) and unorganized (West) boroughs. Sand Point and Unalaska are respective seats for their boroughs that provide services and employment. In all, 13 communities in the region have ANCSA village corporations and Tribes. Also, membership within the village corporations often overlaps with tribal councils. Table 8-2 includes a compilation of the Tribes and ANCSA corporations within their region. The ANCSA regional corporation and non-profit organization offices are in Anchorage.

Table 8-2. Unangaġ Organizations

Community	Name	Type
Anchorage	Aleut Corporation	ANCSA regional corporation
Anchorage	Aleutian Pribilof Islands Association, Inc.	Non-profit organizations serving their tribal members
Akutan	Akutan Corporation	ANCSA village corporation
Akutan	Akutan Village Council	Federally recognized tribe
Atka	Atxam Corporation	ANCSA village corporation
Atka	Atka IRA	Federally recognized tribe
False Pass	Isanotski Corporation	ANCSA village corporation
False Pass	False Pass Tribal Council	Federally recognized tribe
King Cove	Belkofski Corporation	ANCSA village corporation
King Cove	King Cove Corporation	ANCSA village corporation
King Cove	Belkofski Tribal Council	Federally recognized tribe
King Cove	Agdaagux Tribe of King Cove	Federally recognized tribe
Nelson Lagoon	Nelson Lagoon Corporation	ANCSA village corporation
Nelson Lagoon	Nelson Lagoon Village Council	Federally recognized tribe
Nikolski	Chaluka Corporation	ANCSA village corporation
Nikolski	Nikolski IRA Council	Federally recognized tribe
Sand Point	Qagan Tayagungin Tribe of Sand Point	Federally recognized tribe
Sand Point	Unga Tribal Council	Federally recognized tribe
Sand Point	Pauloff Harbor Tribe	Federally recognized tribe
Sand Point	Sanak Corporation	ANCSA village corporation
Sand Point	Shumagin Corporation	ANCSA village corporation
Sand Point	Unga Corporation	ANCSA village corporation
St. George	St George Traditional Council	Federally recognized tribe
St. George	St. George Tanaq Corporation	ANCSA village corporation
St. Paul	Tanadgusix Corporation	ANCSA village corporation
Unalaska	Ounalashka Corporation	ANCSA village corporation
Unalaska	Qawalangin Tribal Council	Federally recognized tribe

8.3.2 Arctic Slope

Utqiagvik is the government seat of the North Slope Borough (NSB), and the NSB has village liaisons in each village. The NSB provides services to all eight villages and is the primary employer in all villages. It is involved with core community issues, including improvement to village services and infrastructure, improvement to water and sewer systems, subsistence, cultural issues, and employment. Eight communities are within the NSB, each having a tribe and ANCSA village corporation. Table 8-3 includes a compilation of the regional and village organizations’ information. ASRC, the ANCSA regional corporation, has offices in Anchorage and Utqiagvik. The Inupiat Community of the Arctic Slope (ICAS) is one of two federally recognized regionalized tribes in Alaska.

Table 8-3. Arctic Slope Organizations

Community	Name	Type
Anaktuvuk Pass	Nunamiut Corporation	ANCSA village corporation
Anaktuvuk Pass	Nagsragmiut	Federally recognized tribe
Atqasuk	Atqasuk Inupiat Corporation	ANCSA village corporation
Atqasuk	Native Village of Atqasuk	Federally recognized tribe
Kaktovik	Kaktovik Inupiat Corporation	ANCSA village corporation
Kaktovik	Native Village of Kaktovik	Federally recognized tribe
Nuiqsut	Kuukpik Corporation	ANCSA village corporation
Nuiqsut	Native Village of Nuiqsut	Federally recognized tribe

Community	Name	Type
Pt Hope	Native Village of Pt Hope	Federally recognized tribe
Pt Hope	Tikigaq Corporation	ANCSA village corporation
Pt Lay	Cully Corporation	ANCSA village corporation
Pt Lay	Native Village of Pt Lay	Federally recognized tribe
Utqiaġvik	Arctic Slope Regional Corporation	ANCSA regional corporation
Utqiaġvik	ICAS	Federally recognized tribe
Utqiaġvik	North Slope Borough	Organized borough
Utqiaġvik	Native Village of Barrow	Federally recognized tribe
Utqiaġvik	Ukpeaġvik Iñupiat Corporation	ANCSA village corporation
Utqiaġvik	Voice of the Arctic Inupiat	Non-profit organization
Wainwright	Olgoonik Corporation	ANCSA village corporation
Wainwright	Village of Wainwright	Federally recognized tribe

8.3.3 Bering Straits

Nome is the largest settlement in the Bering Straits region. The region is an unorganized borough and has no borough seat. It is a U.S. Census area, with the city of Nome being the largest community within the Seward Peninsula. In total, 20 communities are within the Seward Peninsula, along with ANCSA corporations and Tribes. The Bering Straits region includes St. Lawrence Island along with 20 communities. Table 8-4 consists of a compilation of the Tribes and ANCSA corporations in the Bering Straits region. The ANCSA regional corporation and non-profit organization offices are in Nome and Anchorage.

Table 8-4. Bering Straits Organizations

Community	Name	Type
Brevig Mission	Native Village of Brevig Mission	Federally recognized tribe
Brevig Mission	Brevig Mission Village Corporation	ANCSA village corporation
Council	Inupiaq Village of Council	Federally recognized tribe
Council	Council Native Corporation	ANCSA village corporation
Diomedede	Native Village of Diomedede (aka Inalik)	Federally recognized tribe
Elim	Native Village of Elim	Federally recognized tribe
Elim	Elim Native Corporation	ANCSA village corporation
Gambell	Gambell IRA Council	Federally recognized tribe
Golovin	Chinik Eskimo Community	Federally recognized tribe
Golovin	Golovin Native Corporation	ANCSA village corporation
King Island	King Island Native Community	Federally recognized tribe
King Island	King Island Native Corporation	ANCSA village corporation
Koyuk	Koyukuk Native Village	Federally recognized tribe
Koyuk	Koyuk Native Corporation	ANCSA village corporation
Mary's Igloo	Mary's Igloo Traditional Council	Federally recognized tribe
Mary's Igloo	Mary's Igloo Native Corporation	ANCSA village corporation
Nome	Nome Eskimo Community	Federally recognized tribe
Nome	Sitnasuak Native Corporation	ANCSA village corporation
Nome	Bering Straits Native Corporation	ANCSA regional corporation
Nome	Kawerak, Inc.	Regional non-profit
Savoonga	Native Village of Savoonga IRA Council	Federally recognized tribe
Shaktoolik	Native Village of Shaktoolik IRA Council	Federally recognized tribe
Shaktoolik	Shaktoolik Native Corporation	ANCSA village corporation
Shishmaref	Native Village of Shishmaref IRA Council	Federally recognized tribe
Shishmaref	Shishmaref Native Corporation	ANCSA village corporation

Community	Name	Type
Solomon	Solomon Traditional Council	Federally recognized tribe
Solomon	Solomon Native Corporation	ANCSA village corporation
St. Michael	Native Village of Saint Michael IRA Council	Federally recognized tribe
St. Michael	St. Michael Native Corporation	ANCSA village corporation
Stebbins	Stebbins Community Association	Federally recognized tribe
Stebbins	Stebbins Native Corporation	ANCSA village corporation
Teller	Teller Traditional Council	Federally recognized tribe
Teller	Teller Native Corporation	ANCSA village corporation
Unalakleet	Native Village of Unalakleet IRA Council	Federally recognized tribe
Unalakleet	Unalakleet Native Corporation	ANCSA village corporation
Wales	Native Village of Wales	Federally recognized tribe
Wales	Wales Native Corporation	ANCSA village corporation
White Mountain	White Mountain IRA Council	Federally recognized tribe
White Mountain	White Mountain Native Corporation	ANCSA village corporation

8.3.4 Bristol Bay

Dillingham is the largest community in the Bristol Bay region. The region has a combination of organized and unorganized boroughs. The governments include Bristol Bay Borough, the Dillingham Census Area, and the Lake and Peninsula Borough. Thirty-one communities are within the Bristol Bay region, including ANCSA corporations and Tribes. Several parks, refuges, and preserves are within the region. The region is unique for its fish-first policy, which is to preserve and protect the largest sockeye salmon fishery in the world. Table 8-5 includes a mixture of the ANCSA corporations, Tribes, and non-profit organizations. The ANCSA regional corporation and non-profit organization offices are in Dillingham and Anchorage.

Table 8-5. Bristol Bay Organizations

Community	Name	Type
Chignik Bay	Chignik Bay Tribal Council	Federally recognized tribe
Chignik Bay	Far West Inc.	ANCSA village corporation
Chignik Lagoon	Native Village of Chignik Lagoon	Federally recognized tribe
Chignik Lagoon	Chignik Lagoon Native Corporation	ANCSA village corporation
Chignik Lake	Chignik Lake Village Council	Federally recognized tribe
Chignik Lake	Chignik River Limited	ANCSA village corporation
Clarks Point	Village of Clarks Point	Federally recognized tribe
Clarks Point	Saguyak Inc.	ANCSA village corporation
Dillingham	Curyung Tribal Council	Federally recognized tribe
Dillingham	Choggiung Limited	ANCSA village corporation
Dillingham	Bristol Bay Native Corporation	ANCSA regional corporation
Dillingham	Bristol Bay Native Association	Non-profit organization
Egegik	Egegik Village	Federally recognized tribe
Egegik	Becharof Corporation	ANCSA village corporation
Ekuk	Native Village of Ekuk	Federally recognized tribe
Ekuk	Ekuk Native Limited	ANCSA village corporation
Ivanoff Bay	Ivanoff Bay Village	Federally recognized tribe
Ivanoff Bay	Bay View Inc.	ANCSA village corporation
King Salmon	King Salmon Tribe	Federally recognized tribe
King Salmon	Paug-Vik Inc. Limited	ANCSA village corporation
Levelock	Levelock Village Council	Federally recognized tribe
Levelock	Levelock Natives Limited	ANCSA village corporation
Manokotak	Manokotak Village	Federally recognized tribe

Community	Name	Type
Manokotak	Manokotak Natives Limited	ANCSA village corporation
Naknek	Naknek Native Village	Federally recognized tribe
Naknek	Paug-Vik Inc. Limited	ANCSA village corporation
Perryville	Native Village of Perryville	Federally recognized tribe
Perryville	Oceanside Corporation	ANCSA village corporation
Pilot Point	Pilot Point Tribal Council	Federally recognized tribe
Pilot Point	Pilot Point Native Corporation	ANCSA village corporation
Portage Creek	Portage Creek Village (aka Ohgenakale)	Federally recognized tribe
Portage Creek	Ohgsenskale Corporation	ANCSA village corporation
Port Heiden	Native Village of Port Heiden	Federally recognized tribe
Port Heiden	Alaska Peninsula Corporation	ANCSA village corporation
South Naknek	South Naknek Village	Federally recognized tribe
South Naknek	Alaska Peninsula Corporation	ANCSA village corporation
Togiak	Traditional Village of Togiak	Federally recognized tribe
Togiak	Togiak Natives Limited	ANCSA village corporation
Twin Hills	Twin Hills Village Council	Federally recognized tribe
Twin Hills	Twin Hills Native Corporation	ANCSA village corporation
Ugashik	Ugashik Traditional Village Council	Federally recognized tribe
Ugashik	Alaska Peninsula Corporation	ANCSA village corporation

8.3.5 Calista/Yukon Kuskokwim Delta

Bethel is the largest settlement in the Calista/Yukon Kuskokwim Delta Region. The region has two unorganized boroughs. These are the Bethel and Kusilvak Census Area. In total, 44 communities are within the Calista region, including ANCSA corporations and Tribes. Additionally, Nunivak Island is approximately 30 miles offshore from the delta and is the eighth-largest island in the U.S. Table 8-6 includes a mixture of ANCSA corporations, Tribes, and non-profit organizations' information. Their ANCSA regional corporation offices are in Bethel and Anchorage, and their non-profit organization is based in Bethel.

Table 8-6. Calista/Yukon Kuskokwim Organizations

Community	Name	Type
Alakanuk	Alakanuk Traditional Council	Federally recognized tribe
Alakanuk	Alakanuk Corporation	ANCSA village corporation
Bethel	Calista Corporation	ANCSA village corporation
Bethel	Association of Village Council Presidents	Non-profit organization
Bill Moore's Slough	Village of Bill Moore's Slough	Federally recognized tribe
Bill Moore's Slough	Kongnikilnomuit Yuita Corporation	
Chefornak	Chefornak Traditional Council	Federally recognized tribe
Chefornak	Chefarnrmute Inc.	ANCSA village corporation
Chevak	Chevak Traditional Council	Federally recognized tribe
Chevak	Chevak Co	ANCSA village corporation
Chuloonawick	Chuloonawick Native Village	Federally recognized tribe
Chuloonawick	Chuloonawick Corporation	ANCSA village corporation
Eek	Native Village of Eek	Federally recognized tribe
Eek	Iqfijouq Co	ANCSA village corporation
Emmonak	Emmonak Village	Federally recognized tribe
Emmonak	Emmonak Corporation	ANCSA village corporation
Goodnews Bay	Native Village of Goodnews Bay	Federally recognized tribe
Goodnews Bay	Kiutsarak Inc.	ANCSA village corporation
Hamilton	Native Village of Hamilton	Federally recognized tribe
Hamilton	Nunapiglluraq Corporation	ANCSA village corporation

Community	Name	Type
Hooper Bay	Native Village of Hooper Bay	Federally recognized tribe
Hooper Bay	Sea Lion Corporation	ANCSA village corporation
Kipnuk	Native Village of Kipnuk	Federally recognized tribe
Kipnuk	Kugkaktik Limited	ANCSA village corporation
Kongiganak	Native Village of Kongiganak	Federally recognized tribe
Kongiganak	Qemirtalek Coast Corporation	ANCSA village corporation
Kotlik	Village of Kotlik	Federally recognized tribe
Kotlik	Kotlik Yupik Corporation	ANCSA village corporation
Kwigillingok	Native Village of Kwigillingok	Federally recognized tribe
Kwigillingok	Kwik Inc.	ANCSA village corporation
Mekoryuk	Native Village of Mekoryuk	Federally recognized tribe
Mekoryuk	Nima Corporation	ANCSA village corporation
Mertarvik	Newtok Village	Federally recognized tribe
Mertarvik	Newtok Inc.	ANCSA village corporation
Nightmute	Native Village of Nightmute	Federally recognized tribe
Nightmute	NGTA Inc.	ANCSA village corporation
Nunam Iqua	Nunam Iqua Tribal Council	Federally recognized tribe
Paimiut	Native Village of Paimiut	Federally recognized tribe
Paimiut	Paimiut Corporation	ANCSA village corporation
Platinum	Platinum Traditional Village Council	Federally recognized tribe
Platinum	Arvig Inc.	ANCSA village corporation
Quinhagak	Native Village of Kwinhagak (aka Quinhagak)	Federally recognized tribe
Quinhagak	Qanirtuuq Inc.	ANCSA village corporation
Scammon Bay	Scammon Bay Traditional Council	Federally recognized tribe
Scammon Bay	Askinuk Corporation	ANCSA village corporation
Toksook Bay	Nunakauyarmiut Tribe	Federally recognized tribe
Toksook Bay	Nunakauiak Yupik Corporation	ANCSA village corporation
Tuntutuliak	Native Village of Tuntutuliak	Federally recognized tribe
Tuntutuliak	Tuntutuliak Land Limited	ANCSA village corporation
Tununak	Tununak Council (IRA)	Federally recognized tribe
Tununak	Tununarmiut Rinit Corporation	ANCSA village corporation
Umkumiute	Umkumiut Native Village	Federally recognized tribe
Umkumiute	Umkumiute Limited	ANCSA village corporation

8.3.6 Chugach

The largest settlements in the region include Cordova (Eyak), Seward, and Valdez. The Chugach region comprises the organized borough of Kenai Peninsula and the unorganized borough of Valdez-Cordova. Seven communities are within the region, with five ANCSA village corporations and Tribes. Table 8-7 lists the ANCSA corporations, non-profit organizations, and Tribes. The ANCSA regional corporation and non-profit organization offices are in Anchorage.

Table 8-7. Chugach Organizations

Community	Name	Type
Anchorage	Chugach Alaska Corporation	ANCSA regional corporation
Anchorage	Chugachmiut	Non-profit organizations
Chenega	Chenega Corporation	ANCSA village corporation
Chenega	Native Village of Chenega	Federally recognized tribe
Eyak	Eyak Corporation	ANCSA village corporation
Eyak	Native Village of Eyak	Federally recognized tribe
Eyak		Non-profit organization
Nanwalek	English Bay Corporation	ANCSA village corporation
Nanwalek	Nanwalek IRA Council	Federally recognized tribe

Community	Name	Type
Port Graham	Port Graham Corporation	ANCSA village corporation
Port Graham	Port Graham Village Council	Federally recognized tribe
Tatitlek	Tatitlek IRA Council	Federally recognized tribe
Tatitlek	Tatitlek Corporation	ANCSA village corporation

8.3.7 Cook Inlet

The Cook Inlet region is the traditional homeland of the Dena’ina Athabascans. Within the region is the municipality of Anchorage, Alaska’s largest urban city. The Cook Inlet is a large body of water that is referred to as Tikahtnu. The region is in the greater Southcentral Alaska region next to the Chugach area. Historically, seven villages in the region have a mixture of Ahtna, Dena’ina Athabaskan, Unangan, and Alutiiq descent. Table 8-8 lists the ANCSA corporations and tribes’ information. The ANCSA regional corporation and non-profit organization offices are in Anchorage.

Table 8-8. Cook Inlet Organizations

Community	Name	Type
Anchorage	Cook Inlet Region, Incorporated.	ANCSA regional corporation
Anchorage	Cook Inlet Tribal Council	Non-profit organizations
Eklutna	Eklutna Native Village	Federally recognized tribe
Eklutna	Eklutna, Inc.	ANCSA village corporation
Kenai	Kenaitze Indian Tribe	Federally recognized tribe
Salamatof	Salamatof Tribe	Federally recognized tribe
Salamatof	Salamatof Native Association	ANCSA village corporation
Knik	Knik Tribe	Federally recognized tribe
Knik	Knikatnu Inc.	ANCSA village corporation
Ninilchik	Ninilchik Village	Federally recognized tribe
Ninilchik	Ninilchik Natives Assoc., Inc	ANCSA village corporation
Seldovia	Seldovia Village Tribe	Federally recognized tribe
Seldovia	Seldovia Native Assoc. Inc.	ANCSA village corporation
Tyonek	Native Village of Tyonek	Federally recognized tribe
Tyonek	Tyonek Native Corporation	ANCSA village corporation

8.3.8 Koniag

The second largest island in the U.S., Koniag (Kodiak) Island's central community is the city of Kodiak. The island has an organized borough with seven communities. Traditionally, the Alutiiq people have been stewards of the island for thousands of years. Koniag Island has a diverse history, including military aerospace, the U.S. Coast Guard, and wildlife refuge. Additionally, the Alutiiq Museum shares the cultural traditions of the Koniag Alutiiq. Table 8-9 lists the ANCSA corporations and tribes. The ANCSA regional corporation and non-profit organization offices are in Kodiak and Anchorage.

Table 8-9. Koniag Organizations

Community	Name	Type
Kodiak/Anchorage	Koniag, Incorporated	ANCSA regional corporation
Kodiak	Kodiak Area Native Association	Non-profit organizations
Afognak	Native Village of Afognak	Federally recognized tribe
Afognak	Afognak Native Corporation	ANCSA village corporation
Akhiok	Native Village of Akhiok	Federally recognized tribe
Akhiok	Akhiok-Kaguyak, Inc.	ANCSA village corporation
Kaguyak/Kodiak Island	Kaguyak Village	Federally recognized tribe

Community	Name	Type
Kaguyak	Akhiok-Kaguyak, Inc.	ANCSA village corporation
Karluk	Native Village of Karluk	Federally recognized tribe
Karluk	Karluk Native Corporation	ANCSA village corporation
Kodiak	Sun'aq Tribe of Kodiak	Federally recognized tribe
Kodiak	Native of Kodiak Inc.	ANCSA village corporation
Larsen Bay	Native Village of Larsen Bay	Federally recognized tribe
Larsen Bay	Nu-Nachk Pit Inc.	ANCSA village corporation
Old Harbor	Alutiiq Tribe of Old Harbor	Federally recognized tribe
Old Harbor	Old Harbor Native Corporation	ANCSA village corporation
Ouzinkie	Native Village of Ouzinkie	Federally recognized tribe
Ouzinkie	Ouzinkie Native Corporation	ANCSA village corporation
Port Lions	Native Village of Port Lions	Federally recognized tribe
Port Lions	Afognak Native Corporation	ANCSA village corporation
Woody Island	Tangirnaq Native Village	Federally recognized tribe
Woody Island	Leisnoi, Incorporated	ANCSA village corporation

8.3.9 NANA

Kotzebue is the government seat of the Northwest Arctic Borough (NAB), with NAB village liaisons in each village. It is the second largest borough that provides services to its 11 villages and is the primary employer in all villages. Like the NSB, the NAB is involved in various community issues to improve their resident's way of life. The NANA region has one ANCSA village corporation. Ten of the 11 village corporations merged with NANA while Kotzebue retained its village corporation named Kikiktagruk Inupiat Corporation. Table 8-10 includes a compilation of ANCSA corporations and Tribes' information. NANA, the ANCSA regional corporation, has offices in Anchorage and Kotzebue.

Table 8-10. NANA Organizations

Community	Name	Type
Kotzebue/Anchorage	NANA Regional Corporation	ANCSA regional corporation
Kotzebue	Maniilaq Association	Non-profit organizations
Kotzebue	Northwest Arctic Borough	Organized borough
Buckland	Native Village of Buckland	Federally recognized tribe
Deering	Native Village of Deering	Federally recognized tribe
Kiana	Native Village of Kiana	Federally recognized tribe
Kivalina	Native Village of Kivalina	Federally recognized tribe
Kotzebue	Native Village of Kotzebue	Federally recognized tribe
Kotzebue	Kikiktagruk Inupiat Corporation	ANCSA village corporation
Noatak	Native Village of Noatak	Federally recognized tribe
Noorvik	Noatak Native Community	Federally recognized tribe
Selawik	Native Village of Selawik	Federally recognized tribe

8.3.10 Southeast

The ANCSA regional corporation and federally recognized Tribe within southeast Alaska are Sealaska and Central Council of the Tlingit & Haida Indian Tribes (CCTHITA), respectively. Both organizations are headquartered in Alaska's capital, Juneau. The traditional homelands of the Tlingit, Haida, and Tsimshian Peoples have inhabited their area for thousands of years. Like ICAS in the Arctic Slope region, CCTHITA is one of the two federally recognized regional tribes in Alaska. Along with regional organizations, the southeast area includes ANCSA village corporation and smaller tribes. Table 8-11 consists of a collection of ANCSA corporations and tribes. Metlakatla, the only Indian Reserve in Alaska, is on Annette Island. The reserve consists primarily of Tsimshian people.

Table 8-11. Southeast Organizations

Community	Name	Type
Juneau	Sealaska Corporation	ANCSA regional corporation
Juneau	CCTHITA	Federally recognized regional tribe
Angoon	Angoon Community Association	Federally recognized tribe
Angoon	Kootznoowoo Inc.	ANCSA village corporation
Craig	Craig Tribal Association	Federally recognized tribe
Craig	Shaan-Seet Inc.	ANCSA village corporation
Douglas	Douglas Indian Association	Federally recognized tribe
Haines	Chilkoot Indian Association	Federally recognized tribe
Hoonah	Hoonah Indian Association	Federally recognized tribe
Hoonah	Huna Totem Corporation	ANCSA village corporation
Hydaburg	Hydaburg Cooperative Association	Federally recognized tribe
Hydaburg	Haida Corporation	ANCSA village corporation
Kake	Organized Village of Kake	Federally recognized tribe
Kake	Kake Tribal Corporation	ANCSA village corporation
Kasaan	Organized Village of Kasaan	Federally recognized tribe
Kasaan	Kavilco Inc.	ANCSA village corporation
Ketchikan	Ketchikan Indian Community	Federally recognized tribe
Klawock	Klawock Cooperative Association	Federally recognized tribe
Klawock	Klawoock Heenya Corporation	ANCSA village corporation
Klukwan	Chilkat Indian Village	Federally recognized tribe
Klukwan	Klukwan, Inc.	ANCSA village corporation
Petersburg	Petersburg Indian Association	Federally recognized tribe
Saxman	Organized Village of Saxman	Federally recognized tribe
Saxman	Cape Fox Corporation	ANCSA village corporation
Sitka	Sitka Tribe of Alaska	Federally recognized tribe
Sitka	Shee Atiká, Inc.	ANCSA village corporation
Skagway	Skagway Traditional Council	Federally recognized tribe
Wrangell	Wrangell Cooperative Association	Federally recognized tribe
Yakutat	Yakutat Tlingit Tribe	Federally recognized tribe
	Yak-tat Kwaan Inc.	
Metlakatla	Metlakatla Indian Community, Annette Island Reserve	Indian Reserve

8.3.11 Engagement Summary

Open communication with regional and community leadership living along the Alaska OCS is essential for the success of historic preservation. As a federal project reviewer and permitting agency, BOEM must consult with Tribes and ANCSA Corporations. Federal agencies have directives, policies, and guidance for formal government-to-government consultations with Tribes and ANCSA corporations (BOEM 2018). Meaningful engagement requires relationship building and the establishment of trust between parties. While preliminary comments and feedback were provided and included in this report and database, further and continued engagement will be necessary. .

9. Conclusions and Recommendations

In September 2021, BOEM contracted with Gray & Pape and its teaming partners NLURA and ACES to conduct a study to identify coastal and submerged cultural heritage resources in federal waters offshore the State of Alaska. The Alaska database is a comprehensive cultural resources database, having been expanded from an earlier shipwreck table to include precontact site modeling, coastal precontact sites, downed aircraft, NRHP listed sites, as well as interpreted geophysical targets and anomalies that may represent historically significant resources. The scope of work also included engagement with State and Federal agencies and Alaska Native Corporations, Villages, and Tribes. Engagement was conducted to share information and identify culturally significant places that may not be identifiable through traditional archaeological survey methods. The following sections present recommendations for continued engagement, and conclusions and further research for subject matter areas.

9.1 Recommendations for Future/Continued Engagement

The engagement conducted under this project have laid the groundwork for continued engagement by BOEM with Tribes and Alaska Native regional and community leadership outside of project-specific consultations. There is also an opportunity for future engagement in relation to the database project. Building from the BOEM Tribal Consultation Guidance memorandum, with its Department of Interior requirements, future recommendations are provided below from project staff members' experiences in communicating, coordinating, and facilitating stakeholder engagement meetings in Alaska (BOEM 2018). Topics are addressed in different subsections that explain the life of the project and their stakeholder engagement process.

9.1.1 BOEM Policy and Engagement Plan

All federal resource management agencies have national directives, policies, and guidance for conducting formal government-to-government consultations with Tribes and formal talks with Alaska Native corporations. Alaska Native Corporations are any Alaska Native regional or village corporation as defined in or established under the ANCSA. Federal agencies must notify the appropriate Tribes and Alaska Native corporations when considering action with tribal implications (Brooks 2022). Understanding and applying BOEM terms and guiding principles for consultation helps to recognize and respect that sovereign tribal nations are not public and have relationships with federal agencies. As Tribes have a special relationship with federal agencies, making a SEP is recommended. A SEP should outline the stakeholders, the reasons why they need to be engaged, how engagement will occur, and what outcomes are desired. By developing a SEP, an organization can ensure it has the capacity to follow through with stakeholder engagement and make the most of its resources. A SEP will guide an organization through each step, from defining stakeholders to reporting on what outcomes have been achieved. The SEP is a powerful tool for developing activities that are consistent with the existing BOEM Tribal Consultation Guidance memo.

The DOI guiding principles note having appropriate stakeholders from agencies, Tribes, and ANCSA corporation representatives in the consultation process; it is in fact required to identify appropriate Tribal consulting organizations early in the planning process. Early engagement is conducted to provide a meaningful opportunity to participate in the consultation process (BOEM 2018). Using the database project as an example, a SEP for further engagement will need to identify the required Tribes and ANCSA corporations that will have a continuing relationship with the project and should list all the Tribes and ANCSA corporations affected by or having a relationship with the project. The guiding principles further state that agencies will participate “in the consultation process in a manner that demonstrates a meaningful commitment and ensures continuity in the process” (BOEM 2018). Involving

the Tribes and ANCSA corporations from the very start ensures they have every opportunity to participate, contribute, and have a say on how and when they can participate. Involvement from beginning to end shows equity during the project consultation process.

9.1.2 Engagement Timeline and Coproduction of Knowledge

The BOEM consultation process is deliberately designed to create collaboration and informed decision-making. Government-to-government exchange is intended to promote improved communication between entities and emphasizes trust, respect, and shared responsibility (BOEM 2018). This federal directive and the Indigenous-Agency coproduction of knowledge make engagement a significant undertaking in Alaska. The coproduction of knowledge is a shared research process that involves different levels of backgrounds of people involved in a research project. The ICC research protocol guidelines, for example, state that bringing together Indigenous knowledge and Western science ensures Indigenous knowledge is trusted and respected as a knowledge system that brings its own evaluation and validation processes (ICC 2022). Co-production of knowledge is intended to allow for the coexistence of multiple types of information and celebrate the complementarity of knowledge generation, as opposed to integrating or incorporating other knowledge systems into Western Science (Reid et al. 2020). Meaningful engagement can further aid in developing genuine and equitable representation within the coproduced knowledge, resulting in a stronger rapport and greater trust built between participants.

The early stages of coproduction can form the foundation for building Indigenous knowledge partnerships that lead to solid relationships to enhance the project, federal agencies, and regional/local tribal leadership. This process will take time and patience. Suggested seasonal times to begin engagement efforts are the fall and winter, as has been done for the current database project. These targeted periods in the year avoid many food harvesting times, cultural events, and other traditions that Alaska Native communities are preparing for. It is also when regional entities and communities are closer to home and have more consistent availability (e.g., school, conference season, work events). First engagements in the fall provide time for the consultation process to occur meaningfully and respectfully for both agencies and Tribal leadership. It provides time for Tribal leadership to digest project information, discuss amongst themselves, and give feedback to the agencies.

9.1.3 Communication and Collaboration

As the BOEM consultation guidelines and coproduction of knowledge approach enhance a research project from start to finish to building trust and shared responsibility, there are some recommendations on beginning that process. Informally communicating first with the Tribes and ANCSA corporations' leadership that know about their lands, natural resources, and cultural resources would serve to provide these individuals with an understanding of the upcoming official notification/invitation. These individual leaders for both Tribes and ANCSA corporations are the Directors of Lands, Natural Resources, and Cultural Resources. Contacting these specific leaders and including them consistently with their overall leadership could assist with receiving consistent feedback and cooperation. When communicating with the Tribes and ANCSA corporations, it is also recommended to notify the regional and village organizations. For Tribes, most represent a village or community with a few exceptions like the federally recognized regional Tribes CETHITA and ICAS. For ANCSA corporations, include both their regional and village corporations. Tribe and ANCSA leadership can be challenging to schedule. Communicating on finding calendar opportunities to limit leadership experiencing meeting burnout is recommended.

9.1.4 Other Organizations

Each Alaska region has its Tribes, ANCSA corporations, and diverse types of governmental organizations (organized or unorganized boroughs). Although there are similarities, there are differences in how each region kept its original structure or conglomerated its ANCSA corporations. For example, the NANA

region has no ANCSA village corporations besides Kotzebue, while the rest merged into the NANA Regional Corporation. Additionally, Tribes have various levels of support from their regional non-profit organizations. It will be essential to have a team with experience and knowledge in each region, varied levels of organization, and who to communicate with. Furthermore, there are organizations in each region who specialize in Indigenous knowledge and may have a database on Indigenous and cultural knowledge (see for example, discussion of the Traditional Land Use Inventory in Chapter 4.3.1).

Some organizations have Indigenous knowledge networks and manage Indigenous resource databases depending on the Alaska region. Examples include organized boroughs that have a Planning Department or Cultural Resources Division that manages their cultural resources. Others include regional and community museums that collect, gather, and educate residents on their history and cultural traditions. There are also non-profit organizations that work in partnership with their ANCSA corporations and Tribes, such as the Sealaska Heritage Institute. Lastly, all these organizations, including Tribes and ANCSA corporations, may have a wildlife or environmental department that works closely with their regional Indigenous knowledge holders. These organizations have networks with groups specializing in varied knowledge (e.g., terrestrial, marine, song, dance). Table 9-1 shows examples of these organizations.

Table 9-1. Alaska Native Organizations – Indigenous Knowledge Partnerships

Name
Aleutian Pribilof Islands Association – Cultural Heritage Department
Museum of the Aleutians – Unalaska
North Slope Borough – Department of Planning
North Slope Borough – Department of Wildlife Management
Kawerak, Inc. – Cultural & Environmental Programs
Kawerak Katirvik Cultural Center
Bristol Bay Native Association – Marine Mammal Program
Association of Village of Council President – Cultural & Environmental Science Department
Yupit Piciyaraait Museum
Chugach Corporation – Cultural Resources
Native Village of Eyak – Cultural Department
Chugach Heritage Foundation
Cook Inlet Land Department & Tribal Councils
Koniag Corporation, KANA Environmental, and Alutiiq Museum
NANA Regional Corporation, Maniilaq Association, and Northwest Arctic Borough
CCTHITA – Cultural Heritage & Education
Sealaska Heritage Institute

Alaska has a long history of Federal, State, and Tribal governments working together to co-manage the harvest of certain animals. Management includes stewardship and mitigation of impacts on the habitat of an animal. Tribes and ANCSA corporations recommended that some of these organizations be in consistent communication during the timeline of the BOEM Alaska OCS Database Project. While it may not seem intuitive to include wildlife management leaders in engagement discussions for cultural sites preservation, it must be reinforced that many of these organizations have commissioners who wear

multiple hats and are board, council, and assembly members of their other regional organizations. Table 9-2 displays the Alaska co-management organizations throughout the Alaska OCS.

Table 9-2. Co-management Organizations

Name
Alaska Beluga Whale Committee
Alaska Eskimo Whaling Commission
Alaska Nannut Co-Management Council
Alaska Sea Otter and Steller Sea Lion Commission
Aleut Marine Mammal Commission
Alaska Native Harbor Seal Commission
Bristol Bay Marine Mammal Council
Cook Inlet Marine Mammal Council
Eskimo Walrus Commission
Ice Seal Committee
Indigenous People’s Council for Marine Mammals
North Slope Borough, Department of Wildlife Management
Sitka Marine Mammal Commission
Traditional Council of St. George Island
Tribal Government of St. Paul

A final recommendation for effective and continued engagement would be to identify those BOEM staff with experience with or responsibility for engagement and develop a working group for cross-agency collaborations to maximize learning opportunities for working and consulting with Alaska Tribes, ANCSA corporation, and their non-profit organizations. Examples include the National marine fisheries service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the Marine Mammal Commission. These organizations and the University of Alaska programs would be appropriate partners with whom to coordinate, collaborate, and learn from their experiences working with Alaska Native Tribes and ANCSA corporations.

Consultation with Tribal and ANSCA Corporation leadership is an integral part of state and federal undertakings, but early and informed engagement can help to build trust and communication between all parties. Project specific recommendations for continued and improved engagement include:

- Developing a stakeholder engagement plan tailored to one or more regions.
- Targeting the recommended seasonal periods to communicate, coordinate, and collaborate with Tribal and ANCSA leadership to maximize their capacity to respond and engage meaningfully.
- Applying the coproduction of knowledge approach when working with Tribes and ANCSA corporations with consistent and meaningful dialogue to produce information of value to all parties.
- Being aware of Tribe and ANCSA corporation Indigenous knowledge holders and leaders with appropriate networks to these individuals and groups, so that lines of communication are open and inclusive.

- Being prepared to follow up on Tribe and ANCSA corporation leadership recommendations that include communicating, coordinating, and collaborating with non-profit entities, boroughs, and regional museums with access and partnerships with Indigenous knowledge and cultural resource information.
- Being ready to notify and work with Alaska co-management organizations who have vast amounts of Indigenous knowledge of marine life.

9.2 Inventories and Geodatabases

The primary objective of this study was to develop a comprehensive inventory and georeferenced database of known, reported, and possible submerged cultural resources within the Alaska OCS. Submerged cultural resources were defined as including high probability submerged paleolandforms, potential coastal precontact sites, NRHP listed sites, TCPs, historic shipwrecks, and downed historic aircraft, and geophysical targets and anomalies interpreted as potentially significant cultural resources. This database will be used by BOEM as a planning and resource management tool to ensure federal permitting activities and permitted projects comply with Section 106 of the NHPA.

The database contributing the greatest number of known resources to BOEM’s mission are those for shipwrecks and downed aircraft. An initial shipwreck database had already been constructed by BOEM and was provided as a starting point for data entry; however, early inspection of the database revealed that many of the entries lacked coordinates or actionable location information. The updated database includes 4,638 historic shipwreck entries, including 1,261 with plotted locations of varying accuracy. A total of 90 downed aircraft were identified that could be plotted with varying accuracy. These entries have been cross-referenced across all available research to avoid redundant or duplicated records. Contextual information from over 350 historic maps was reviewed, with over 180 maps containing specific information of relevance, including various ship routes and flight paths, of which a select number of maps were then digitized and georeferenced. These digitized historic map shapefiles are included with the final GIS deliverables. The plotted shipwrecks, downed aircraft, and digitized map resources extend across both federal and state waters. A breakdown of the number of sites identified within each database is listed in Table 9-3, with a further breakdown by location of selected database site information listed in Table 9-4.

Table 9-3. Breakdown of sites by database

Coastal Sites and NRHP Database	
Total sites in database	32,876
Sites in database with no time period recorded	3,151
Sites in database recorded as having a Prehistoric component	11,462
Sites in database recorded as having a Protohistoric or Historic component	18,809
Sites in database with a Modern component	1,198
Sites in database with no recorded cultural affiliation	13,718
Sites in database that intersect U.S. Federal Waters	4
Sites in database that intersect Alaska State Waters	4,802
Sites in database that do not intersect State or Federal Waters	28,070
Shipwreck Database	

Total shipwrecks in database	4,638
Sites with no recorded coordinates	3,377
Sites with coordinates	1,261
Sites in database that intersect U.S. Federal Water	159
Sites in database that intersect Alaska State Waters	988
Sites in database that do not intersect State or Federal Waters	113
Downed Aircraft Database	
Total downed aircraft in database	90
Sites in database that intersect U.S. Federal Waters	39
Sites in database that intersect Alaska State Waters	29
Sites in database that do not intersect State or Federal Waters	22

Table 9-4. Breakdown of sites within selected databases by Planning Area

Shipwreck Database	
Sites in database that intersect US Federal Waters by Planning Areas (159):	
Aleutian Arc	6
Aleutian Basin	0
Beaufort Sea	10
Bowers Basin	2
Chukchi Sea	24
Cook Inlet	9
Gulf of Alaska	33
Hope Basin	5
Kodiak	12
Navarin Basin	0
North Aleutian Basin	6
Norton Basin	14
Outside Planning Area	0
St. George Basin	15
St. Matthew-Hall	4
Shumagin	19
Downed Aircraft Database	
Sites in database that intersect US Federal Waters by Planning Areas (39):	
Aleutian Arc	22
Aleutian Basin	0
Beaufort Sea	0

Downed Aircraft Database (cont.)	
Bowers Basin	0
Chukchi Sea	1
Cook Inlet	1
Gulf of Alaska	3
Hope Basin	0
Kodiak	3
Navarin Basin	0
North Aleutian Basin	1
Norton Basin	1
Outside Planning Area	1
St. George Basin	3
St. Matthew-Hall	0
Shumagin	3

Creation of the Coastal Sites and NRHP Data table resulted in the identification of 32,876 total entries, all of which are in either state or federal waters, and/or within a 160-km (99.4-mi) buffer of the US Census coastline. 442 of the entries are NRHP-Listed or are part of listed districts or landmarks. A single TCP lies within the study area, as discussed in Chapter 6. While many of these resources are outside of BOEM's area of direct responsibility, ancillary activities to federally permitted actions, such as onshore cable routing, may affect these resources. Densities of known sites or NRHP-Listed resources indicate areas where previous work has been done, providing context for submerged cultural resources potential within adjacent offshore areas. Lower density or absence of recorded resources also informs BOEM management decisions. For example, in support of Section 110 responsibilities, BOEM may consider NRHP nominations as a priority, given the current lack of nominations for sites in federal waters.

The submerged paleolandscapes portion of the inventory resulted in construction of regional sea-level stands based on water depths that indicate subaerial exposure and the potential for precontact sites. Based on these sea-level stands, the majority of federal waters had likely transitioned to a fully inundated marine environment by approximately 10,000 BP. Following transition to a marine environment, cultural resources would be limited to watercraft, materials associated with marine resource harvest, or run-off from land. Despite extensive search efforts, few data sets were identified that discuss the Alaska OCS in a broad context. Multiple detailed bathymetric mapping studies were identified for small, isolated swaths of seafloor, typically within an individual inlet and/or in state waters. Alternately, studies were identified that provided qualitative imagery without locational information.

Finally, the anomalies data entry table constructed for this effort provides a mechanism for capturing targets and anomalies reported to BOEM as potentially historically significant resources. By categorizing unidentified targets and anomalies separately from reported losses, BOEM personnel can easily identify targets for future studies, or compare results from overlapping survey areas to determine if previously recorded targets coincide. When targets and anomalies are investigated, the entries can be updated to reflect the findings. For example, a reported target confirmed to be a shipwreck can be moved to the shipwreck table, while an entry for an unknown target confirmed to be modern debris can be updated to reflect that the target is a seafloor feature but does not represent a historically significant resource.

The tables, shapefiles, and metadata resulting from this project are intended to be updated and maintained, so that they continue to reflect the most up-to-date information about Alaska’s submerged and coastal cultural resources. Recommendations for maintenance and updating, and further studies, are listed below.

9.2.1 Maintenance and Updating

The data entry tables and georeferenced files for this database were specifically constructed to allow for updates and the addition of new information. The data entry attributes and definitions provided in Appendices A-D provide sufficient information to enable consistent data entry procedures. The use of Excel for the data entry tables, as requested by BOEM, provides a stable, user-friendly format with a vast potential for additional entries. According to Microsoft (2023), Excel tables can accommodate a maximum of 1,048,576 rows of data and 16,384 columns. Individual sheets can be loaded into ArcGIS Pro with no conversion, as long as the formatting remains simple (e.g., no pull-down menus, no links). While the current shapefiles represent a static view of the data, they should be updated periodically, as new data are entered into the tables. A regular maintenance plan will help to ensure the GIS data stays current and relevant to BOEM’s mission.

There are two methods that could be used to update the Excel and GIS files. (1) Data could be added manually to the Excel spreadsheet. XY coordinates in the database coordinate system would need to be calculated to complete the entry. To maintain an up-to-date shapefile, the Excel sheet would need to be converted to a new shapefile in GIS. In this case, the user would also need to regenerate or apply the metadata to the new shapefile to maintain completed metadata status for the database. (2) Data could be added manually to both the spreadsheet and shapefile. The user would need to add the point to the shapefile manually using Create in the Edit menu of ArcGIS Pro, then add the rest of the data entry concurrently to the Attribute Table and Excel sheet. XY geometry could then be calculated within the attribute table of the shapefile and pasted back into to the Excel spreadsheet to complete the database entry. This method would not require re-entry of metadata.

Because of the additional metadata work and the potential for error or difficulty placing the new point correctly using calculated coordinates, the first method is not recommended.

The scope of work for this project included development of a Story Map to be hosted online that presents a static presentation of study results and information that can be shared with the general public. Other public outreach or engagement materials, such as the existing Alaska Shipwreck Table hosted on BOEM’s website, referenced in Section 1.1, were not included in the scope of work and do not reflect the contents of the updated and expanded Database. BOEM may wish to consider updating the webpage for “Shipwrecks Off Alaska’s Coast” that references the table last updated May 2011 (<https://www.boem.gov/about-boem/shipwrecks-alaskas-coast>).

9.3 Management Recommendations

The background research conducted as part of the inventory and database development resulted in the identification of multiple actions that BOEM may consider, in addition to continued engagement previously discussed in Chapter 9.1. These management recommendations broadly include immediate actions and longer-term objectives.

9.3.1 Continuation of Alaska Native Engagement

An immediate item that BOEM will need to address is how best to continue engagement with Alaska Native Corporations, Villages, and communities initiated under this scope of work. Responses to multiple rounds of engagement letters and calls were received during report finalization and in the final days of the contract. It is likely that responses may continue to be received following contract close out, and while all

contracted parties are committed to facilitating responses, a formal process and point of contact should be identified.

9.3.2 Research Initiatives

The historical research and contextual development identified several areas where further or focused research may result in additional entries to the various data tables. As previously discussed in Section 5.1.4.2, archival research yielded multiple records that were summarized but not entered into the database. These records could not be cross-referenced against the existing historic shipwrecks and downed aircraft tables within the time frame required for shapefile creation. Additionally, further work may be considered at archival repositories. For example, repeated attempts to contact and visit the collections held by the Pacific Northwest Maritime Historical Society were unsuccessful; however, future attempts to coordinate research at this facility may yield valuable information. Possible research themes and topics were outlined in Section 5.1.2 and may serve as the catalyst for future BOEM funded studies.

As evidenced in Chapters 2 and 3, the physical environment offshore Alaska in federal waters and paleolandscapes are areas that would benefit from additional research. The study area was defined by using a 160-km (99.4-mi) buffer from the shoreline. The definition of shorelines in Alaska is an extensive area of research in and of itself, as the definition varies on tidal ranges, and active erosion. For the purposes of this study, the shoreline was defined using the U.S. Census Bureau's 2020 TIGER shapefile for the Alaska coastline (U.S. Census 2020). This allowed for a consistent source to be used across the entirety of Alaska, however, the effects of climate change on active shorelines were identified by early engagement participants as a key area of concern. Targeted research on specific shoreline areas may be warranted as case studies of impacts to existing cultural resources. Limited paleolandscape modeling has been conducted within southeast Alaska, usually along the coastline in state waters (e.g., Monteleone et al. 2012, Carlson 2015). This is in contrast to the vast expanse of formerly subaerial portions of Beringia, which underlies a significant portion of the Alaska OCS within federal waters and remains largely unexplored for archaeology. A review of existing, unredacted geophysical survey reports previously submitted to BOEM may yield information concerning bathymetry or shallowly buried subsurface features of potential archaeological interest.

The Anomalies data entry table is a forward-looking tool that can be populated following a review of existing, unredacted geophysical survey reports submitted in compliance with Exploration and Development Plans. Based on data available from BOEM, a total of 109 wells have been drilled within federal waters offshore Alaska as of 2020, suggesting that prior geophysical surveys were submitted to BOEM, in compliance with either shallow hazard and or archaeology requirements. A review of all available reports could result in the identification of targets and anomalies of potential archaeological significance that can be added to the Anomalies table. Further, as stated above, these reports may also include significant information on bathymetric, geologic, and or seafloor features of interest for precontact site occurrence and preservation modeling. Data samples and maps contained in the reports can also provide information concerning data quality and the efficacy of different survey instruments and methodologies across planning areas.

With specific regard to future studies, BOEM may wish to consider formal consultation with Alaska Native communities as part of the studies process. The objective of the recommended consultation would be to develop future studies that not only help BOEM identify areas or specific resources of concern to better safeguard these resources as part of the offshore permit application process, but that are also of relevance to Alaska Native communities.

9.3.3 Inter-agency Agreements and Data Sharing

The information contained in this report was the result of extensive research and coordination with federal, state, and local agencies and entities. BOEM has a very specific regulatory responsibility for protecting submerged cultural resources, however, these resources may be identified by other agencies without a mechanism in place that requires reporting of the finds to BOEM.

As discussed in Section 5.2.1, the State of Alaska SHPO and DNR are responsible for inventorying and cataloguing information on verified and potential cultural resources in both state and federal waters. Further, Alaska DNR OHA maintains the AHRS, which was used extensively with permission, to inform the current database. Use of the AHRS is permissible by qualified users, as evaluated by OHA; use of the data in this report and georeferenced database is limited to redacted information about site types, or site visualization at a scale that does not allow for precise positioning. Alaska DNR and SHPO officials would allow BOEM full access to this data pending a formal data sharing agreement, such as a MOU. Further, it is recommended that BOEM and Alaska DNR OHA develop a regular schedule for data sharing and updates that would serve to keep the data entry tables as current as possible, ensuring that decisions are made using the most up to date information.

BOEM may also wish to consider inter-agency agreements and data sharing with NHHHC and NOAA. NHHHC maintains records of military losses and protects submerged cultural resources under the auspices of the Sunken Military Craft Act. As discussed in Section 5.2.2, NHHHC is actively developing their own GIS platform for information sharing. While preliminary discussions with NHHHC suggested a willingness to engage with BOEM and coordinate on information pertaining to U.S. and Japanese assets, they requested that BOEM contact them directly following the completion of their new database. NOAA routinely funds ocean exploration research projects, either through the OE funding program (such as the Arctic coast mapping project discussed in Section 5.2.2) or through NOAA's own hydrographic or oceanographic survey work. Coordination with NOAA may allow BOEM to nominate targets for investigation during NOAA missions, for example, *Okeanos Explorer* expeditions, or provide input into research priorities.

9.3.4 Updated Survey Guidance

As discussed in Chapter 7, archaeological survey guidance for the Alaska OCS region is provided in NTL 2005-A03, and generally states that surveys may be required when there is a "reason to believe" that archaeological resources may be present within the proposed area of effect. Based on the results of this project, it is difficult to say that enough evidence exists to negate the possibility of archaeological site occurrence or preservation in any area on the OCS, for any specific type of resource. The results of precontact shoreline modeling (discussed in Chapter 3) suggest that the majority of the continental shelf within federal waters was exposed as dry land at the last glacial maximum, resulting in an extensive amount of area for potential occupation or exploitation by early populations. Archival and historical research resulted in the identification of 159 shipwrecks and 39 downed aircraft that reliably plot within federal waters; however, references were found for an additional 3,377 shipwrecks that are located off Alaska but cannot be plotted with any degree of confidence, pending further research. A search of Russian, Japanese, and Canadian archives, which was beyond the current scope of work, may yield additional shipwrecks or downed aircraft that can be plotted with confidence in federal waters of the Alaska OCS.

The guidance in NTL 2005-A03 outlines the basic instruments and methods to be used when a survey is requested, consisting mainly of bathymetry data, side scan sonar, and acoustic profiling. These sensors can be effective in identifying submerged and buried paleolandforms correlating with potential precontact sites; however, NTL 2005-A03 only requires precontact site assessments to be conducted in water depths

up to 60 m (196.8 ft.). Updated sea-level curve information and models of precontact site occurrence suggest that these assessments should be conducted out to water depths of 140 m (459.3 ft.) (as discussed in Chapter 3). Further, NTL 2005-A03 states that magnetometer data may be requested, on a case-by-case basis. There is not enough baseline information to determine if historically significant cultural resources will be buried or exposed on the seafloor. Therefore, magnetometer data should be required to help identify contact period resources. Anecdotal evidence has been encountered that states magnetometer data acquisition in some areas within the Alaskan OCS may be compromised by the presence of volcanic sediments. Given the utility of magnetometer data for identifying post-contact period shipwrecks or downed aircraft, BOEM may wish to consider a review of existing reports for magnetometer data quality or a future study to determine if the remnant magnetism of volcanic sediments adversely impacts the interpretation of magnetometer data for archaeological assessments.

Specific recommendations are made here for updates to the existing survey guidance provided in NTL 2005-A03. Depending on the anticipated leasing program needs, BOEM's Alaska OCS region may consider adopting existing guidance from other regions, such as the Office of Renewable Energy Program's (OREP) *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*) or the updated oil & gas survey guidance pending as the Department of the Interior's proposed rule, *Protection of Marine Archaeological Resources* (RIN 1010-AE11). The adoption of existing agency guidance would provide consistency across regions and resource types.

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Appendix A: BOEM Alaska Coastal Sites and NRHP Data Definitions

Table A1. Alaska Coastal Sites and NRHP Data Definitions

Attribute	Definition
FID	Feature ID (automatically assigned by GIS)
Shape	Geometry of current shapefile (automatically defined by GIS)
CentroidX	X-coordinate of site centroid calculated from AHRS shapefile
CentroidY	Y-coordinate of site centroid calculated from AHRS shapefile
MERGE_SRC	Source of the entry prior to merge: AHRS shapefile table name in the format "AHRS Data [company] [user] [YYYYMMDD]_[geometry abbreviation]_ExportTable"
AhrsID	Unique relate key assigned to site in AHRS database
AhrsNo	State site ID number assigned by AHRS
SiteName	The common name of the site. If there is no common name, the default site name is the AHRS Number.
LocationDe	Description of the location of the site and how to get there. Notable landforms or natural features that would help locate the site and directions or distances from the site location to landmarks. For buildings, location information should indicate the part of the city, town, village, etc. Street addresses may be entered for buildings. The location information narrative should describe the regional surroundings and compliment coordinates, or other location information.
ResourceDe	Keywords and phrases that succinctly describe what the site is
ResourceNa	Picklist from National Register of Historic Places: Site, Building, Structure, Object, District.
Resource_1	Resource nature subtype (picklist for each ResourceNa)
AssignedTo	Agency and person who requested the site number
Cultures	Cultural affiliations of the site occupations. Euroamerican is used for historic and modern American cultural resources, unless otherwise identified.
Ownership	Landowners or institutions/agencies that own the land on which the cultural resource is located
OtherNumbe	Any other numbers associated with the cultural resource
Condition	Condition of the cultural resource based on the most up-to-date information. Picklist: Normal state of weathering, undisturbed by vandalism, construction or abnormal weathering such as flooding or earthquakes (A); Normal state of weathering and investigated (AC); Normal state of weathering and tested (AC3); Disturbed site, degree unknown or Modified building, degree unknown (B); Partially destroyed (B1); Site investigated and found to be partially destroyed (B1C); Totally destroyed (B2); Site investigated and found to be totally destroyed (B2C); Site investigated and found to be disturbed, degree unknown (BC); All or partially destroyed and tested (BC3); All or partially destroyed and partially excavated (BC4); All or partially destroyed and totally excavated (BC5); Site archaeologically or historically investigated (C); Tested only (C3); Partially excavated (C4); Site undergoing historical restoration, alteration or other preservation activity (D); Unknown (E)
CardStatus	Picklist: Complete (the form, including location information, is finished or this is all the information available for this record at this time), Not complete (the form is not complete)
OccupancyD	Site use dates with units, if known.
Desctructio	Year site was destroyed

Attribute	Definition
SourceReli	How reliable the source information is for this cultural resource. Picklist: Professional reports, records and field studies (A); Historical or non-professional sources of apparent reliability (B); Reports of unknown reliability (C)
LocationRe	Picklist choice: Location exact and site existence verified (1); Location vague, but site existence verified (2); Location exact, but site existence not verified (3); Location vague and site existence not verified (4)
Descriptio	Site description (truncated by GIS word limit): physical aspects of the cultural resource at the time of investigation. May include topography, viewshed, ground cover, artifacts, site length/width/area, buildings. The description field is also where any additional information about the site is entered that does not belong in or supplements information in another field.
Significan	Description of the cultural significance of the resource. The significance field may be updated after completing a Determination of Eligibility (DOE) document for the site and after a determination has been made by the SHPO. It may be updated again if a National Register Nomination (NRN) determination has been made.
Associatio	Association of the site with a larger group of sites (which may or may not be a district), landforms, regions, projects, etc. Usually the associated name or abbreviation is commonly known and related with this site. Association keywords may also relate the cultural resource with commonly understood cultural contexts.
Area	Site area in acres. Measurements in any other unit are noted in the field.
PeriodCode	Time period for the cultural resource. Picklist: Prehistoric, Historic, Protohistoric, Paleontological, Modern. More than one may be chosen.
CurrentFun	Current Function. Picklist from many categories and subcategories
HistoricFu	Historic Function. Picklist from many categories and subcategories
Destruct_1	Adverse activities noted during the last site visit that have affected the site. Picklist of up to five choices from many categories.
BiaNumbers	Any BIA numbers associated with the cultural resource
OtherNames	Any secondary site names
Modified	Date and time the site form was completed or updated
IsApproxim	Modified date/time is approximate: True/False
SourceSRID	Coordinate system code for site form coordinates
SurveyYear	Years survey was conducted
GpsGrade	Type of GPS used to get coordinates or 'none' if GPS not used
AliquotPar	Portion of parcel or section. 1/4 1/4 1/4 section in cardinal directional abbreviations only (e.g., SNENW)
GeometryTy	Shapefile geometry type. Picklist: Point, Multipoint, Line, Polygon

Appendix B: BOEM Alaska Shipwreck Database Definitions

ALASKA SHIPWRECK DATABASE

DATAFIELD DEFINITIONS

1. BOEM 2011 ID: ID number, taken from 2011 Access Database column marked, "Original ID".
2. AHRS ID: ID of vessel as referenced within the Alaska Heritage Resources Survey (AHRS) database. Cross-reference ID.
3. Vessel Name: Name of vessel or object as provided in the sources examined. In some instances, this might be a descriptive name, such as "24-foot pleasure boat," or "10-foot pipe," "obstruction," or simply "object." If no name or descriptors are available for an entry, the terms "Unknown vessel" or "Unknown object" are used.
4. Registration ID: Numeric/integer field, designated number attributed to vessel. Examples of numbers could be either an IMO 7 digit number, or one defined by USCG, between 6 and 8 digits long.
5. Planning Area Name: A list of the regional location designations. The entries are:
ALA – Aleutian Arc
ALB – Aleutian Basin
BFT – Beaufort Sea
BOW – Bowers Basin
CHU – Chukchi Sea
COK – Cook Inlet
GAK – Gulf of Alaska
GEO – St. George Basin
HOP – Hope Basin
KOD – Kodiak
MAT – St. Matthew-Hall
NAL – North Aleutian Basin
NAV – Navarin Basin
NOR – Norton Basin
OUT – Outside Planning Areas
SHU – Shumagin
6. Protraction ID: A list of regional location designations, located within Planning Areas. Text and numeric field broken out into a picklist.
7. Protraction Name: Some protractions have a Name (text) attributed to it as well. This information is included within the Protraction Name column.

8. Lease Block: Block number within a Protraction, within a designated Planning Area. Text and numeric field broken out into a picklist.
9. Coordinate System: Record of the coordinate system used for entry, along with units used.
10. X: Shapefile X coordinate. Number field.
11. Y: Shapefile Y coordinate. Number field.
12. Original Coordinate System: Record of the coordinate system originally used for entry, along with units used.
13. Original (X): Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
14. Original (Y): Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
15. Loss Depth (m): Depth of water at site of sunken vessel or object when the reported depth is confirmed or considered reliable, in meters. Numeric field.
16. Lost Location: Text field that provides short description of where vessel was lost.
17. Location Reliability: Reliability of available information on the reported location of loss, rated 1 – 5. Rating system is here:
1. Wreck location is confirmed through physical verification and has been accurately positioned (e.g., with GPS or on an accurate, modern map) or is identified on the basis of accurately positioned remote sensing survey. The location is considered to be very reliable such that a wreck would be easy to relocate using standard DGPS equipment.
 2. A specific location is provided for a wreck or a vessel loss by an informant, reported in the literature or on a map. Included in this category are wrecks or losses whose position is given to at least the nearest actual minute of latitude and longitude, to a specific offshore lease block, and those that have been discovered and positioned using LORAN equipment. The location reliability of these wrecks or losses is considered to be moderate to good. It is anticipated that these wrecks could be discovered, but discovery would require a moderate amount of field survey with remote sensing equipment, plus it may require additional historical

research.

3. A general location for a wreck or a vessel loss is provided by an informant or in the literature. Included in this category are vessels whose locations of loss are given only in degrees of latitude and longitude. Also included in this category are vessels whose general position of loss is provided in relation to a known landmark, such as "10 miles south, southeast of Ship Island." The location reliability of these wrecks or losses is considered to be fair to poor. Discovery of wrecks included in this category could be very difficult and commonly would require a considerable amount of historical research and/or remote sensing survey.
4. Unreliable or vague location information is provided on a wreck or place of loss of a vessel. Examples would include many early accounts of vessel losses such as reports of vessels lost in hurricanes, "near latitude such and such" or other general indications of loss, such as, "15 miles south of Ketchikan," "off Shumagin Island," "near Simeonof Island," or "Near Helm Bay, between Caamano Point and Point Francis." Directed searches for these vessels are nearly impossible and their discovery will mainly be by chance. Also included in this reliability category are items that were reported to be "adrift" when there is no evidence to indicate where, or if, they sank as well as those cases where information is unavailable to make any assessment of the reliability of the position given.
5. Insufficient data to make a determination about approximate location for loss of vessel. This could include even more vague information, such as, "off coast of Alaska," which does not assist in locating any potential remains. There may not be enough data available in order to identify a more process location.

18. Loss Type:

This is a two-letter code for the documented cause of loss. The entries are:

AB – Abandoned	GF – Gunfire/Battle
BE – Beached	ICE – Ice
BU – Burned	OTH – Other
CA – Capsized	SC – Scuttled
CO – Collided	ST – Stranded and Swamped
EX – Explosion	SU – Sunk
FO – Foundered	UN – Unknown

19. Loss Type Other:

This provides for a narrative, text, description of a vessel's loss, such as if it is designated as, "OTH – Other."

20. Nationality: Three-letter code for the flag under which vessel was operating when lost, if known. Three-letter codes are:

BRI – Britain/England

CAN – Canada

GER – Germany

NOR – Norway

JAP – Japan

PAN – Panama

RUS – Russia/Soviet Union

USA – United States of America

OTH – Other

21. Vessel Use: Text field that provides short description of intended use of vessel/aircraft. Included as options are: CIV - Civilian/Commuter, COM - Commercial, or MIL – Military, or OTH – Other.

22. Vessel Type: Two or three-letter code of the vessel type, object associated with a vessel, or an aircraft as given on the historical records, or obtained from archaeological data. If type is unknown or unreported, "UNK" is entered. Designations are:

ANC - Anchor/Chain

BAR - Barque

BGE - Barge

BNK - Barkentine

BRI - Brigantine

BRG - Brig

BYT - Buoy Tender

CCR - Cabin Cruiser

CLP - Clipper

CRB - Crane Barge

CRW - Crew Boat

CUT - Cutter

DES - Destroyer Escort

DIR - Drilling Rig/Ship

DRE - Dredge

DST - Destroyer

DVT - Dive Tender

EXP - Exploration Vessel

F/V - Fishing Vessel

FER - Ferry Boat

FRT - Freighter

GBT - Gunboat

GLN - Galleon

H/B - Hopper Barge

ICE - Icebreaker

JUB - Jack-up Barge

LDC - Landing Craft

LNS - Landing Ship

LST - Landing Ship, Tanks

LUG - Lugger

M/V - Motor Vessel

OTH - Other

P/C - Pleasure Craft

PAS - Passenger Steamer	SKI - Skiff	TRA - Trawler
PAT - Patrol Boat	SLP - Sloop	TUG - Tug Boat
PDL - Paddlewheel Boat	SPV - Supply Vessel	WHA - Whaling Ship
PIL - Pilot Boat	ST - Steamer/steamboat	WHB - Whaling Bark
SAI - Sailboat	STW - Sternwheeler	YCT - Yacht
SB - Schooner/Barge	SUB - Submarine	UNK – Unknown
SCH - Schooner	T/B - Tug or Tow Boat	
SDW - Sidewheeler	TNK - Tanker	
SHM - Shrimp Trawler	TOW - Tow Boat	
SHP - Ship	TPB - Torpedo Boat	

23. Vessel Type Other: This provides for a narrative, text, description of a vessel, such as if it is designated as “OTH – Other.”
24. Year Built: Integer field, YYYY, for the year the vessel was built. If the year built is unknown "0" is entered.
25. Manufacturer: Text field for name of person or firm who built hull, if known.
26. Owner: Name of person or firm who owned vessel when lost, if known.
27. Length: Measured length of vessel to 10th of a foot, if known. Object lengths are provided, if known. Number field with 2 decimal places.
28. Beam Width (ft): Measured width (beam) of vessel to 10th of a foot, if known. Object widths are provided, if known. Number field with 2 decimal places.
29. Hold Depth (ft): Measured depth of hold of vessel to 10th of a foot, if known. Number field with 2 decimal places.
30. Gross Tonnage: Total or gross tonnage (burden), if known; to the nearest ton.
31. Net Tonnage: Net tonnage (burden), if known; to the nearest ton.
32. Hull Material: General description of the material that the hull of the vessel was built, as reported in source of information. Two-letter codes are:

AL – Aluminum
CM – Composite (iron/steel hull, some wood framing)
CN – Concrete
DH – Double hull
FG – Fiberglass
IR – Iron
MT – Metal
Plastic – MSIS Legacy
RS – Rivetted steel
ST – Steel
WD – Wood
UN – Unknown

33. Propulsion: Two-letter code for the propulsion system as given in the source for the record. If no information on propulsion is provided, "Unknown" (UN) is entered. Two-letter codes are:

DS – Diesel Screw
GA – Gas
GS – Gasoline Screw
OR – Oar
OS – Oil Screw
SA – Sail
SM – Steam
SS – Steam Screw
ST – Steam Sternwheeler
SW – Steam Sidewheeler
TW – Towed
UN – Unknown

34. Engine Type: Three-letter code for type of main engine(s), if known. "UNK" is entered if engine type is unknown. Three-letter codes are:

DEI – Diesel Engine
GAS – Gasoline Engine
STH – High Pressure Steam Engine
STL – Low Pressure Steam Engine
STM – Steam Engine
TUR – Turbine
UNK – Unknown

35. Engine Other: Text description to describe, if known, the type of boilers, number of boilers, number of cylinders, number of propellers, and horsepower (HP) of main engine(s).

36. Vessel Value: Value of vessel when lost, in denomination provided in historical records, if known. Leave blank if unknown. Text field, short description.

37. Vessel Value Loss: Total loss of vessel, partial recovery, or other, if known. Leave blank if unknown. Text field, short description.

38. Vessel Other: Text/narrative location for providing additional vessel details

(for example, previous vessel names, multiple owners, etc.).

39. Loss Year: Date field of Year in which vessel was lost, if known, as YYYY. If the year built is unknown "0000" is entered.
40. Loss Month: Date field of Month in which vessel was lost, if known, as MM. If the month lost is unknown "00" is entered.
41. Loss Date: Date field of combined info from Year, Month, and Day of Loss. Formula field, MM/DD/YYYY.
42. Loss Date Specificity: Text field that allows for a narrative description as to the accuracy of the date in which the vessel was lost.
43. Origination: Text field, for a short description of where the vessel originated on final voyage. Could be home port, if known, as well.
44. Destination: Text field, for the destination of the vessel on final voyage, if known.
45. Number of Crew: Number of crew onboard the vessel, if known. Leave blank if unknown. Numeric/integer field.
46. Number of Passengers: Number of passengers onboard the vessel, if known. Leave blank if unknown. Numeric/integer field.
47. Number Human Losses: Total number of casualties lost as a result of vessel loss, if known. Leave blank if unknown. Numeric/integer field.
48. Cargo Weight: Cargo weight, if known. Leave blank if unknown. Text field, short description.
49. Cargo Type: Cargo type, if known. Leave blank if unknown. Text field, short description.
50. Cargo Value: Value of cargo when lost, in denomination provided in historical records, if known. Leave blank if unknown. Text field, short description.
51. Cargo Loss: Contents/amount of cargo lost, if known. Leave blank if unknown. Text field, short description.
52. Salvage Code: Yes, No, Partial, or "UN" – unknown.
53. Salvage Comments: Narrative, text field, that allows for a short description to provide context to salvage code.
54. Other Research: Text/Narrative field for additional notes, locations of other information, supplemental research, etc.

55. Sources: Text/Narrative field, short description that includes the principal source(s) of information for the record, most specifically the source that provided information on the location of the vessel or object.
56. Public Outreach Potential: Yes or No option (picklist) If there is enough information available, or, if there is an important narrative credited to the vessel, either historically or culturally, this attribute allows for searchable option to locate specific vessels for public outreach opportunities.
57. Entry Creator: Narrative field for initials or name of database entry person.
58. Entry Date: Date Field, if known, of entry date MM/DD/YYYY.
59. Updater: Narrative field for initials or name of database update person.
60. Update Date: Date Field, of entry update date, MM/DD/YYYY.

Appendix C: BOEM Alaska Downed Aircraft Database Definitions

ALASKA DOWNED AIRCRAFT DATABASE

DATAFIELD DEFINITIONS

1. AHRS ID: ID of aircraft as referenced within the Alaska Heritage Resources Survey (AHRS) database. Cross-reference ID.
2. Registration ID: ID of aircraft; Text field, short description: BuNo/(serial number for aircraft assigned by the Navy Bureau of Aeronautics)/Serial/Registration Number used to identify the aircraft. In some instances, this might be a descriptive name, such as "glider," or "bush plane," or simply, "plane." If no name or descriptors are available for an entry, the terms "Unknown aircraft" or "Unknown object" are used.
3. Planning Area ID: A list of the 3 letter codes for the regional location designations. The entries are:

ALA
ALB
BFT
BOW
CHU
COK
GEO
HOP
KOD
MAT
NAL
NAV
NOR
SHU
4. Planning Area Name: A list of the regional location designations with their 3 letter ID in parentheses. The entries are:

Aleutian Arc (ALA)
Aleutian Basin (ALB)
Beaufort Sea (BFT)
Bowers Basin (BOW)
Chukchi Sea (CHU)
Cook Inlet (COK)
St. George Basin (GEO)
Hope Basin (HOP)
Kodiak (KOD)
St. Matthew-Hall (KOD)

North Aleutian Basin (NAL)
Navarin Basin (NAV)
Norton Basin (NOR)
Shumagin (SHU)

5. Protraction ID: A list of regional location designations, located within Planning Areas. Text and numeric field.
6. Protraction Name: Some protractions have a Name (text) attributed to it as well. This information is included within the Protraction Name column.
7. Lease Block: Block number within a Protraction, within a designated Planning Area. Text and numeric field broken out into a picklist.
8. Coordinate System: Record of the coordinate system used for entry, along with units used.
9. X: Shapefile X coordinate. Number field.
10. Y: Shapefile Y coordinate. Number field.
11. Original Coordinate System: Record of the coordinate system originally used for entry, along with units used.
12. Original X: Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
13. Original Y: Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
14. Depth (m): Depth of water at site of sunken aircraft or object when the reported depth is confirmed or considered reliable, in meters. Numeric field.
15. Airframe: Picklist field that provides short description of intended use of aircraft. Included as options:
 - AIR - Airplane
 - GL - Glider
 - HEL - Helicopter
 - OTH - Other
 - UN - Unknown
16. Aircraft Use: Picklist field that provides short description of intended use of

- aircraft. Included as options: Military, Commercial, or Civilian/Commuter.
17. Manufacturer: Text field for name of person or firm who built aircraft, if known.
18. Model: This provides for a narrative, text, description of an aircraft's model/design.
19. Loss Year: Date field of Year in which aircraft was lost, if known, as YYYY. If the year lost is unknown "0000" is entered.
20. Loss Month: Date field of Month in which aircraft was lost, if known, as MM. If the month lost is unknown "00" is entered.
21. Loss Day: Date field of Day in which aircraft was lost, if known, as DD. If the day lost is unknown "00" is entered.
22. Loss Date: Date field of combined info from Year, Month, and Day of Loss. Formula field, YYYYMMDD.
23. Date Specificity: Text field that allows for a narrative description as to the accuracy of the date in which the aircraft was lost.
24. Loss Location: Text field that provides short description of where aircraft was lost.
25. Location Reliability: Reliability of available information on the reported location of loss, rated 1 – 5. Rating system is here:
1. Wreck location is confirmed through physical verification and has been accurately positioned (e.g., with GPS or on an accurate, modern map) or is identified on the basis of accurately positioned remote sensing survey. The location is considered to be very reliable such that a wreck would be easy to relocate using standard DGPS equipment.
 2. A specific location is provided for a wreck or an aircraft loss by an informant, reported in the literature or on a map. Included in this category are wrecks or losses whose position is given to at least the nearest actual minute of latitude and longitude, to a specific offshore lease block, and those that have been discovered and positioned using LORAN equipment. The location reliability of these wrecks or losses is considered to be moderate to good. It is anticipated that these wrecks could be discovered, but discovery would require a moderate amount of field survey with remote sensing equipment, plus it may require additional historical research.
 3. A general location for a wreck or an aircraft loss is provided by an informant or in the literature. Included in this category are aircrafts whose locations of loss are given only in degrees of latitude and longitude. Also included in this category are aircrafts whose general position of loss is provided in relation to a known landmark, such as "10

miles south, southeast of Ship Island." The location reliability of these wrecks or losses is considered to be fair to poor. Discovery of wrecks included in this category could be very difficult and commonly would require a considerable amount of historical research and/or remote sensing survey.

4. Unreliable or vague location information is provided on a wreck or place of loss of an aircraft. Examples would include many early accounts of aircrafts lost due to weather "near latitude such and such" or other general indications of loss, such as, "15 miles south of Ketchikan," "off Shumagin Island," "near Simeonof Island," or "Near Helm Bay, between Caamano Point and Point Francis." Directed searches for these aircraft are nearly impossible and their discovery will mainly be by chance. Also included in this reliability category are items that were reported to be "adrift" when there is no evidence to indicate where, or if, they sank as well as those cases where information is unavailable to make any assessment of the reliability of the position given.
5. Insufficient data to make determination about approximate location for loss of aircraft. This could include even more vague information, such as, "off coast of Alaska," which does not assist in locating any potential remains. There may not be enough data available in order to identify a more process location.

26. Loss Type: This is a two-letter code for the documented cause of loss. The entries are:

AB – Abandoned	MF – Mechanical Failure
BU – Burned	OTH – Other
CO – Collided	WEA – Weather Related
EX – Explosion	UN – Unknown
GF – Gunfire/Battle	

27. Loss Type Other: This provides for a narrative, text, description if an aircraft's loss is designated as "OTH – Other."

28. Origination: Text field, for a short description of where the aircraft originated on final flight. Could be home airport, if known, as well.

29. Destination: Text field, for the destination of the aircraft on final flight, if known.

30. Year Built: Integer field, YYYY, for the year the aircraft was built. If the year built is unknown "0" is entered.

31. Owner: Name of person or firm who owned aircraft when lost, if known.

32. Length: Measured length of aircraft, nose to tail, to 10th of a foot, if known. Number field with 2 decimal places.

33. Wingspan: Measured width, wingspan, of aircraft to 10th of a foot, if known. It is measured in a straight line from wingtip to wingtip, regardless of wing shape or sweep. Number field with 2 decimal places.
34. Tail Height: Measured height, ground to top of tail with landing gear extended, to a 10th of a foot, if known. Number field with 2 decimal places.
35. Wheelbase: Measured distance between the center of the nose-wheel and the centerline of the main undercarriage of the aircraft, to a 10th of a foot, if known. Number field with 2 decimal places.
36. Physical Class: Two and three-lettered codes for the documented type of aircraft, based on propulsion method. The entries are as follows:
- | | | |
|------------------|-------------|--------------|
| GL – Glider | PI – Piston | OTH – Other |
| HEL – Helicopter | PR – Prop | ROT – Rotary |
| JET – Jet Engine | NA – None | UN – Unknown |
37. Physical Class Other: This provides for a narrative, text, description if an aircraft’s physical class is designated as “OTH – Other.”
38. Number of Engines: Text or numeric field identifying the number of engines of Aircraft, if known.
39. Engine Type: If identifying number(s) of engine is/are known, text or numeric field available to input engine ID.
40. Aircraft Nationality: Three-letter code for the flag under which aircraft was operating when lost, if known. Three-letter codes are:
- | |
|--------------------------------|
| BRI – Britain/England |
| CAN – Canada |
| JAP – Japan |
| RUS – Russia/Soviet Union |
| USA – United States of America |
| OTH – Other |
41. Salvage Code: Yes, No, or “UN – unknown”.
42. Loss Report Agency: If a report of the aircraft loss was created, which agency filed the report, if known. Two, three, or four-letter codes. The entries are as follows:

DoD – Department of Defense

FAA – Federal Aviation Administration

NTSB – National Transportation Safety Board

USCG – United States Coast Guard

OTH – Other

UN – Unknown

43. Loss Report ID: ID of report associated with aircraft loss. Numeric/integer field.
44. Number of Crew: Number of crew onboard the aircraft, if known. Leave blank if unknown. Numeric/integer field.
45. Number of Passengers: Number of passengers onboard aircraft, if known. Leave blank if unknown. Numeric/integer field.
46. Number of Humans Lost: Total number of casualties lost as a result of aircraft loss, if known. Leave blank if unknown. Numeric/integer field.
47. Aircraft Value: Value of aircraft when lost, in denomination provided in historical records, if known. Leave blank if unknown. Text field, short description.
48. Aircraft Value Loss: Total loss of aircraft, partial recovery, or other, if known. Leave blank if unknown. Text field, short description.
49. Cargo Weight: Cargo weight, if known. Leave blank if unknown. Text field, short description.
50. Cargo Type: Cargo type, if known. Leave blank if unknown. Text field, short description.
51. Cargo Value: Value of cargo when lost, in denomination provided in historical records, if known. Leave blank if unknown. Text field, short description.
52. Other Research: Text field available for additional information to be included about the aircraft that does not fit in another attribute column.
53. Sources: Text/Narrative field, short description that includes the principal source(s) of information for the record, most specifically the source that provided information on the location of the aircraft or object.
54. Public Outreach Potential: Yes or No option. If there is enough information available, or, if there is an important narrative credited to the aircraft, either historically or culturally, this attribute allows for searchable

option to locate specific aircraft for public outreach opportunities.

55. Entry Creator: Narrative field for initials or name of database entry person.

56. Entry Date: Date Field, if known, of entry date YYYYMMDD.

57. Updater: Narrative field for initials or name of database update person.

58. Update Date: Date Field, of entry update date, YYYYMMDD.

Appendix D: Anomalies Database Definitions

ALASKA ANOMALIES DATABASE

DATAFIELD DEFINITIONS

1. ID: Feature ID, a unique identifier to this database.
2. Source Survey Report Citation: Textual reference to the survey report in which the anomaly was located.
3. Unique Project ID: Text/Numeric identifier associated within survey or report.
4. Line Name: Text/Numeric identifier of survey line in which anomaly was located.
5. Year of Acquisition: Date field of Year in which anomaly was located, if known, as DD. If the day lost is unknown "00" is entered.
6. Month of Acquisition: Date field of Month in which anomaly was located, if known, as DD. If the day lost is unknown "00" is entered.
7. Day of Acquisition: Date field of Day in which anomaly was located, if known, as DD. If the day lost is unknown "00" is entered.
8. Date Auto Generated: Date field of combined info from Year, Month, and Day of Loss. Formula field, YYYYMMDD.
9. Planning Area: A list of the regional location designations.
 - ALA - Aleutian Arc
 - ALB - Aleutian Basin
 - BFT - Beaufort Sea
 - BOW - Bowers Basin
 - CHU - Chukchi Sea
 - COK - Cook Inlet
 - GEO - St. George Basin
 - HOP - Hope Basin
 - KOD - Kodiak
 - MAT - St. Matthew-Hall
 - NAL - North Aleutian Basin
 - NAV - Navarin Basin
 - NOR - Norton Basin
 - SHU - Shumagin
10. Protraction ID: A list of regional location designations, located within Planning Areas. Text and numeric field.
11. Protraction Name: Some protractions have a Name (text) attributed to it as well. This information is included within the Protraction Name column.

12. Lease Block: Block number within a Protraction within a designated Planning Area. This is a text and numeric field broken out into a picklist.
13. Coordinate System: Record of the coordinate system used for entry, along with units used.
14. X: Shapefile X coordinate. Number field.
15. Y: Shapefile Y coordinate. Number field.
16. Original Coordinate System: Record of the coordinate system originally used for entry, along with units used.
17. Original X: Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
18. Original Y: Prior to converting the NAD83, entry might have a different coordinate system. Input this here, using the same number field, with 6 decimals recorded in decimal degrees.
19. Sensor: Equipment used to capture anomaly. Current list includes, Side scan Sonar, Magnetometer, Sub-bottom Profiler, and Bathymetry.
20. Depth: Depth of anomaly, in meters. Numeric field.
21. Fish Height: Height of the sensor, or “fish,” in the water column during survey, in meters. Numeric field.
22. Water Depth: Depth of water at site of anomaly, in meters. Could be a range of numbers. Numeric field.
23. Length: Length of anomaly, in meters. Numeric field.
24. Height: Height of anomaly, in meters. Numeric field.
25. Width: Width of anomaly, in meters. Numeric field.
26. Depth Below Bottom: Sub-bottom profiler data, collected in meters. Numeric field.
27. Intensity: Magnetometer data, collected in nT. Numeric field.
28. Duration: Magnetometer data, collected in meters. Numeric field.
29. Signature: Magnetometer data, with a selection of “Monopole +”, “Monopole –”, “Monopole Unspecified”, “Dipole”, or “Complex.”
30. Description: Narrative field to allow for a description of the anomaly.
31. Corresponding Features: Narrative field to provide context to the surrounding survey area and the anomaly in question, such as correlating anomalies or targets.
32. Image Available: Text option for if an image is available of the anomaly information. “Yes” or “No” option in table.

33. Image Location: Narrative field for file or report where image is located.
34. Entry Creator: Narrative field for initials or name of database entry person.
35. Entry Date: Date Field, if known, of entry date YYYYMMDD.
36. Updater: Narrative field for initials or name of database update person.
37. Update Date: Date Field, of entry update date, YYYYMMDD.

Appendix E: Shipwreck Sources and Notes

SHIPWRECK SOURCES and NOTES

Information for shipwrecks in this table are based primarily on Treasury Department "Report of Casualty" records, Merchant Vessels of the US volumes, accounts from Lewis & Dryden's *Marine History of the Pacific Northwest*, H.W. McCurdy's *Marine History of the Pacific Northwest*, and B. D. Berman's *Encyclopedia of American Shipwrecks*. See bibliography for complete citations.

ADN = *Anchorage Daily News* (a newspaper)

ADT = *Anchorage Daily Times* (a newspaper)

AF = *Alaska Fisherman* (a journal)

AFA 1946 = Alaska Fisherman's Almanac, 1946

AFJ = *Alaska Fisherman's Journal* (a journal)

AHRS database = State of Alaska, Dept. of Natural Resources. 1985. Alaska Heritage Resources File and Location Maps. Office of History and Archaeology.

Air AK = *Alaska Air* (a journal)

AK Boating = *Alaska Boating* (a journal)

AM = AK Maritime

AK Bear = *Alaska Bear* (a journal)

AK Emp = DAE = *Daily Alaska Empire* (a newspaper)

AK Fish = *Alaska Fisherman* (a journal)

AK Fish News = *Alaska Fishing News* (a journal)

AK Herald = Alaska Herald (a newspaper)

AK Heritage = Newsletter of the Alaska Division of Parks & recreation, Office of History and Archaeology

AK Journal = *Alaska Journal* (a journal)

AK Life = *Alaska Life Magazine* (a journal)

AK Mag = *Alaska Magazine* (a journal)

AK Mar = AK Maritime

AK Maritime = Gibbs, J.A., Jr. 1997. *Alaska Maritime*. West Chester, PA: Schiffer Publishing.

AK Per List = Source list from the Alaska Periodical Index

AK Philatelist = *Alaska Philatelist* (a journal)

AK Sports = *Alaska Sportsman Magazine*

AK Sportsman = *Alaska Sportsman Magazine* (now *Alaska Magazine*)

AK Steam = McDonald, L.S. 1984. *Alaska Steam: A Pictorial History of The Alaska Steamship Company*. Anchorage, AK: Alaska Northwest Publishing Co., 144 pp.

AK Times = *Alaska Times* (a newspaper)

AK Week = *The Alaska Weekly* (a journal)

AK Weekly = *The Alaska Weekly* (a journal)

Alaskana = *Alaskana* (a journal)

Alaska Maritime = Gibbs, J.A., Jr. 1997. *Alaska Maritime*. West Chester, PA: Schiffer Publishing.

Alta California = *The Alta California* (a newspaper)

AM = AK Maritime

AMS I = Matthews, F. 1987. *American Merchant Ships, 1850-1900*. Series I. Dover.

AMS II = Matthews, F. 1987. *American Merchant Ships, 1850-1900*. Series II. Dover.

Andrews = Andrews, C.L. 1916. Marine Disasters of the Alaska Route. *The Washington Historical Quarterly* 7(1):21-37.

Andrews CR = Andrews

Andrews Cust. Rec. = Andrews

Andrews 1938 = Andrews, C.L. 1938. The Story of Alaska.

Anichtchenko and Rogers 2007 = Anichtchenko, E. and J. Rogers. 2007. Alaska's Submerged History: The Wreck of the Kad'yak (in Russian and English). Alaska Department of Natural Resources, Office of History and Archaeology. Funded by the U.S. National Park Service, Shared Beringian Heritage Program, Cooperative Agreement No. 98070500XX, Anchorage.

AT = Anchorage Times (a newspaper)

AWOSIS = NOAA Wrecks and Obstructions (AWOIS) =

=<http://www.nauticalcharts.noaa.gov/hsd/awois.html> Wrecks and Obstructions (AWOIS)

Appendix F: Geophysical Survey and Interpretation - Supplemental

Geophysical surveys submitted to BOEM in compliance with NTLs or other survey guidance are conducted to determine if potentially historically significant resources are present within a given area, and if so, if they may be adversely impacted by proposed activities on the OCS. The resulting survey reports can include definitive identifications of sunken vessels or downed aircraft, as well as unidentified targets and or anomalies that may represent potentially historically significant resources (Chapter 7). The following sections provide an overview of the instruments commonly used in marine archaeological cultural resources surveys, and the processes for interpreting targets of potential cultural significance.

F.1 Geophysical Survey Methods and Instruments

Locating cultural resources on or beneath the seabed may be costly and require extensive planning. There are occasional finds by fishers or dredgers, as referenced in earlier chapters, but these methods are unscientific, unexpected, and may harm the site as they are usually unintended contacts. A more systematic approach to locating sunken vessels, aircraft, and paleoenvironments that may contain potential precontact sites is through geophysical surveying, such as remote sensing. Using nondestructive methods, based on acoustics and magnetism, marine scientists can examine the seafloor and the regions beneath it for evidence or indications of potential archaeological sites.

A typical survey consists of a vessel set up with positioning equipment to know its exact location. This is based on a Differential Global Positioning System (DGPS), a system of satellites that circle the earth and emit timed radio signals to be acquired by ground-based receivers. The data transmitted to the receivers contain information that assists with positioning navigation and timing, all valuable information while conducting a survey at sea. Once accurate positioning is achieved, a successful survey can commence. Usually, a block of area is chosen for survey and the survey vessel will systematically traverse numerous parallel and perpendicular track lines that are evenly spaced for continuity of data acquisition over the examined location. Data are recorded and will be subsequently analyzed for indications of magnetic anomalies and acoustic contacts. At sea, where there are no observable landmarks, accurate positioning is a vital element for successful survey and, most importantly, to relocate a target or anomaly of interest for avoidance or further investigation.

The survey vessels can deploy an array of equipment that are integrated with the positioning system to assist in locating and positioning potential shipwrecks, aircraft, or submerged paleolandscapes. The two main methods to interrogate the seabed and below are magnetic and acoustic. The earth can be viewed as a giant magnet as it has a magnetic field with a north pole and south pole. Although the geographic poles are different from the magnetic poles, they mostly correlate and are useful in general direction finding over most of the globe. The earth's magnetic field is measurable by a magnetometer, with the basic unit used to measure magnetic fields being the nanoTesla or gamma (1 gamma is equivalent to 1 nanoTesla). The magnetic field is strongest at the poles and weaker at the equator, and this force changes slowly over time and space. Locally, however, the ambient magnetic force can be considered a relative constant for survey purposes or adjusted to a constant for long-term projects. Any radical departure from the ambient background is known as an anomaly. Magnetometers can detect magnetic anomalies produced by ferromagnetic sources that protrude above, are on, or are buried below the seabed.

There are many causes for anomalies such as large concentration of ferrous or other magnetically susceptible materials and electrical currents running through wires. There are two types of magnetism: permanent and induced. Permanent magnetism has to do with the specific properties of the object while made or being in a specific orientation to the earth's magnetic field for a prolonged period. Induced magnetism is the combined effect of the properties of the object and its shape and orientation within the

earth's magnetic field. A detected magnetic anomaly is the sum of both induced and permanent magnetization (Breiner n.d.). Shipwrecks and aircraft contain many iron components that create their specific magnetic signature.

When a magnetometer enters the magnetic field created by ferromagnetic components, the sensor will record their presence as an interruption in the ambient, or surrounding, magnetic field. Upon analysis, an experienced marine geophysicist or archaeologist should be able to detect these anomalies within the recorded stream of magnetic data. However, most anomalies do not represent significant cultural materials. The size and signature of the anomaly must be taken into consideration. The size of the anomaly is known as its amplitude, its deflection in nanotesla/gamma from background in a positive or negative direction. The signature of the anomaly is based on how it is represented in the streaming record. If an anomaly has a single deflection to either the positive or negative it is called a monopole. If the deflection has both a positive and negative deflection it is called a dipole. If the anomaly has multiple deflections, say one negative and two positives, it is a complex anomaly. Finally, the length or duration of the anomaly in feet or meters is also a component that must be considered.

The individual characteristics of an anomaly are important, but only in the context of their spatial location and patterning. For example, a short duration, low amplitude anomaly located on only one of several adjacent and closely spaced survey transects is not representative of a shipwreck site. However, multiple anomalies in proximity of each other and clustered across multiple parallel survey transects are more likely to represent cultural material of potential significance. The sea is littered with refuse of human origin, much of it containing ferrous materials. To increase the chances of locating an anomaly signature that may represent a target of interest, a systematic approach needs to be taken. Due to the physics of magnetism, the amplitude of a magnetic source decreases at a much greater rate than compared to the distance (either horizontal or vertical). "In other words, for a discrete object, as the distance between sensor and object is doubled, the anomaly decreases by a factor of 8 (Breiner n.d.:8)." Therefore, a single magnetic anomaly on a single survey transect is not considered significant.

Magnetometers and the known physics of magnetism are valuable tools in locating historic cultural resources like shipwrecks and downed aircraft. There are several methods that have been developed to analyze the data to assist in discriminating Historic resources from other sources, including but not limited to modern debris, marine infrastructure, local geologic variability, or even the effects of heave or cavitation on the tow cable.

The other primary tool used to locate shipwrecks is based on another physical phenomenon that has constant and repeatable properties, which is sound. Acoustic equipment used during survey may include the single beam echo sounder (SBES), multibeam echo sounder (MBES), side-scan sonar (SS), and sub-bottom profiler (SBP).

Using the known properties of water and sound, each piece of acoustic equipment has its own application based on the frequency and energy of sound. Sound has an average speed through seawater of approximately 1,500 m (4,921 ft) per second (in two-way travel time). There are variables that change this such as temperature, pressure, and salinity, but these can be factored in when exact measurements are acquired during survey operations. Various sound frequencies have different properties in water. Those of a higher range, for example 400–900 or higher kilohertz (kHz), have exceptionally good resolution but are not as effective at distance, while lower frequencies such as 4–40 kHz have good penetration but lower resolutions. Although using the same basic mechanical properties of sound, each piece of acoustic equipment, using variable frequencies and power settings, has certain advantages and disadvantages for their intended applications.

The singlebeam echosounder (SBES) is also known as a depth sounder or a fathometer. They are used to determine the depth of a body of water based on the physical characteristics of sound traveling to the

seabed and returning to the source, or transducer. A SBES works by focusing a thin cone of sound through the water column directly towards the seafloor. Some of the energy may be lost due to matter (turbidity) in the water column but most of it hits the seafloor and is reflected back as an echo to its source, where some of the energy makes contact. Therefore, it is a straightforward process to time the speed at which a sound signal is emitted and returned to the transducer. If an emitted signal takes one second to return, down and then up, it is known that the water is approximately 1,500 m (4,921 ft) deep. Data collected come from beneath the boat and represent only a small fraction of the seabed in a survey area. Although good for determining depth, SBESs are limited in the broader search for sunken materials as they collect a single thin swath of data.

The multibeam echosounder (MBES) works on the same basic principles as the SBES but is a much more expensive and complex tool to determine the depth of a body of water. As the name implies, it emits multiple beams of sound in a fan shape toward the seabed which then return and are calculated. The result is a much wider swath of covered seabed. Due to the multiple beams being emitted and returned, the complexity of the system is much greater than that of the SBES, which also increases expense and calls for elevated technical sophistication in both application and processing. However, the data collected paint a much broader and more detailed representation of the seabed's surface. In many cases, the entire seabed in a survey area can be represented as a point cloud of returned signals. Shipwrecks, aircraft, and geologic features can be distinguished via this method if they are prominent on the seafloor.

Side-scan sonar units are used to examine swaths of the seabed. There are applications for both low and high-frequency sonar surveys. Sound energy is emitted from the transducer in two fan-shaped beams at oblique angles to and along the seabed. The reflected sound energy returns to the transducers at different times from different distances as the vessel runs along a survey transect. This creates a continuous acoustic image of the seabed across both channels. Two forms of information are returned. As the seabed may not be uniform, comprised of relatively harder and softer components, the amount of energy absorbed by the seabed and reflected back can be determined. Materials such as sands, gravels and oyster shells produce a different return than soft sediments and silts. This information can be used to characterize the seabed. Additionally, due to the angle of the sound encountering the seabed, any material protruding from it or a depression in the seabed will have a hard return and leave an acoustic shadow, an area behind the reflection where no sound energy accessed. It is similar to shining a flashlight on an object in a dark room and seeing a shadow on a wall where no light penetrated. Shipwrecks create an interpretable image based either on their different density against the surrounding seabed, if sitting on the seabed, or their shadowing, if projecting above, the seabed. Keys to finding disarticulated shipwreck sites are linearity, shape, and association of multiple contacts.

SBPs are used to examine below the seafloor. Like SBESs they transmit their sound energy directly through the water column to the seafloor. Unlike SBESs they use much lower frequencies, in some cases as low as 50Hz, that not only encounter and reflect the seabed, but penetrate below it and reflect off sub-seabed materials. These layered materials, such as sand, gravel, and bedrock, have different densities that can be distinguished in the data record. The depth of penetration is based on the frequency and power, the lower power and higher frequency for shallow penetration and high power and low frequency for deep penetration. The data are useful in determining geologic features such as drowned river valleys or embayments, that may have a gravel bottom that were subsequently covered by sediments. Other ecologically distinct microenvironments like layers of peat or organics beneath sands and sediments can also be determined. This information is useful in creating paleolandscape interpretations that may indicate the higher likelihood of potential ancient habitation sites. Although not used for shipwreck surveys, SBPs can be used to localize known or suspected buried shipwrecks.

F.2 Data Processing, Analysis, and Interpretation

The tools to remotely examine the seabed for archaeological resources are based on two fundamental physical properties: magnetism and sound. Instruments to measure these phenomena have been developed and deployed for archaeological surveys successfully for decades. Conditions at sea may add some factors that make projects more difficult to accomplish due to physical variables of geology or marine conditions. High levels of ferrous materials in the underlying geology may interfere with the magnetometer or high turbidity or wave conditions might interfere with marine acoustics. These conditions can be recorded and accounted for during the survey. Data processing and interpretation of field data represent another aspect of the total process, and knowing the variables encountered during data collection can assist in these activities.

Interpreting data from a survey area in an archaeological context relative to remote sensing analysis depends on the evaluation criteria. There are few baseline numbers or qualitative assessments to be referred to or consulted. Experience and in some respects professional judgement are required to make a subjective evaluation based upon the variables pertaining to the conditions worked in. The only way to know the source of every magnetic anomaly or side-scan image is to conduct an examination either by an archaeological diver or remotely operated vehicle. "Hands-on inspection of every buried anomaly source may not be an economic possibility, so researchers must trust their interpretive abilities" (Gearhart 2011a). However, some interpretations are easier than others.

The interpretation of acoustic data is straightforward. In the case of SBESs, a number unit, be it in feet or meters, is generated for each ping of the seabed representing the distance between the transducer and bottom. These data can be represented in table form or graphically; by interpolating between points a contour map may be created. MBESs make this process a bit more complex due to the multiple beams of simultaneous data being sent and returned. However, processing software easily accomplishes the process of plotting the datapoints to again create a contour map or rendering from the data cloud of the seabed. Side-scan sonar creates an acoustic image that is comparable to a photograph but that uses sound rather than light. Finally, the SBP creates a trace that indicates multiple reflectors of the seabed and materials below it exhibited in profile view. Thus, sound is turned into a visual record that can be interpreted for subsurface geologic features based on variable reflectivity of sub-seabed materials.

Analysis and interpretation of magnetic anomalies is both simple and difficult. The data collected are basically the same as SBES data, three streams of numbers representing an X and Y position and a value for either depth (SBES) or magnetic deviation (magnetometer). Looking for an unexploded ordinance (UXO), for example, or other discrete targets is different than looking for oil, gas, and mineral deposits, which again is different than looking for shipwrecks or downed aircraft. Therefore, the target type that motivated a survey will influence the interpretive method best suited for the application. That said, the same data collected during a single survey may be used for multiple purposes.

The analysis and interpretation of remote sensing data are a process that is not 100 percent accurate in identifying an anomaly as a specific object, be it UXO, marine debris, or historic resource. Therefore, a rational method has to be used to discriminate the likelihood that a magnetic anomaly represents a potentially significant cultural resource. Applying the physics of magnetometry, several authors have attempted to quantify the variables of verified shipwreck sites; these variables serve as guidelines for interpretation and are not absolutes.

Magnetic amplitude, signature, and duration have been used in early attempts to create spatial distribution models and more recently contoured anomaly orientation has become a model for locating shipwrecks. Effective analysis of magnetic remote sensing data depends on quality data collection, knowledge of the environment from which the data are collected, and experience with examining anomaly sources. Through the years, several authors have created models to aid in interpreting magnetometer data. Garrison

et al. (1989) created an early model based on selected shipwrecks in the Northern Gulf of Mexico. The authors suggest that “a shipwreck as an archaeomagnetic feature can be defined as a cluster of multiple anomalies within an area of 50,000 sq m or less” (Garrison et al. 1989: Vol II, 222). They further state that “isolated anomalies over a large spatial area with little or no expression on adjacent survey lines of reasonable width will, in most instances, be marine debris” (Garrison et al. 1989: Vol II, 222). The authors do warn that both statements are generalizations and cite the magnetic signature of a coil of cable, modern debris, as mimicking their expected pattern for a historic shipwreck. The authors conclude by providing some criteria for characterizing historic shipwrecks from magnetometer data. These include multiple peak anomalies, varying amplitudes, areal distribution of anomalies over greater than 10,000 square meters, axial or linear orientation of anomalies, and long durations (Garrison et al. 1989: Vol II, 223).

Pearson et al. (1991) developed a model to help predict the potential presence of shipwrecks based on the observed characteristics of magnetic amplitude and duration of a known sample of shipwreck sites. A proposed lower magnetic amplitude limit for potential shipwreck sites was set at 50-gamma total magnetic deflection from background located on two or more adjacent and parallel survey tracklines. The duration of an anomaly was also considered, and a linear duration of greater than 24 m (80 ft) was posited. Later Linden and Person, “recognizing a considerable amount of variability,” have revised Pearson’s initial quantitative measurements downward to eliminate targets with magnetic signatures of 50-gamma deflection and less than 20-m (65.6-ft) duration (Pearson 2010). In addition to these quantitative limits, Pearson with Hudson (1990) have argued for a qualitative assessment of remote sensing data. The environmental context in which an anomaly is located is a key factor in its analysis and interpretation. For example, a magnetic anomaly that has the signature of a shipwreck found in an active and regularly maintained (i.e., dredged) navigation channel may be more likely to represent marine debris. Quantitative and qualitative variables should be factored into any assessment.

Another model does not rely exclusively on a specific magnetic deflection or area of coverage but on the very essence of the earth’s magnetic field and the orientation characteristics of a recorded magnetic anomaly located on at least two adjacent transects. Recognizing that, “Only a tiny fraction of seafloor magnetic anomalies is associated with shipwrecks,” Gearhart (2011a:91) has created a model for identifying shipwreck sites based, in part, on the principles of magnetic orientation. Using 29 known shipwreck sites mostly from the Gulf of Mexico region comprising a varied selection of vessel types exhibiting a wide range of horizontal dimensions and magnetic amplitudes, the basis of other magnetic interpretive models, Gearhart highlights the orientation of the represented anomaly itself, an overall dipole configuration. A unique magnetic characteristic shared by the contoured data from confirmed shipwrecks in the sample is the magnetic orientation of the anomaly, where the negative component of a dipolar anomaly unfailingly resides to the geographic north. Thus, a dipolar anomaly with a positive gamma deflection to the north is not consistent with known shipwreck sites and therefore may not be considered a potential shipwreck. Gearhart later updated this model based on a larger sampling of 42 targets and continues to develop and refine this model as new data are acquired (Gearhart 2011b, 2016, 2019). This model is based on vessels from a limited geographic region and may not be applicable globally.



U.S. Department of the Interior (DOI)

DOI protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.



Bureau of Ocean Energy Management (BOEM)

BOEM's mission is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program

The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).