I. AOOS OVERALL APPROACH & PRIORITIES

Goals: The goals of the Alaska Ocean Observing System (AOOS), as identified through stakeholder engagement, adopted by the AOOS Board and reflected in this proposal, are to 1) increase access to existing coastal and ocean data; 2) package information and data in useful ways to meet the needs of stakeholders; and 3) increase observing and forecasting capacity in all regions of the state, with a priority on the Arctic and the northern Gulf of Alaska.

Background: Developing an integrated ocean observing system at high latitudes creates unique challenges. In addition to the harsh environment, the region encompassed by AOOS is made up of nearly 44,000 miles of coastline, larger than the marine systems in the rest of the United States combined. No other observing system in the United States has such climate extremes, significant geographic distances, and limited observing infrastructure. Although the population of Alaska is small (about 735,000), 80% of the residents live on the coast, including a large indigenous population that relies on the ocean for survival.

Approach: This proposal builds upon existing efforts, takes into account the challenges of providing real-time observations in Alaska, places a premium on access to and integration and synthesis of existing data and data sources, and relies extensively on collaborations. The proposal leverages funding with other programs and provides coordination and synthesis services to better integrate and add value to existing research and monitoring activities. It also draws upon the 2011 AOOS Preliminary Build-out Plan and the 2013 AOOS Arctic Build-out Plan as guidance, as well as the plethora of regional and national plans, especially those for the U.S. Arctic (see Appendix B).

Geographic approach: The Board has placed a priority on expanding observation capacity in the Arctic (Beaufort and Chukchi Seas) and in the northern portion of the Gulf of Alaska (GOA). The GOA includes Prince William Sound and Cook Inlet, two regions with high vessel traffic, including oil and gas tankers, large commercial fisheries critical to the state's economy and dynamic and complex circulation systems that border the main population centers of Alaska.

The Arctic as a national priority: One of the priority objectives in the National Ocean Policy (NOP) highlights changing conditions in the Arctic and specifically calls upon the nation to: "Address environmental stewardship needs in the Arctic Ocean and adjacent coastal areas in the face of climate-induced and other environmental changes." AOOS has used the NOP Implementation Plan, NOAA's Arctic Vision & Strategy, the U.S. Navy Arctic Roadmap, the U.S. Coast Guard and Arctic Strategy, the U.S. Arctic Research Commission Goals & Objectives, the Arctic Marine Shipping Assessment, the Alaska Arctic Policy Commission Report, and other recent documents in developing its Arctic monitoring activities to increase Alaska resiliency to climate change impacts. With local, regional and national needs in mind, AOOS also completed an Arctic Build-out Plan in 2013 to map out an approach to accomplish collective Arctic observing goals that increases the environmental intelligence and infrastructure needed for Arctic Marine Domain Awareness.

Approach to funding scenarios: Although the original proposal seeks $4 million a year over a five-year period, the activities described here in the most detail are for $2,771,480 in Year 1 $2,659,861 in Year 2, $4,450,245 in year 3, $4,516,512 in year 4, and a $4,581,372 for Year 5 ($4,656,372 with hold-backs).

Key focus areas: AOOS focuses its efforts on four major thematic areas: marine operations; coastal hazards and inundation; ecosystems, fisheries and climate trends; and water quality.

II. KEY FOCUS AREAS

A. Marine Operations

Goal: To improve safety of marine operations (including search and rescue and oil spill response), AOOS will focus on sustaining weather and sea state observations, more effectively disseminating weather

information to users, and developing related information and decision support tools for stakeholders, especially related to the emerging Arctic Marine Highway.

Audience and Benefits: Alaska's marine operations and stakeholders are diverse, ranging from oil tankers and container ships to ferries, commercial and charter fishing boats, recreation vessels and marine subsistence users. Weather conditions change quickly, are locally specific, and are not always captured by Alaska's limited coastal and marine weather stations. The state is home to a $6 billion fishing industry, offshore oil exploration in Cook Inlet and the Arctic, a Marine Highway System serving local and visitor traffic, and cruise ships carrying a million passengers per year. Ninety-five percent of Alaska's goods cross Cook Inlet, navigating through dynamic sea ice and extreme tidal and circulation variation, to arrive at the Port of Alaska. As Arctic sea ice retreats and the Northwest and Northern Route passages stay ice-free for longer periods, more vessels will pass through Alaskan waters, take shipments to international destinations or tour the Arctic for recreation. Representative stakeholders include commercial fishermen and recreational boaters, subsistence users, port and harbor managers, local citizen advisory groups and communities, regional research institutes, federal and state agencies and industrial interests including offshore oil and gas companies.

B. Coastal Hazards and Inundation

Goal: To improve the ability to forecast and plan for changing storm, sea ice and tsunami conditions and their impacts on coastal communities and habitats, AOOS will focus on increasing water level, wave and seismic-tsunami observations and related products for stakeholder decision-making and increased resilience.

Audience and Benefits: The impacts of climate change have become increasingly apparent in Alaska. As our nation's only Arctic state, Alaska is experiencing dramatic reductions in sea ice cover, increased storm surge, thawing coastal permafrost, and consequent coastal erosion and infrastructure damage. These conditions are endangering coastal communities, most of which are home to Alaska Natives. In a statewide assessment by the Government Accounting Office in 2003, flooding and erosion affects 184 out of 213 Native villages, 31 of which are considered in imminent danger. Many may require expensive engineering fixes or community relocation. Meanwhile, better forecasting for storm surge and inundation is needed to help local people prepare for dangerous storm events and increase their resilience to impacts. The need for wave buoys and water level sensors has been loudly voiced and documented in both state and national plans. Despite this, NOAA's National Data Buoy Center (NDBC) has struggled to maintain existing buoys in Alaska, and several key buoys are no longer operational. Stakeholders include coastal subsistence communities including the Yukon-Kuskokwim, Bering Strait, Northwest Arctic and North Slope regions, as well as oil and gas companies active in offshore drilling and exploration, agency managers, the U.S. Army Corps of Engineers, National Weather Service forecasters, shippers, fishermen, and the U.S. Coast Guard.

C. Ecosystems, Fisheries and Climate Trends

Goal: To understand marine climate variability and ecosystem change in the long term, as well as how local conditions affect ocean circulation and ecosystem productivity in the short term, AOOS will build upon and leverage existing programs to develop an integrated network of physical, chemical, biological and community-based ocean observations and a synthesized State of Alaska's Coasts and Oceans Report.

Audience and Benefits: Alaska's coastal waters support a rich and diverse ecosystem, home to one of the world's largest fisheries, as well as abundant populations of pelagic and migratory seabirds and protected marine mammals. Ecosystem change in Alaska has direct social and economic implications that are likely to be more profound with the advances of climate change. Representative stakeholders include the fishing industry (commercial and recreational), federal and state management entities, subsistence-based communities, and academic and agency researchers.

D. Water Quality

Goal: To understand and respond to current and future changes to Alaska's marine waters, AOOS will support monitoring of ocean acidification, harmful algal blooms and marine debris and explore opportunities for providing data products and decision-support tools for contaminants and watershed/ocean linkages.

Audience and Benefits: Ocean acidification (OA) has emerged as a potentially high impact issue in Alaska, with the relatively shallow shelf seas in the northern Gulf of Alaska, the Bering Sea, and the Chukchi Sea already experiencing seasonal OA manifestations. Given the productivity of the Alaskan marine environment, increased acidity could lead to significant ecosystem effects, with wide-reaching environmental and economic impacts. Warmer ocean temperatures have also increased the threat of harmful algal blooms (HABs) throughout Alaska waters, and even into the Bering and Chukchi Seas. There is also increasing concern over industrial activities affecting Alaska's freshwater and marine ecosystems, including potential mercury contamination of Alaska fish. In Southeast Alaska, neighboring Canadian mining activities have raised worries about the impacts of a mine-waste breach on transboundary waters that pass through Alaska. Representative stakeholders include the fishing industry, federal and state management entities, policy makers, emergency responders, academic and agency researchers, and residents.

III. REGIONAL GOVERNANCE & MANAGEMENT SUBSYSTEM

The Alaska Ocean Observing System (AOOS) is the regional association for Alaska as part of the national Integrated Ocean Observing System (IOOS). Within AOOS are three geographically, culturally and economically diverse regional coastal and ocean observing sub-systems (Gulf of Alaska, Bering Sea/Aleutian Islands and Arctic). AOOS began in July 2003 as a consortium of partners operating under a Memorandum of Agreement (adopted in 2005, and revised 2009, see www.aoos.org). AOOS was formally certified in 2017 as the Regional Association for Alaska. Activities described below will be conducted in Year 4.

- *Board:* AOOS is governed by a Board of Directors, currently made up of 19 federal and state agencies, research entities, and private sector organizations (see www.aoos.org for members). Once the membership reaches 25 or more members, the Board may choose to elect a subset of members to serve as directors. An Executive Committee, made up of the AOOS officers and a representative of the fiscal sponsor, acts on behalf of the AOOS Board between meetings.
- *Committees and Advisory Groups:* AOOS uses one standing committee and numerous ad hoc committees and working groups for guidance. The Data Management Advisory Committee (DMAC) is composed of technical experts, including both data users and providers, and provides technical advice to the AOOS Data Team and program staff. That committee was disbanded in May 2020, since its original purpose had concluded. Ad hoc advisory groups are topic or regionally specific and convened as needed.
- *Program staff:* AOOS currently employs three full-time staff: an Executive Director, a Director of Operations and Development, and a Director of Administration and Outreach. A fourth half-time staff member is the Director of Special Projects, including Director of the Alaska Ocean Acidification Network and co-facilitator of the Alaska Harmful Algal Bloom Network. AOOS contributed FY 2015 funds to support a full-time Alaska Sea Grant coastal resilience position and supported a full-time Alaska Sea Grant Fellow in 2018-19 using FY 17 funds. Staff members manage all program components, engage with stakeholders to identify program requirements, implement the observing system with contractors to meet stakeholder needs, work with the data team to develop products for

users, and collaborate with other regional, national and international ocean observing initiatives, including the national IOOS office and other IOOS Regional Associations.

- *Fiscal sponsor:* The Alaska SeaLife Center, an incorporated nonprofit, acts on behalf of AOOS as its fiscal sponsor, and performs all its legal, financial and administrative functions. The fiscal sponsor fee is based on the direct costs of those services.
- *Alaska regional partnerships and collaborations*. Numerous collaborative initiatives have begun in Alaska designed to inform or guide science or resource management issues, particularly in the face of climate change. These include the North Slope Science Initiative (NSSI), the Alaska Climate Change Executive Roundtable (ACCER), the Alaska Center for Climate Assessment and Policy Steering Team (ACCAP is the NOAA RISA for Alaska), Alaska Sea Grant and its advisory group, the Alaska Landscape Conservation Cooperatives, and NOAA's regional collaboration team. AOOS will continue to be an active participant in all these initiatives.
- *Process for identifying user needs.* Due to the vast geographic size with limited transportation corridors, and the diversity of coastal and marine issues in the state, the AOOS board determined it would be more effective to use existing communication pathways and forums (advisory committees, professional organizations, conferences and workshops), as well as specific stakeholder engagement events, to provide input to AOOS rather than maintain a standing "stakeholder committee". These activities are summarized in Section IV below and described in more detail in Appendix C.

IV. OUTREACH, STAKEHOLDER ENGAGEMENT & EDUCATION

Goal: Our goal is to increase awareness of ocean issues in Alaska and engage with stakeholders to identify and respond to their needs for ocean observations and information products.

Background: The AOOS Board has made stakeholder outreach, facilitation, coordination, and partnership building one of the cornerstones of the AOOS program, and the Executive Director and staff devotes significant time to these efforts. AOOS has a strong reputation in Alaska as one of the few multi-agency, multi-disciplinary organizations whose mission includes facilitating and coordinating marine-related efforts. More details can be found in Appendix C. All the activities described below will be conducted in Year 5.

Objectives and Approaches:

1. *AOOS website and publications.* AOOS uses its website as its primary outreach tool to feature ocean observing news and highlight data resources and new user products. The site archives all meeting documents and reports and connects users with the data tools developed by the AOOS data team. AOOS also maintains an active Facebook page, disseminating news and resources to a broad audience. Blogs are also used periodically as an outreach tool (the AOOS Blob Tracker for example). Hard copy documents continue to make up a central part of the outreach approach, including an AOOS primer, data tools brochures, newsletter, annual report, and topic-specific handouts that are widely circulated.

2. *Stakeholder interaction*. Stakeholder activities include hosting AOOS meetings on specific topics, providing demonstrations of the AOOS data portal to targeted user groups around the state, and circulating online surveys to get input on projects and observing gaps. AOOS receives consistent user feedback about the AOOS data portal through a feedback tab on the website, and systematically responds to the submitters, documents and reviews their recommendations, and implements the top priorities.

3. *Stakeholder working groups*. AOOS will continue to facilitate three working groups made up of scientific and technical experts and impacted stakeholders. These are: 1) a statewide Alaska Ocean Acidification Network coordinating research, monitoring and outreach; 2) the Alaska Water Level Watch, integrating water level observations and products; and 3) a statewide Alaska Harmful Algal Bloom Network. AOOS may respond to other needs as they develop.

4. *Education activities*. Now that COSEE Alaska has ended, AOOS will continue to partner with marine education and outreach entities such as the Sitka Science Center, Prince William Sound Science Center, Alaska SeaLife Center, Kachemak Bay National Estuarine Research Reserve, and the Kasitsna Bay Laboratory to promote virtual field trips, educator lesson plans and other activities.

5. *AOOS Short Film Contest*. AOOS held its annual Ocean Film Contest, from 2014-2017, to promote ocean issues and awareness of AOOS. The short films showcase a variety of captivating stories to hundreds of viewers in venues around the state, as well as through the AOOS website and Facebook page. Due to recent low response, we suspended the contest in 2017.

6. *Alaska Marine Policy Forum.* Co-hosted with Alaska Sea Grant, AOOS supports bi-monthly teleconferences with participants from across the state interested in marine funding, legislation and state and federal policy issues. Speakers include congressional and state staff, as well as other contributors discussing timely topics.

7. *IOOS Outreach Committee*. AOOS continues to serve on the volunteer IOOS Outreach Committee, which provides a forum for discussing effective outreach strategies and techniques, sharing products and coordinating efforts among the 11 RAs and the IOOS Program Office. AOOS works with other RAs to communicate its impact through shared success stories, training and shared experiences with social media and other tools.

8. IOOS Federal Advisory Committee. In Year 3 AOOS provided logistical support for the IOOS FAC during its August 2018 meeting in Juneau, Alaska. AOOS Executive Director Molly McCammon is now a formal member of the FAC.

V. OBSERVING SYSTEM SUBSYSTEM

A. Overall Approach

Given Alaska's immense geographic scope, remoteness and harsh environmental conditions, as well as the paucity of existing observations, AOOS is not able to create or sustain the ideal ocean observing system with its current resources. For that reason, the AOOS Board, based on stakeholder and local and scientific expert input, has chosen largely to augment existing observation programs, contribute to observing consortia and fill in key observation gaps with new assets until additional and sustainable funding becomes more readily available. In Years 3, 4 and 5 AOOS received additional funds provided by the national IOOS program to help "fill gaps." See Section X: Fill the Gaps Expenditures and the attached Fill the Gaps Descope Collection Table.

B. Marine Operations

1. *Sustain weather observations in the Gulf of Alaska (GOA)*. AOOS will continue its efforts to provide accurate, real-time weather observations in Prince William Sound and Cook Inlet. In partnership with the Oil Spill Recovery Institute, the Prince William Sound Science Center (PWSSC) and the Cook Inlet and Prince William Sound Regional Citizens Advisory Councils, AOOS will provide funding in Year 5 to the PWSSC to maintain eight SnoTel weather stations providing real-time web accessible data. Webcam images from these stations are accessed through the AOOS real-time sensor map by pilots, boaters, lodge owners, fishermen, and recreationists, and are one of the most popular resources on the AOOS website. The weather data are used in both real-time and for modeling and forecasting. *If additional funds from other sources become available in Year 5, more stations will be added, including potential sites at the Valdez Marine Terminal in Port Valdez and elsewhere in Prince William Sound.*

2. *Increase access to weather observations using AIS.* AOOS will continue its partnership with the Marine Exchange of Alaska (MXAK) in Year 5 to disseminate real-time weather data and forecasts to vessels using Automatic Identification System (AIS) transmitters. By establishing joint

weather/AIS stations at existing AIS locations, and installing new stations in remote areas, real-time weather information can be displayed on a vessel's AIS display in a more reliable and clear manner and at greater distances than the method in which weather information is presently disseminated (via VHF radio voice broadcasts). With most commercial vessels required to be equipped with AIS by the International Maritime Organization (IMO) treaties, AIS is one of the most reliable means of communicating weather and other environmental information (e.g., weather, ice reports) to vessels operating in coastal waters out to 50 miles offshore. When complete, the technological solutions will be shared with other IOOS members for nationwide application of this new capability. Overall, this will enhance maritime safety throughout all the IOOS regions. In Year 5, 3 new weather stations will be installed and 6 existing sites upgraded.

3. Support sea ice radar in Barrow. Using funds from Year 1, repairs were made to the radar which monitors near-shore ice conditions and evaluates the stability of landfast sea ice. Local subsistence hunters and analysts at the National Weather Service's Anchorage Ice Desk use the radar to assess ice conditions in the Utqiaġvik area. Commercial and civilian mariners also use the sea ice radar imagery and animations for navigational purposes during periods of the year when mobile sea ice poses a potential threat to their vessels. Funds in the next 5-year agreement will be used to support a suite of new ice radars funded by the US Army Corps of Engineers.

4. Support freeze-up detection buoy Ocean Technology Transition project. In year 2 funds were used to help with deployment and data management for testing delivery of data from the buoy to the NWS' GTS data delivery system. Due to covid-19 travel restrictions, the buoy will not be deployed in the coming year.

5. *Sustain critical wave buoys for navigation safety*. Continued funding in Year 5 will support operation and maintenance of the Coastal Data Information Program (CDIP) buoy in Cook Inlet, jointly sponsored by AOOS and the U.S. Army Corps of Engineers, a wave/current buoy outside the Port of Nome, and a CDIP buoy previously deployed by Department of Energy off Kodiak now on loan to AOOS, who will take over operation and maintenance responsibilities. We have suspended use of the wave buoy in Norton Sound/Bering Strait due to logistical problems. The three buoys provide essential real-time sea state conditions for recreational, commercial and subsistence mariners.

6. *Mapping surface currents with high frequency radars (HFRs).* Current funding in Year 5 funds the operation and maintenance by the University of Alaska Fairbanks of three HFR sites on the Chukchi and Beaufort Sea coasts (Wainwright, Point Barrow and Cape Simpson). These sites are operational during the open water season, July through mid-November, although the coast at Cape Simpson is seriously eroding and the site will likely need to change. Data are used to guide the development and evaluation of oil spill trajectory models, ocean research, and in real-time for operational applications. Additional Fill the Gaps funding in Years 3 and 4 is funding the planning, permitting, site work, equipment, and piloting of 3 new radars in the Bering Strait. Additional Fill the Gaps funding in Year 5 will support final deployment of the Bering Strait radars, as well as upgrading unused, short-range radars that would be made operational and available for emergency or temporary use in either Cook Inlet or Prince William Sound.

7. *Port of Alaska observations*. AOOS is initiating collaborations with port managers, barge and cargo companies and the Marine Exchange of Alaska to enhance observations at the Port of Alaska, which handles 95% of the consumer goods for 85% of Alaska and is one of 19 national strategic seaports for the U.S. Department of Defense. The port's expansion and modernization has the potential of modifying adjacent nearshore ocean conditions, increasing the need for more observations. No funds are available in Year 5 for this activity.

C. Coastal Hazards and Inundation

1. *Increase water level observations in western and northern Alaska*. Accurate water level observations are key for a number of purposes: 1) to operationally forecast in real-time for storm surge and coastal inundation warning systems; 2) to monitor seasonal changes in river mouth entrances used by tugs and barges delivering fuel and other cargo to Alaska's river-based villages; 3) to establish baseline sea level data for shoreline mapping and tracking sea level trends; and 4) to improve nearshore ocean models for coastal planning, infrastructure development (harbors, airports, etc.) and resource habitat management (e.g., waterfowl), as well as for research purposes. Permanent water level gauges north of the Aleutian Islands are operated at Nome on the Bering Sea, Red Dog at the Kivalina River on the southern Chukchi Sea, and Prudhoe Bay on the North Slope. A fourth gauge was installed in 2016 in Unalakleet, south of Nome in Norton Sound. These four sea level stations are responsible for providing coverage for almost half of Alaska's coastline. AOOS is partnering with the National Weather Service, NOAA's Center for Operational Oceanographic Products and Services (CO-OPS), Alaska Department of Natural Resources (ADNR), U.S. Army Corps of Engineers, Western and Arctic Landscape Conservation Cooperatives, U.S. Geological Survey (USGS), the University of Alaska Anchorage Arctic Domain Awareness Center (U.S. Department of Homeland Security), and others to develop and implement an Integrated Water Level Observing Network called the Alaska Water Level Watch. AOOS is helping coordinate the working group to help set priorities for various types of water level sensors. Based on the priorities established by this group and with National Weather Service and AOOS funding, AOOS will support ADNR, the University of Alaska Fairbanks and UNAVCO and ASTRA LLC to install sensors at village and coastal sites most vulnerable to inundation, flooding and erosion. In Year 2, additional funds were provided to AOOS by the National Weather Service to continue these activities. In Year 3, funds were provided to ADNR, UNAVCO and ASTRA to support these efforts. Funds from the Year 3 Fill the Gaps were used to pilot an Alaska Water Level Watch data portal for Tier B and C water level data. Additional one-time funds from the IOOS Program Office and CO-OPS continued development of this data portal in Year 4. Year 4 Fill the Gaps "Streamline Access to Observations" funds are being used to deploy an ASTRA GPS sensor at Utqiagvik and develop operational water level data algorithms for coastal UNAVCO sites. Year 4 and 5 funds also are being used to support a Notre Dame University project to enhance grid generation software to better represent the river-coastal grid interface. Year 5 FTG funds will be used to install a new water level station in Dillingham.

2. *Increase wave observations for water level forecasting and planning*. Wave observations provide real-time sea state conditions and also support water level forecasting and planning. Key gaps remain in implementing the IOOS National Operational Waves Observation Plan in Alaska. We worked with the Port of Nome and the MXAK to deploy a wave buoy outside Nome in Year 3, and in Year 4 AOOS took over operation and maintenance of a Department of Energy wave buoy off Kodiak. In Year 5, AOOS will continue to support these 3 wave buoys.

3. Pilot new program for coastal vessel traffic. Fill the Gaps "Streamline Access to Observations" funds in Year 4 and 5 are being used to to field test as a proof-of-concept the use of Hydroballs - a towed single beam bathymetric mapping system - using local community residents and vessels to collect nearshore hydrographic data to serve local barge traffic and improve inundation models. The unpredictable nature of river mouths increasingly interferes with vessel traffic due to natural variations in channels. Water level patterns are modified by long-term environmental factors, such as permafrost thaw, increased coastal erosion from higher frequency storms, and changes in precipitation. All these factors put shipping activities at increased risk of grounding and escalates the chances of oil/fuel spills.

4. *Crowd-source non-NOAA hydrographic (water depth) survey data to improve navigation safety.* The recent incident involving a vessel near Dutch Harbor, Alaska serves as a reminder that the Alaska coastal and shelf bathymetry data are insufficient in many locations for navigation and maritime safety. This has become a red flag issue for the state. AOOS has been exploring a collaboration with NOAA's Office of Coast Survey and Integrated Ocean and Coastal Mapping Program, the U.S. Coast Guard, Alaska state agencies and the maritime industry to facilitate the collection, aggregation, sharing and reuse of hydrographic survey data by non-NOAA partners. *No funds are available in Year 5 for this.*

5. *Support statewide geospatial mapping coordination.* In Year 5 multiple sources of funding received in prior years will continue to support a statewide mapping coordinator to facilitate implementation of a statewide coastal and ocean mapping plan and related activities.

6. *Support tsunami-related seismic observations.* In Year 5 funds will be used to support maintenance of seismic stations that provide data to the National Weather Service Tsunami Warning Center.

D. Ecosystems, Fisheries and Climate Trends

D. 1 Sustained Observation Network

The 2011 AOOS Preliminary 10-year Build-out Plan includes support for a long-term sustained observing network to track climate trends and support ecosystem-based management of fisheries and endangered and threatened species. The goal is to unite these observations – made with moorings, ship and glider transects, instrumented fish and marine mammals, passive acoustic sampling, community observers and other platforms - into a unified system. AOOS is partnering with management agencies, academic partners and the Distributed Biological Observatory (DBO) program to help maintain long time series data collection, develop consistent data collection protocols, synthesize new and existing data, and ensure that data are accessible and usable.

1. *Sustain ship-based sampling along the Seward Line*. AOOS will contribute in Year 5 to a consortium led by University of Alaska Fairbanks (UAF) to support two cruises a year along the Seward Line, the most comprehensive long-term multidisciplinary sampling program in the coastal Gulf of Alaska. This line has been sampled continuously since October 1997, with some measurements dating back to late 1970s. and is now integrated within the Gulf of Alaska Long Term Ecological Reserve (LTER). Observations over the past 20 years have fundamentally revised our understanding of the coastal Gulf of Alaska ecosystem, which is critical to Alaska's fisheries and subsistence and coastal community economies. In Year 5 with Fill the Gaps funds, glider surveys will be run to to improve spatial and temporal monitoring of this line and use for opportunistic ecosystem sampling during El Nino and La Nina events in the GOA. In addition, the AOOS gliders will be used in winter 2021 as a component of a collaborative project with NOAA Alaska Fisheries Science Center as part of the International Year of the Salmon.

2. *Support ecosystem moorings in Alaska's Large Marine Ecosystems*. AOOS is building a network of fully instrumented ecosystem moorings in the Chukchi, Beaufort and Bering Seas and the Gulf of Alaska to serve as year-round anchors for the Distributed Biological Observatory (DBO). AOOS began the ecosystem mooring program with a consortium led by UAF with the first mooring deployed in 2014 in the central Chukchi Sea offshore of Wainwright. This is a critical region for observing the through-flow of water between the northern Bering Sea and the interior Arctic, and a location of large primary productivity in an Arctic shelf sea. AOOS funding in Year 5 will continue the buildout of the Bering Sea moorings (M8 and M2, supported by NOAA's Pacific Marine Environmental Laboratory), as well as purchasing spare moorings and sensors to aid in annual turnaround and maintenance of the Chukchi and Gulf of Alaska moorings. AOOS funds are used for equipment purchases, with data analysis and operational costs covered by other partners. In Year 5 Fill the Gaps Funding will be used to purchase new or replacement sensors for

moorings used by other ecosystem programs, including NSF's Beaufort Sea Coastal Lagoon Long Term Ecological Reserve, the Arctic Marine Biological Observing Network, and the Distributed Biological Observatory.

3. *Pilot use of glider surveys to monitor ocean conditions and marine mammals and in support of commercial fisheries management.* AOOS will continue in Year 5 supporting the pilot implementation of a real-time marine mammal detection system deployed on a Slocum buoyancy-controlled glider currently operating in the northeastern Chukchi Sea. This pilot project is improving the capabilities of an AOOS-funded autonomous marine mammal detection and classification system (DMON/LFDCS), designed specifically for sub-Arctic and Arctic species. The pilot project is now in its seventh year with additional support from the North Pacific Research Board (NPRB), to allow for purchase of a backup glider, refinement of the call library, and support for some of the deployment costs. The glider will operate for up to 12 weeks in a biological hot spot in the Chukchi Sea. The data are documenting oceanographic conditions including temperature and salinity and positions of mixing fronts throughout the region while documenting underway acoustic signals from bowhead, fin, humpback, North Pacific right, beluga, and killer whales, as well as walrus and bearded seals. All these species could be impacted by increased human activities in the region, as well as by climate change. In addition, Fill the Gaps funding in Years 4 and 5 supported upgrading the existing UAF glider fleet to support additional glider s to support commercial fisheries in the Bering Sea and Gulf of Alaska.

4. *Support community based monitoring*. This project combines a key set of standardized geophysical and local expert-driven observations to improve the understanding of interannual to decadal-scale change in coastal ice conditions and their impact on human activities. The methodology for advancing these goals has already been developed with strong community engagement and development of a database. Data entry is web-based through a public access portal developed through the Exchange for Local Environmental Knowledge in the Arctic (ELOKA), a project funded by the National Science Foundation. *No AOOS funds are available in Year 5, but we are exploring additional opportunities for community-based monitoring, especially for Harmful Algal Blooms and ocean acidification.*

5. *Use of telemetered animals*. Animal telemetry data are currently being piloted for incorporation into the AOOS Ocean Data Explorer Portal, and telemetered animals equipped with sensors are increasingly being used to provide broader spatial coverage for ocean monitoring where other platform logistics are not feasible or are too expensive. In Year 2, AOOS hosted a regional ATN workshop, and in Years 3 and 4 AOOS supported the national Animal Telemetry Network Data Assembly Center. In Year 5 AOOS received a direct subaward (outside of IOOS) from the Office of Naval Research to operate the ATN DAC.

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D.2. Regional sentinel observations

The AOOS Build-out Plan includes supporting more intensive, shorter-term monitoring activities at key sites around the state, especially in regions with local scientific capacity. AOOS has already begun hosting collaborations among these entities to better coordinate and integrate such efforts. AOOS provides small amounts of funding to these local efforts, which are then leveraged by our partners to develop larger programs.

1. *Sentinel monitoring in Prince William Sound (PWS)*. AOOS seeks to meet short-term and long-term fisheries and ecosystem-based management needs by contracting with the PWS Science Center and partnering with the PWS Regional Citizens Advisory Council and the Oil Spill Recovery Institute, to maintain intensive sentinel monitoring in PWS as a Prince William Sound Observing System. Partners are seeking additional funding for glider transects, moorings and ship cruises, and additional sensors and equipment. Priorities for AOOS in Year 5 are to support:

a. *Weather stations*: AOOS will continue to fund the six SNOTEL stations deployed at sea level in PWS since 2005, and two stations at alpine elevations. Each station measures temperature, wind velocity, precipitation, and solar radiation, and includes a webcam. The main mission is to provide real-time weather observations, but also to provide information for hydrological and circulation models, as well as oil spill trajectory modeling.

b. *PWS Ocean Tracking Network*: AOOS will continue to support a partnership with Dalhousie University's Ocean Tracking Network to operate and maintain six acoustic arrays across the major entrances to PWS (Hinchinbrook Entrance, Montague Strait, and the four Southwest Passages). The array is used to document the movements and survival of marine animals and fish (salmon, sharks, and whales) carrying acoustic tags and how both are influenced by oceanographic conditions.

c. *Replace CTD on Cordova tide station:* AOOS previously supported installation of a CTD on the Cordova NWLON to provide real time temperature and salinity data at that location. Year 5 Fill the Gaps funding will be used to replace that instrument.

2. *Sentinel monitoring in Cook Inlet*. AOOS will continue to partner in Year 5 with NOAA/UAF's Kasitsna Bay Laboratory, Cook Inlet Regional Citizens Advisory Council, the Kachemak Bay NERR and the Gulf Watch Alaska long-term monitoring program funded by the *Exxon Valdez* Oil Spill Trustee Council to collect oceanographic data along repeated transects in Kachemak Bay and lower Cook Inlet. Data are used to improve a harmful algal bloom risk assessment tool; support development of risk assessment tools for ocean acidification, pathogens (vibrio) and invasive species; assess estuarine responses to climate change; and provide validation for the National Ocean Service's Cook Inlet operational forecast system.

3. *Sentinel monitoring in Southeast Alaska*. *No funds are available in Year 5 to initiate a new partnership with the Sitka Sound Science Center to enhance its capacity to serve as a sentinel station for Southeast Alaska.* This would include support for oceanographic buoy observations and long-term monitoring of kelp forests and pinto abalone populations as sentinels of climate change.

4. *Sentinel monitoring in other regions*. AOOS will continue to seek opportunistic funding to develop and enhance sentinel monitoring in other regions of the state that have local science capacity and resources to support such operations, such as Kodiak, Pribilof Islands, Kotzebue and Barrow. We will also seek out opportunities to add sensors to existing platforms around the state to enhance local observing capacity, such as adding conductivity sensors to tide stations (that already have temperature measurements) along the coast to better understand large-scale oceanographic changes in salinity.

D.3 Climate Products

1. *Distance learning modules*. In year 3 AOOS supported the Alaska Center for Climate Assessment and Policy to develop distance learning modules on climate decision support. No additional funds are available for this effort in year 5, but at least one module will be used by AOOS for climate change education and outreach.

E. Water quality

1. *Ocean acidification (OA) monitoring.* After a decade of bi-annual OA sampling along the Seward Line in the northern Gulf of Alaska with the UAF Ocean Acidification Center and the NOAA OA Program, AOOS will support reduced sampling during 2 cruises and collect additional samples for calibration. The data is being used to help quantify the physical and biogeochemical controls on OA in the region, including the influence of glacial runoff, meteorological forcing (upwelling) and longer-term trends caused by climatological forcing. With funds from both IOOS and the OAP, AOOS will continue to contribute to the consortium that supports two moorings (Bering Sea and Gulf of Alaska) equipped with a surface and bottom sensor package to measure pCO_2, pH, temperature, salinity, nitrate, oxygen, chlorophyll, and

turbidity to quantify the seasonal and interannual variability in the ocean carbonate system. The surface package contains a meteorological and atmospheric monitoring station and transmits both surface water and atmospheric parameters in real-time via satellite telemetry. With funds from the OAP, AOOS will support OA sampling along Distributed Biological Observatory (DBO) cruise stations in the Chukchi Sea, as well as development of OA indicators for the Bering Sea Ecosystem Status Report, and support for glider operations in the Gulf of Alaska in 2021 to track pH and phytoplankton as a replacement for an originally planned Gulf of Alaska OA cruise. With funding from the OA Program and the IOOS Ocean Technology Transfer program, "Burke-o-Lator" instruments equipped with sensors that measure these parameters have been installed in Seward at the Alutiiq Pride Shellfish Hatchery, and in Ketchikan, Sitka and Kodiak. Money saved from the reduced sampling along the Seward Line continues to be used in Year 5 to bridge a funding gap of the Burke-o-Lator operations at Alutiiq hatchery and help support continuous operation of this asset and community-based OA monitoring for the region through the end of May 2021. In Year 5 funds from the OAP program will be used by Wiley Evans at Hakai Institute to provide technical support to Burke-o-Lator operators, as well as to support technical expertise at the Sitka and Seward sites.

AOOS held an OA technology workshop in winter 2016 to develop a coordinated Integrated Ocean Acidification Monitoring Strategy for Alaska with the multiple partners currently monitoring OA. The goals of the workshop were to identify preferred technologies and methodologies for making accurate and meaningful OA measurements, and to develop a phased approach to a coordinated network. Best practices for sampling and data sharing were also defined to the best state of the technology. Based on that workshop, we identified priorities for any additional AOOS and partner funding. In Year 1 this included instrumenting a state ferry that routinely transits the Gulf of Alaska and adding an additional Burk-o-Lator in Ketchikan. In Year 5 we will continue to support the ferry project.

Funds from the NOAA OA Program in Year 5 will be used to support the Alaska Ocean Acidification Network and its suite of activities including hosting the Alaska OA Network website, list serve, OA State of the Science workshop, OA expert network, and stakeholder outreach. Funds in Year 5 will also be used to support the AOOS/AK OA Network outreach efforts as part of a larger project called "Thresholds in a changing ocean environment: bioeconomic implications to inform adaptation decisions for Alaska's salmon fisheries".

2. *Support monitoring of harmful algal blooms.* In Year 5 AOOS will use new HABs funds to support a full-time coordinator for the Alaska Harmful Algal Bloom Network, develop a statewide monitoring plan with special attention on the Arctic, and continue some small community-based monitoring efforts with NOAA, Alaska Sea Grant, and the US Arctic Research Commission in the Bering Strait region and their potential impacts on subsistence resources.

3. *Support monitoring of marine debris.*. In Year 4 AOOS co-hosted a workshop with Alaska region EPA to explore micro-plastics in the Arctic and the potential need for an Alaska marine debris network. In Year 5 AOOS will continue to collaborate with NOAA's Alaska marine debris coordinator to develop an Alaska Marine Debris action plan and determine the future role of AOOS in this realm.

4. *Support for monitoring for contaminants*. Contaminants in Alaska's waters may be an increasing problem in the future, especially as industrial activities continue to develop in the watersheds that feed into Alaskan waters, and with increased shipping activities throughout the state. ADEC is currently testing for mercury concentrations in marine fish and identifying any potential public health risks due to consumption of effected species. The Alaska Department of Natural Resources is concerned about watershed and local impacts of large-scale mines. Contaminant monitoring is very expensive, so these efforts are limited. The AOOS Board has asked staff to monitor current activities and consider ways to provide data integration or supportive data for these agency efforts.

VI. DATA MANAGEMENT & COMMUNICATIONS SUBSYSTEM

Goal: The goals of the AOOS Data Management and Communications Subsystem are to serve as the Alaska regional data assembly center (DAC) for Alaska coastal and ocean data collected by AOOS as well as other federal, state, local, private and tribal entities; leverage collaborations with other IOOS regional associations; and develop data and information products to meet stakeholder needs.

Background: AOOS supports a data management system that allows a complex array of oceanographic data types to be well organized, accessible, and understandable. Working on behalf of AOOS with AOOS staff and other partners, Axiom Data Science has developed the AOOS data system to be a scalable, open source platform that uses existing and emerging software resources, high performance compute clusters and interoperability services consistent with IOOS standards and protocols (see Appendix D for more details). In its current capacity, the AOOS regional Data Assembly Center is the largest data management service in this region.

Developing functional standalone DMAC systems is laborious, time consuming and expensive. IOOS regional associations are similar in that their DMAC systems must meet IOOS DMAC requirements and each regional association must support the local needs of their constituents. The AOOS data framework is now able to directly leverage and benefit from the systems, capabilities and lessons learned through Axiom's contractual support for data management and communications (DMAC) activities for the Southeast Coastal Ocean Observing System (SECOORA, which began summer 2015, Central and Northern California Ocean Observing System (CeNCOOS) and the Integrated Ocean Observing System (IOOS). These relationships will increase access to and use of data by all user groups, allow AOOS data management staff to rapidly develop new capabilities and tools to meet a variety of user needs, and reduce costs and increase performance. In Year 5 all the activities below will be continued. In addition, Axiom continues to implement recommendations from an external review by a team of experts held in 2017.

Objectives and Approaches:

1. *Support the cyberinfrastructure that underpins the AOOS Data Assembly Center.* The AOOS data contractor, Axiom Data Science, will ensure that the AOOS data system is healthy, secure and monitored, respond to system problems, and map out future upgrade and expansion strategies. This task includes the support, cultivation and expansion of both the hardware and software, which enable the AOOS data management system to function. Axiom staff will also focus on extending the capabilities of the existing AOOS cyberinfrastructure by exploring and implementing new software server technology. Physical hardware configurations will be optimized and additional server resources deployed to power applications and functionality that are requested by the user community and required for the multiple, integrated-research efforts that AOOS supports. Axiom will continue to work with the broader IOOS community to implement protocols for applying Quality Assurance of Real Time Ocean Data (QARTOD) checks to existing real-time data feeds. This is a database-level enhancement that will ensure quality control is performed on all real-time data being archived and served out of the AOOS data system.

2. Maintain and enhance the Ocean Data Explorer. The Ocean Data Explorer is the flagship statewide data portal for AOOS and includes tools to visualize and explore oceanographic and coastal data across Alaska. The custom-built tools allow for dataset cataloging, elastic searches, automated and custom visualization, time-series exploration and extraction, data downloading using static files and multiple interoperable web services, map representation of multiple data layers, and more. This objective focuses on maintaining the portal's backend data storage as well as the front-end user interface. Activities consist of monitoring and documenting the use of the portal and integrating user feedback and emerging technologies into future system iterations. These include further implementation of AOOS lite (useful for mobile phone and low bandwidth AOOS Web access), and "myAOOS" personalized functions. Future development

activities range from visualizing more complex data types (gliders, animal telemetry, CTDs, Saildrone, AI) to providing next generation visualization capabilities to users (e.g., Ocean in 4D).

3. *Maintain and provide access to existing and new products*. Existing products supported by AOOS include the AOOS Real-time Sensor Map, Research Assets Map, Model Explorer, Sea Ice Atlas, AIS database, and the Cook Inlet Response tool. Work will continue in Year 5 on the pilot Alaska Water Level Watch data portal. New products could also include mobile-enhanced applications, specialized data portals, products or tools for particular sub-regions or unique Alaska stakeholder groups (e.g., recreational or commercial fisheries, mariculture siting, emergency planners, etc.), or topical issues such as Arctic shipping, ocean acidification, and community-based monitoring.

4. *Maintain and provide access to existing and new data sets.* As the certified regional Data Assembly Center for Alaska, AOOS has prioritized ingestion of valuable physical, biological and chemical data sets collected primarily by federal and state agencies, academic partners and large ecosystem research programs. AOOS provides data management services for many of those programs, including the Marine Arctic Research Ecosystem Study, Arctic Marine Biodiversity Observing Network, Arctic Ecosystem Integrated Study, components of the Distributed Biological Observatory, and Gulf Watch Alaska and Herring Research and Monitoring Program. By providing these services (with costs reimbursed) through use of the Research Workspace (a cloud-based data management application designed for storing, documenting and sharing data among members of scientific communities), AOOS has access to all data for inclusion in the AOOS Ocean Data Explorer. We will continue to pursue other funding to ingest other priority data sets.

5. *In collaboration with other IOOS regional associations (RAs), develop cross-regional and US-wide data products*. AOOS will work with the other IOOS RAs over the course of the funding cycle to enhance and standardize stakeholder access to data, services and interfaces. This will be done by collaborating with other RA staff to agree on common access methods to existing data services through the use of Application Programming Interface (APIs) and interoperability systems (WMS, WFS, WCS and SOS). It will also include discussing standardized interfaces for exploring and downloading data that focus on data and products common to all regions (e.g., glider data, model nowcasts and forecasts, key climate variables). AOOS spearheaded the development of the data portal and catalog interfaces currently used by AOOS, CeNCOOS and SECOORA, and converging on common data interfaces is one step in providing a consistent "look and feel" for IOOS stakeholders that use data from more than one region.

6. *Collaborate with other state, regional, national and international data management programs.* Axiom Data Science actively participates in national IOOS data management committees and teams. They will develop partnerships with other existing data management systems in Alaska and the Arctic, including those for the USGS Oceanographic Biological Information System (OBIS), the Arctic Observing Network (AON) and the Sustained Arctic Observing Network (SAON).

7. *Provide support to national IOOS Data Management and Communications Program.* In Year 5, AOOS will continue enhancements to the Environmental Sensor Map and support the use of ERDDAP; operate the ATN Data Assembly Center (with funding now provided outside of this agreement); support the Marine Biodiversity Observing Network (MBON) portal; continue work on the national High Frequency Radar range series file archiving and Optimizing Machine Learning for novel biological data streams. New projects for Axiom in Year 5 include a project for the National Weather Service on Seasonal to Subseasonal Sea Ice guidance, and for the Office of Coast Survey's Development Laboratory on cloud implementation support for modeling and post-processing. In Year 5 the "Matt Howard" funds will also be used to enhance the integration of biological data into the AOOS system, especially the Pacific Seabird Database managed by US Fish and Wildlife Service.

8. Support Regional Ocean Data Sharing Initiative. In Year 5 Regional Ocean Partnership funds will be used to enhance access and utility to ocean and coastal data in support of priority federal and state management needs, and in particular the Bering Sea region and its rapidly changing ocean conditions.

VII. MODELING, ANALYSIS & PRODUCT DEVELOPMENT SUBSYSTEM

Goal: The goals of this component are to increase the accuracy, reliability and scope of operational ocean products and services for Alaska, add value to existing data and models and develop new products based on stakeholder needs.

Background: AOOS originally proposed to expand ocean modeling efforts initiated in Prince William Sound into a statewide modeling and forecasting framework. Because of the extensive geographic area, paucity of *in situ* observations, limited AOOS resources and lack of support from other potential funders, this has not proven to be a realistic approach. Depending on the amount of funding available, we now propose instead to focus on three main objectives described below:

Objectives and Approaches:

1. *Support in Year 5 existing models and data products developed with prior AOOS funding.*

a. Continue annual updates to the Historical Sea Ice Atlas and the Yukon-Kuskokwim Chinook Run Timing Forecast.

b. Continue support of the prototype *AIS Vessel Tracking Tool.* The Marine Exchange of Alaska's Automatic Identification System (AIS) data archive is a valuable source of information that tracks shipping trends across several dimensions (space, time, ship velocity and type). However, the extensive data archive with over 1 billion records prohibits expedient analysis of the entire time series. Raw data are accessed by users either through one-off data requests or a subscription service from the Marine Exchange, but exhaustive processing is required to produce tangible products that, for example, reveal ship route trends in the region. Axiom is working on increasing the accessibility and re-use of this data resource by developing an advanced spatial/temporal analytic interface powered by high performance computing techniques. The continued effort will significantly increase the accessibility of the AIS data archive by resource management, scientific and policy communities. Products will include output from advanced graphical analytics, such as dynamic heat maps, which show density of shipping routes. It will also allow for user-enabled inputs and offer interactive graphics that display regional spatial and temporal trends, as well as data overlay capabilities (e.g., mapping vessel traffic patterns over marine mammal migration routes).

c. *AOOS will discontinue long-term support for operating the ROMS model for Prince William Sound (PWS) and Gulf of Alaska (GOA)* (due largely to the lack of meaningful partner funding) and will steer these resources towards data products and tools that can be developed from model hindcasts/forecasts and datasets.

d. The data team is exploring methods for serving four-dimensional (4-D) and higher datasets via THREDDS, ncWMS and other NetCDF data management and interoperability systems. AOOS has now developed sophisticated model evaluation tools to better enable managers, scientists, educators and stakeholders to assess model output quality. Advanced tools can compare these outputs against each other through model-to-model comparisons, and assess model framework utility through model observation comparisons. The AOOS data system currently allows users to place a virtual sensor to extract time series data at a point and specific depth within a numerical modeling grid. AOOS has expanded upon this capability by developing tools that extract virtual transects (depth curtain profile over a line at a specific time instance) and virtual profiles (changing depth profile over time at a specific location). Users will be able to directly compare *in situ* observational data from sensors, buoys, gliders and profiling instruments (ADCPs and CTDs) against modeling outputs.

2. Develop select new modeling and data products that are priorities for stakeholders. In Year 5, AOOS will:

a. Develop a "State of Alaska's Coasts and Oceans Report". Building upon the existing Arctic Report Card, National Marine Fisheries Service (NMFS) Ecosystem Report Cards, Alaska Climate Assessment, the developing Integrated Ecosystem Assessments, and the PICES Status of the North Pacific Ocean, AOOS will work with partners to produce an annual status report that is electronic and web accessible, but also includes a brief summary in hard copy. This would be a signature AOOS product and complement the existing AOOS Ocean Data Explorer, providing a comprehensive annual assessment of the state of Alaska's oceans and coast. In Year 5 funds will continue to support development of the annual State of the Arctic Report, released annually at AGU. Also in Year 5 NOAA Regional Collaboration Team funds will continue to be used to initiate a pilot effort to increase the utility of NMFS ecosystem status reports by making Alaska Fisheries Science Center's reports available through the AOOS DAC and linking directly to the data used in the reports.

b. Develop new products prioritized by stakeholders. Stakeholders have identified numerous product needs. AOOS will focus on these priorities for new product development efforts, including a higher resolution historical sea ice atlas, additional fishery run timing forecasts, ocean climatologies, a particle trajectory tool, and spatial analysis tools to analyze vessel traffic corridors for planning purposes.

3. Initiate the Alaska Modeling Testbed. In Year 2, due to lack of partner funding, AOOS eliminated funding support for the real-time PWS ROMS model. Using Year 5 and other funds, AOOS will work with the National Weather Service to initiate an Alaska Model Testbed and produce model related end-user products, including a sea ice model inter-comparison and operationalizing the HIOMAS circulation model. Similar to the IOOS Coastal Ocean Modeling Testbed (COMT), the mission of the AOOS Modeling Testbed effort will be to accelerate the transition of advances from the coastal ocean modeling research community to improved operational ocean products and services for Alaska, and thereby increase the accuracy, reliability, and scope of Alaska operational coastal and ocean forecasting products. For AOOS, a modeling team will be assembled to develop the program's mission, objectives, and criteria for proposals (e.g., must solve a specific modeling problem, validate an existing model, add operational value to an existing model, etc.). The criteria will be used to select candidate projects, considering a number of factors, including the current status of model in question (e.g., existence and functionality of a model versus building a model from the ground up). Model status will be balanced with stakeholder-identified needs, model priorities and potential for leveraging. Other potential modeling needs include:

a. National Ocean Service (NOS): Add value to the NOS Coast Survey Development Laboratory (CSDL) circulation model for Cook Inlet by using hindcast model runs to develop decision support tools. Tools could include particle trajectory analysis (oil spill response planning, larval transport for shellfish), residence time (harmful algal blooms, oil spills), resource management (current/future environmental conditions for crab and groundfish distribution and herring spawning) and climate change scenario testing (impact of snowpack melt and precipitation changes, timing of seasonal changes).
b. Improve existing circulation models (AOOS ROMS, NOAA GNOME, and Alyeska ATOM) to include surface and subsurface currents in Port of Valdez, home to the Valdez Marine Terminal and tanker loading activities. This would improve our understanding of how oil may move and disperse in confined regions. (This was accomplished in Year 1).
c. Use 20 years of hindcast data from a tidal model (Grumbine Model) in the Bering Sea to develop tidal prediction capability using the model-derived tidal constituents for a number of communities along the Bering Sea coastline that currently do not have an active tide gauge (> 2/3 of Alaska coastal waters are under-sampled with respect to tides). This product will provide a model tool that is directly useful to

local communities as well as stakeholders and resource managers working on emergency and spill response and storm surge issues.(This was initiated in Year 2 but was unsuccessful.)

VIII. PROJECT BUDGET

Program Components	Year 1	Year 2	Year 3	Year 4	Year 5	**Total**
Management, Facilitation, Stakeholder Engagement & Outreach	617,353	707,945	649,186	694115	834,004	
Observing	1,036,049	808,000	2,446,059	1,992,787	2,157,148	
Data Management	540,000	540,000	890,000	1,244,923	858,651	
Modeling & Products	465,538	488,000	390,000	519,334	509,463	
Fiscal Support Fee	112,540	115,916	124,000	136,808	143,106	
Holdbacks (Obs)	25,000	25,000	25,000	25,000	75,000	
Total w/o holdbacks	**2,771,480**	**2,659,861**	**4,375,245**	**4,565,402**	**4,581,372**	**18,953,360**
Total w/holdbacks	**2,796,480**	**2,684,861**	**4,400,246**	**4,590,402**	**4,656,372**	**19,128,360**

Detailed budget information. Appendix A includes an overall project budget and budget narrative, as well as budget information for all subawards. A holdback of $25,000 in Year 5 is requested for NOAA Kasitsna Bay Laboratory (Holderied) to perform oceanographic surveys in Cook Inlet and Kachemak Bay4,581,372 and $50,000 for NOAA Pacific Marine Environmental Laboratory (Stabeno) to support purchase of sensors for Bering Sea ecosystem moorings. AOOS wishes for NOAA to retain these funds and have them used by the specified NOAA office. No equipment described in this proposal is available for lease. All items require a direct purchase.

Base capacity and enhancements. AOOS has submitted a budget request for $4 million a year for Years 1-5, which would minimally meet the need for ocean observing activities in Alaska. Appendix E describes the activities that would occur under the three funding scenarios ($1.5M, $2.5M, and $4M). This proposal focuses on the $2.5M scenario since that is closest to our current funding level. Under all three funding scenarios, program staff and the data management team would stay roughly the same since these are AOOS Board priorities. The primary difference is in the extent of proposed observations and equipment purchases, and resources devoted to modeling.

IX. MILESTONES & DELIVERABLES

MILESTONES & DELIVERABLES ($2.5M)	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
REGIONAL GOVERNANCE & MANAGEMENT SUBSYSTEM					
Ongoing board, committee and partnership activities	*	*	*	*	*
Finalize AOOS certification as AK IOOS RA	*	*			
OUTREACH, STAKEHOLDER ENGAGEMENT & EDUCATION					
Ongoing activities (website, publications, communications)	*	*	*	*	*
Work with partners to support Ocean Acidification Network	*	*	*	*	*
Work with partners to develop AK Harmful Algal Bloom Network		*	*	*	*
Develop IOOS-wide materials with IOOS Outreach Committee	*	*	*	*	*
OBSERVING SYSTEM					
Marine Operations					
Sustain weather observations in the GOA	*	*	*	*	*
Increase access to weather observations using AIS	*	*	*	*	*
Sustain critical wave buoys for navigation safety	*	*	*	*	*
Map surface currents with high frequency radars (HFRs)	*	*	*	*	*
Enhance observations at Port of Alaska	no	no	no	no	no
Coastal Hazards & Inundation					
Increase water level observations in western & northern Alaska	*	*	*	*	*
Increase wave observations for water level forecasting & planning	*	*	*	*	*
Pilot use of new hydroball technology for nearshore bathymetry					*
Ecosystems, Fisheries & Climate Trends					
Sustained Observation Network					
Sustain Seward Line sampling	*	*	*	*	*
Support ecosystem moorings in Alaska's LMEs	*	*	*	*	*
Glider monitoring of ocean conditions and marine mammals	*	*	*	*	*
Host regional ATN workshop		*			
Regional sentinel observations					
Support sentinel monitoring in Prince William Sound	*	*	*	*	*
Support sentinel monitoring in Cook Inlet	*	*	*	*	*
Water Quality					
Sustain Ocean acidification (OA) monitoring	*	*	*	*	*
Support marine debris activities	no	no	no	*	no
DATA MANAGEMENT & COMMUNICATIONS					
Support AOOS Data Assembly Center cyber infrastructure	*	*	*	*	*
Maintain and enhance Ocean Data Explorer	*	*	*	*	*
Maintain existing data products	*	*	*	*	*
Develop new data products	*	*	*	*	*
Develop Products for National IOOS Program & national partners	*	*	*	*	*
Operate & Maintain ATN Data Assembly Center			*	*	*
MODELING, ANALYSIS & PRODUCTS					
Support existing models & data products	*	*	*	*	*
Continue development of AIS Vessel Tracking Tool	*	*	*	*	*
Develop Model Tools and Products	*	*	*	*	*
Support and enhance AOOS Model Explorer		*	*	*	*

Develop State of Alaska's Coasts and Oceans Report		no	no	yes	yes
Initiate and maintain AOOS Modeling Testbed	no	*	*	yes	yes
Explore Arctic Marine Highway decision tools		*	*	*	*

X. FILL THE GAPS EXPENDITURES

Note: FY 20 plans are included in IOOS-required Excel spreadsheet attached to this descope submission. The table below summarizes FY 19 and FY 20 plans.

	FY 19	FY 20
HFR Procurement	$120K to deploy additional site in Bering Strait	
HFR O&M		$120K for annual maintenance and operation of HFR sites in Bering Strait
HFR (1-time)		$100K to refurbish and upgrade two existing HFR systems for deployment in Prince William Sound, Cook Inlet, or elsewhere needed in Alaska.
Glider Procurement	$100K to upgrade buoyancy pumps in existing glider fleet	$60K to add sensors to existing gliders
Glider O&M	$195K to complete upgrades and test new transects in Gulf of Alaska to support commercial fisheries	$180K to calibrate and conduct repeat transects in Bering Sea and Gulf of Alaska to support commercial fisheries
Streamline Access to Obs	$80K: $45K to deploy GPS water level station at Utqiagvik; $30K to develop algorithms to calculate water level data from GPS; $5K to initiate planning for proof of concept use of Hydroball for community-based, nearshore bathymetric surveys	$226K: $151K towards sensor add-ons to enhance statewide buildout of new and existing ecosystem moorings (Chukchi, Beaufort, and Gulf of Alaska); and $75K to deploy a long-term water level station in Dillingham, Alaska.
Streamline Access to Obs (1-time)	$25K to match additional CO-OPS $25K to implement Phase II development of AK Water Level data portal.	