

Semi-annual Program Performance Report for NA16NOS0120027
FY 2016-20 Implementation and Development of a Regional Coastal Ocean Observing
System: Alaska Ocean Observing System
For reporting period June 1, 2021 – November 30, 2021
Prepared by Sheyna Wisdom, Project PI on December 17, 2021

1.0. PROGRESS AND ACCOMPLISHMENTS

1.1. Regional Governance & Management Subsystem

1.1.1. Support ongoing board and committee activities.

- The Alaska Ocean Observing System (AOOS) Executive Committee met June 24, 2021 to review spend plans for both the FY 2016-20 and the FY2021-26 cooperative agreements; and again on August 26, 2021 to discuss the agenda for the Fall board meeting and accept awards from the National Park Service (NPS) and the National Science Foundation (NSF).
- The Board met on October 19, 2021. Board action items included the approval of Steve White from the Marine Exchange of Alaska (MXAK) and Megan Kohler from the Alaska Department of Environmental Conservation as a new board members. Several program updates were given by staff and subaward Principal Investigators (PIs).
- A final spend plan for FY21 core funding, Year 5 carryover funds, and funding for the Regional Data Sharing Initiative (RODSI), Alaska Harmful Algal Bloom (AHAB) Network, and the Alaska Ocean Acidification Network (AK-OAN) was submitted and approved by the Executive Committee on June 24, 2021.

1.1.2. Provide ongoing fiscal and administrative oversight for the program.

- Executive Director Wisdom and Senior Advisor McCammon conducted annual evaluations for Carol Janzen, Darcy Dugan, and Thomas Farrugia.
- A final descope of the Year 1 funding award was submitted to the IOOS Program Office in July. Subawards and contracts for Year 1 of our NOAA Cooperative Agreement were executed. The team continues to work with the IOOS Program Office to finalize the award.
- AOOS continues to seek additional external funding, and in this reporting period, three proposals were submitted with AOOS as a partner; all are pending.
- The administrative team has developed and implemented new processes for improved project management and tracking.
- Wisdom and McCammon participated in numerous meetings with the IOOS Program Office and IOOS Association (IA) for funding as part of the Infrastructure Bill.

1.1.3. Support national and international partnerships and collaborations.

- McCammon sits on the IOOS Federal Advisory Committee (FAC), which met virtually in August and in November, as well as held several administrative calls. The FAC finalized a set of recommendations to the IOOS Program Office and the Interagency Ocean Observing Committee relating to vision and strategy, requirements, and partnerships.
- Wisdom and McCammon attended the annual fall IOOS meeting, held virtually, in October. Wisdom was elected on to the IA Finance Committee and meets regularly with the IA Board. McCammon continues to serve on the IA Public Policy Committee. They also participated in IA's strategic planning sessions, as well as IA's Public Policy calls.
- Wisdom represents AOOS in the Consortium for Ocean Leadership and participates in their member calls.
- McCammon is co-lead of the Interagency Arctic Research Policy Committee (IARPC) Environmental Intelligence Collaboration Team which is facilitating coordination of Arctic research cruises. AOOS is helping to maintain a monthly Arctic research cruise status report.
- McCammon sits on NOAA Science Advisory Board's Ecosystem Sciences Management Working Group (WG) which meets virtually every two months. The WG is now focusing on new reports on NOAA's Leadership role in Coastal Resilience, and in addressing needs for rapidly changing living marine resources.
- McCammon continues to work with the Sustaining Arctic Observing Network (SAON) on planning for a session to be held at the Arctic Observing Summit in Tromsø, Norway in March 2022.

1.1.4. Support Alaska and regional partnerships and collaborations.

- Wisdom and Kent participated on the organizing committee for the 2022 Alaska Marine Science Symposium to be held in January.

- AOOS staff continue to attend and co-host the Alaska Marine Policy Forum (AMPF) held every other month.
- Wisdom presented at the Alaska Eskimo Whaling Commission (AEWC) in July and December and will continue to attend their tri-annual conventions as possible to continue her long-standing relationship with this organization.
- Wisdom and McCammon continued to engage with the Alaska delegation staff to discuss AOOS and future funding opportunities.
- Wisdom sits on the Alaska Center for Climate Assessment and Policy's (ACCAP) Advisory Committee and is participating in their bi-monthly meetings.
- Wisdom and McCammon participated in monthly meetings of NOAA's Alaska Regional Collaboration Team.
- Wisdom was a panel on Arctic research as part of the Marine Risk Symposium in November 2021.
- Wisdom met with members of the Pacific Northwest National Laboratory (PNNL) in August and November 2021 to discuss opportunities for collaboration. A monthly meeting with members from NOAA, PNNL, and AOOS will start in January.
- Wisdom and McCammon participated in a workshop with the Arctic Marine Biodiversity Observing Network (AMBON) program team in October 2021. Based on the meeting, AOOS will be starting an Ecosystems Collaboration Network (name to be determined) for Alaska.
- See section 1.2.3 for activities relating to the AK-OAN, the AHAB Network, and the Alaska Water Level Watch (AWLW). See section 1.2.6 for Alaska Marine Science Symposium (AMSS) activities.

1.2. Outreach, Stakeholder Engagement & Education Subsystem

1.2.1. Support website, Facebook, and printed publications as key AOOS communication tools.

- Kent continued to add content to the new AOOS website and Facebook page, including news, featured stories, and descriptions of new data tools.
- Kent updated the *Education and Outreach Inventory* developed with the IOOS Association Education and Outreach Committee and located at the IOOS Cloud for Collaboration.

1.2.2. Support stakeholder working groups including ocean acidification network, integrated water level observation network, harmful algal bloom network.

Alaska Ocean Acidification Network

- Darcy Dugan facilitated three meetings of the AK-OAN steering committee to keep track of progress and identify new activities and objectives for the network.
- Dugan worked with the steering committee to begin planning a discussion series for spring 2022. This included circulating a stakeholder survey to gather input for topics and bringing a facilitator onto the team.
- Dugan worked with network members to produce a 6-part podcast series called "Our Future Ocean: what can carbon policy do for the ocean and our fisheries" in response to fishing industry interest in solutions to OA. The podcast has been accessed over 500 times on Spotify/Apple podcast and viewed 2,900 times on the AOOS webpage since its launch in September.
- Dugan worked with Southern Dipper Productions on a short video about a NOAA OAP funded project looking at tipping points and salmon response to OA and circulated the video widely in June.
- Dugan continued writing and producing bi-monthly OA Network eNews, including articles about monitoring, research, outreach, and scientist interviews, as well as maintaining the network website as a hub for OA information in Alaska.
- Dugan worked on developing components of a new suite of webpages on "OA State of the Science" and overhauling the AK-OAN website - both to be unveiled in early 2022.
- The network updated and recirculated two key resources on species response: a poster with arrows showing how species respond to OA in the lab, and an annotated bibliography providing more detail on the results of those studies.
- Dugan continued to organize, host, and/or publicize events related to OA in Alaska, including researcher talks or panels at the 2021 Alaska Fishermen's Expo, United Fishermen of Alaska Board meeting, the Alaska Tribal Managers Conference, a public radio show in Kodiak, and to South Anchorage high schoolers. Darcy also gave a tutorial on disseminating results to interested communities at the NOAA OA Vulnerability Assessment Workshop and was on a panel about stakeholder engagement at the GOA-ON "OA Week".
- Dugan continued to facilitate the OA Tribal monitoring working group, implementing bi-monthly calls to address issues across regions and work with researchers and regional Tribal coordinators to identify and improve standards for sample analysis, data sharing, and communication.
- The AK-OAN continued to host small group meetings between OA researchers and the crabbing industry to review the latest science and discuss strategies for strengthening partnerships, messaging and outreach.

Alaska Harmful Algal Bloom Network

- Thomas Farrugia has continued to host monthly meetings with the entire AHAB Network and produce meeting notes from each meeting that are distributed throughout the network. The monthly meetings have received very positive feedback from the network members, and there is a high level of engagement with at least 35 members participating in every meeting.
- Farrugia has also been maintaining and updating the AHAB website with recent news articles, events, job openings, and funding opportunities related to HABs in Alaska. The website is currently being rebuilt as a stand-alone website and will be unveiled in early 2022.
- AHAB network members have also contributed to the Alaska Marine Ecosystem Status Reports produced by NOAA's Alaska Fisheries Science Center by reporting on their monitoring and research efforts on HABs during the 2021 season.
- Farrugia has also actively sought out new network members, establishing connections and starting collaborative projects to provide members with support. There are now over 150 individuals from over 50 organizations that are part of the network.
- Along with the steering committee, Farrugia finalized and published the AHAB Action Plan. The Plan is now available on the AHAB website and has been used by members of the general public to learn more about HABs in Alaska and what HAB-related activities are being conducted in Alaska.
- Farrugia has also been putting together budgets and spend plans for the AHAB network, to maximize the benefits of HAB funding for Alaska and the network members.
- In addition to the AHAB working groups on lab capacity and event coordination, another working group on freshwater HABs in Alaska is being formed. This group, composed of state agency representatives, community members, and researchers, will focus on coordinating the research and monitoring efforts of primarily cyanobacterial blooms in Alaska, which to date have received much less attention than marine HABs. However, with a changing climate, there is concern that cyanobacterial blooms could become more common and pose a threat to drinking water sources, especially in remote communities.
- Farrugia is continuing to work with Axiom to revamp the AHAB data portal with the goal of using it as a central, long-term storage of phytoplankton and toxicity data from Alaska. The data sources will be expanded to include all data being collected on HABs in Alaska, as well as all the regular sampling locations, which will be useful when determining geographic gaps in sampling.
- Farrugia has been engaging in several HABs outreach efforts, including presenting at a variety of meetings and conferences, leading trainings on HAB monitoring, and participating in discussion groups with university courses about HABs.
- In collaboration with the Alaska Conservation Foundation, Farrugia has started a pilot program on Community Sampling for HABs. This program will work with 2-3 communities to set up a HAB monitoring program with funds going directly to community samplers. This project will produce HAB data from locations without a long history of HAB monitoring and will test out an individual payment system for supporting the work of community samplers.
- Farrugia has also been communicating with many network members about the equipment needs in Alaska to further develop the testing capacity in the state. This effort will culminate in an equipment budget to be used for funding requests in the future. Items such as microscopes, freezers, sampling bottles, phytoplankton nets, and lab equipment for toxin testing are all being considered.
- See section 1.3.2.5 for additional information about the new water level data portal.

1.2.3. Support partnerships with marine education and outreach programs.

- Staff provided support to Alaska Sea Grant's marine education programs. A work plan for this support has been developed.

1.2.4. Support Alaska Marine Policy Forum.

- AOOS partnered with Alaska Sea Grant to host sessions of the AMPF in June, August, October, and December.

1.2.5. Continue to co-sponsor the Alaska Marine Science Symposium.

- AOOS staff serve on the organizing committee. The 2022 symposium will be held virtually in January 2022.

1.2.6. Participate in IOOS Outreach Committee.

- Kent attended monthly meetings of the committee and responded to various requests for materials from the IOOS Program Office for inclusion into IOOS publications and website.

1.3. Observing Subsystem

1.3.1. Marine Operations

1.3.1.1. Sustain weather observations in the Gulf of Alaska (GOA).

- **Subaward to Prince William Sound Science Center (PWSSC) to service 8 SnoTel stations in Prince William Sound (PWS) and Cook Inlet.**
 - Contract with Natural Resources Conservation Service (NRCS) to maintain the most critical SnoTel stations in PWS and Cook Inlet providing real-time web accessible data; Original completion date: May 2021.
Status: Complete.

1.3.1.2. Increase access to weather observations using Automatic Identification System (AIS).

- **Subaward to the MXAK to increase access to Weather Observations using AIS.**
 - Install new weather sensors at Cape Spencer; Original completion date: May 2021. Site survey completed, equipment purchased. Installation planned for June 2021.
Status: Delayed.
 - Recapitalize six existing weather sensors; Original completion date: May 2021.
Status: Complete.

1.3.1.3. Sustain critical wave buoys for navigation safety.

- **Operate and maintain Cook Inlet buoy.** Original completion date: December 2021.
A replacement Coastal Data Information Program (CDIP) wave and surface current buoy was deployed in lower Cook Inlet on August 6, 2021 approximately 9 nautical miles WSW of Homer. The buoy was cut loose from its mooring earlier in the summer on May 26, 2021 from what appears to be a vessel strike. This required a complete recovery of the existing mooring using an acoustic release. CDIP shipped a new mooring with anchor and acoustic release along with the replacement buoy in late June, but due to shipping delays, the replacement buoy was not delivered to Homer, Alaska until late July. Weather also prevented immediate deployment opportunities once the buoy arrived. The buoy has been operating real time since its deployment. Exceptionally cold weather throughout most of November did cause some build-up of ice on the buoy, affecting data transmission and faulty temperature readings for several weeks in late November.
Status: Complete.

1.3.1.4. Map surface currents with high frequency radars (HFRs).

- **Subaward to University of Alaska Fairbanks (UAF) to support operation and maintenance of three HFR sites on the Chukchi and Beaufort Seas.**
 - Operate three HFR sites in the northeastern Chukchi and western Beaufort Seas during the open water season, with maintenance trips as needed. Original Completion Date: June 2021 – May 2022.
Status: On track.
 - Reactivate the Wainwright, Point Barrow, and Cape Simpson field sites for the open water season. Original Completion Date: June – August 2021.
Status: Complete.
 - Monitor HFR and power systems and perform maintenance, as necessary, until freeze-up. Original Completion Date: July to November 2021.
Status: On track.
 - Maintain HFR central computer at UAF and ensure real-time data is being received from field sites, is made available to the public, and is being delivered to the national data server Original Completion Date: June 2021 – May 2022.
Status: On track.
 - Ensure the continuation of valid land use agreements, permits, and indemnity for land owners where field sites are located Original Completion Date: June 2021 – May 2022.
Status: On track.

1.3.1.5. Install three new HFR field sites in the Bering Strait.

- **Subaward to UAF to install three new HFR field sites in the Bering Strait Region.**
 - Identify/hire field help in Wales Alaska. Original Completion Date: July 2020. Michael Ahkinga was identified as a local technician in Wales who is assisting with the Wales installation logistics.
Status: Complete.
 - Identify reliable power source in Shishmaref, Alaska, to have that site operational for the winter season. Original completion date: September 2020.
Status: Delayed.

- Operate and maintain HFR sites in Wales and Shishmaref, Alaska; Original completion date: September 2020 – May 2021. The sites were not operational in 2021. We have a solution for the internet connectivity issues in Wales by using a HughesNet system in place of the GCI WiFi. Shishmaref never granted permission to visit the site in 2021 (see first bullet), preventing completion of the power tests with the School. The Wales installation was beginning to become operational remotely with local technician Michael Ahkinga, but the HFR transmit antenna fell in a storm. Internet connectivity limitations prevented sharing of photos of the damage, making it difficult to complete an off-site assessment, and we were not able to travel there to make an assessment due to COVID-19 travel restrictions in 2021. Plans are complete for the new remote powered HFR location up the coast from Wales. The HFR site in Wales was scheduled to be relocated in summer 2021 to this new site, in order to increase HFR spatial coverage, but that was delayed due to ongoing COVID-19 travel restrictions. Plans are now to deploy in late spring/early summer of 2022, depending on COVID-19 travel restrictions, as well as snow and ice melt in the region.

Status: Delayed.

- Ensure the continuation of valid land use agreements, permits, and indemnity for landowners where field sites are located. Original Completion Date: June 2021. The Wales Native Corporation, who owns the land where the remote power site will be located, had their first land management meeting since before the pandemic in August 2021, where they granted permission for us to use their lands with a fee of \$500/month. The University of Alaska Lands department is in the process of finalizing the land lease with the Wales Native Corporation, as well as renewing our land use permit with Shishmaref Native Corporation. IOOS NEPA documentation was updated subsequent to the granted permission of the Wales Native Corporation in September 2021 to relocate the Wales HFR system.

Status: Delayed.

- Fabricate Remote Power Module (RPM) Lite; Original Completion Date: May 2020. After delays related to COVID-19, APRS World, LLC, completed fabrication of the RPM Lite, which was delivered to Fairbanks in September, 2021.

Status: Complete.

- Conduct field test of the RPM Lite low power remote power system; Original Completion Date: April – May 2021. The RPM Lite was installed on the coast of Seward, Alaska, at the Seward Marine Center in October 2021 to begin a field test of the new system.

Status: Delayed.

1.3.1.6. Upgrade two out-of-date HFR systems that are no longer operable, so that they can be utilized for future projects, thereby increasing coverage along the Alaskan coastline.

- **Subaward to UAF to upgrade two out-of-date HFR systems.**

Receive modernized equipment, antennas, and cables from CODAR Ocean Sensors; Original Completion Date: March 2021. Out-of-date HFR systems were sent to CODAR to determine what was needed to make these operational. After minimal manufacturing delays due to COVID-19 work restrictions, the refurbished HFR systems were returned to UAF from CODAR Ocean Sensors in May 2021. Payment was sent in June 2021, completing this project.

Status: Complete.

1.3.2. Coastal Hazards & Inundation

1.3.2.1. Increase water level observations in western & northern Alaska.

- **Subaward to the Alaska Department of Natural Resources (ADNR) to Facilitate an Integrated, Interagency Water Level Network for the Alaska Coast.**

- Support 5 locations with operational real-time water level sensors by conducting maintenance.

Status: Complete.

- ADNR Division of Geological & Geophysical Surveys (DGGS) reinstalled water level sensors at Kotzebue (iRadar) and Deering (iGage-extended battery) in June 2021; however, the sensor at Kotzebue promptly stopped reporting after the reinstallation. Future planning for water level sensing at Kotzebue will include more resilience systems to replace the rapidly failing iRadars. The Deering system is reporting on the AWLW data portal.

Status: Complete.

- An NWLON-Lite water level system was installed in Dillingham by AOOS contractor JOA Surveys, LLC (JOA) to replace the iRadar system. This installation used other funds outside this agreement. ADNR will not pursue an iRadar installation at Dillingham for this reason.

- Status: Discontinued (though install completed by JOA in October 2021).*

 - DGGS provided a sensor for the UAF Arctic Coastal Geoscience Lab to install in Nelson Lagoon (iGage-extended battery). The sensor is reporting on the AWLW data portal.
Status: Complete.
 - The sensor at the Chignik River weir stopped reporting in the summer of 2021. A sensor (iGage) was sent to Kodiak for replacement by Alaska Dept. of Fish & Game (ADF&G) staff. The sensor is now reporting at the Alaska Pacific River Forecast Center site and is available for ingestion into the AWLW data portal.
Status: Complete.
 - DGGS submitted metadata for the Tununak station to Axiom Data Science (Axiom) installed earlier this summer; however, the sensor (Judd) stopped reporting later in the summer of 2021 and has not been fixed.
Status: Complete.
 - The Homer water level sensor installed in July 2020 continues to report, although the sensor does not detect the lowest water levels.
Status: Complete.
 - A water level sensor was installed in Kwigillingok (iGage), although travel funds were not available from this award, an opportunistic trip for another DGGS project allowed staff time to conduct the installation at the cost of the sensor alone. New site metadata were submitted to Axiom, and the sensor is currently reporting on the AWLW data portal.
Status: Complete.
 - State database for coastal storm flood documentation, to make storm-by-storm updates to an online database and to document new events that occur in 2019-20 storm season.
Status: On track.
 - DGGS continues work to update the DGGS catalog of historical storm events (<http://maps.dggs.alaska.gov/photodb/#show=96&search=storm>). As a part of other DGGS projects, staff have been updating the catalog with historical flood information from Alakanuk, Napakiak, and Kotlik, including ice jam floods. DGGS met with Axiom to coordinate integrating high water marks into the ALWL data portal.
Status: On track.
 - DGGS completed work and published the community report and flood map series for Nunam Iqua in June 2021 (available at the same link above). Work is ongoing for Shaktoolik.
Status: On track.
 - Inform the National Weather Service (NWS) of potential flood impacts in advance of storm events. No major storms were tracked during this reporting period.
Status: On track.
 - Maintain AWLW Webpage content.
Status: On track.
 - DGGS maintains the online data catalog of water level activities shown in the AWLW Build Out map, updates were made to the catalog throughout this reporting period. Updates were made to the catalog to show new sensors and broken sensors. A new feature story was added to the main website.
Status: On track.
 - Train NWS and State Emergency Operations Center (SEOC) to use coastal flood mapping products.
Status: On track.
 - DGGS collaborated with NWS staff to present a pre-storm informational webinar to all three Alaska NWS regional offices. The webinar covered online tools made available by DGGS to NWS for pre-storm flood assessment and decision making.
Status: On track.
 - DGGS did not present to the SEOC this reporting period. Future updates will come directly from NWS.
Status: Complete.
 - Conference and meeting attendance for discussions on water level sensors and deployments.
Status: Complete. (Note: This work is completed annually)
 - The AWLW steering committee met in June 2021 and discussed the final 2020-2025 guidance plan, which was distributed for signatures.
Status: Complete.

- PI Overbeck continues to participate in Alaska Mapping Executive Committee (AMEC) and Coastal Subcommittee meetings, which include discussions on the water level network with state and federal partners (this work was completed with State of Alaska funds).
Status: On track.
- The Coastal and Ocean Mapping Summit was held and hosted by PI Overbeck (and others) on December 1-2, 2021.
Status: On track.
- Monitoring coastal hazard conditions with near real-time camera systems. The Reolink (cell-enabled camera) was installed at Napakiak in June 2021 and will be operated by the City of Napakiak on site. An additional Reolink camera was tested at other communities, including St. Paul, Kotlik, and Alakanuk. Only Alakanuk had fast enough cellular service to support the Reolink camera; however, vandalism was a concern, so the second camera was not installed at a community. The NuPoint camera system was received and evaluated in Anchorage. Additional testing was slated for work in Shaktoolik; however, the tower structure where the camera was to be placed was not yet built by the end of summer 2021. This camera is slated for additional testing under future awards including installation at Shaktoolik.
Status: Complete.
- **Contracts to JOA and ASTRA to install water level instrumentation at Utqiagvik, Alaska.** Original Completion Date: Summer 2020. Travel restrictions from COVID-19 delayed installation until 2021. JOA completed the desktop recon in the spring of 2020 to identify suitable installation locations. The North Slope Borough (NSB) Municipal building Shop 3 was identified as a suitable location for the GPS installation. In May 2021, AOOS received permission from the NSB to install the water level system as long as those entering the community are vaccinated. There is a tower attached to the building also used to support the MXAK's AIS system. A recon on-site visit was performed by JOA July 17-19, 2021 to get measurements of the tower for installation hardware and cables, and a recon report was submitted on July 20, 2021. ASTRA, JOA, and the MXAK travelled to Utqiagvik to install the GPS reflectometry system on September 27-29, 2021. The on-site and qualified tower climber from MXAK completed the receiver installation on the tower, and ASTRA and JOA installed the supporting hardware and established real time communications using a cell modem. Staff from the NSB assisted. ASTRA is working on the real time data feed to be shared with AOOS via the data portal. JOA is assisting with data qualification prior to posting data on the portal. ASTRA will support data for 6 months following the installation, after which the water level data will directly stream real time from the Utqiagvik installation to the AOOS data portal through the cell phone modem. A post-installation meeting was held with all participating project members on October 29, 2021 to discuss the installation logistics, lessons learned, status report on data, and next steps.
Status: Complete.
- **Contract to ASTRA to operationalize codes that process global navigation satellite system (GNSS) observations to extract water level measurements.**
ASTRA provided the code for St. Michaels and Cape Spencer UNAVCO operated GNSS-r water level conversion to Axiom in February 2021, and submitted a report on the station data and data quality factors. During this reporting period, Axiom has integrated the ASTRA-provided code to convert the satellite data into water levels for display on the AWLW data portal. The preliminary station data are posted on the portal, but require a correction using a datum to reference level the data. There is no datum for this location, so JOA is being contracted to use the data from this station to compute a datum correction in 2022. ASTRA has agreed to work with Axiom and JOA to implement this correction once it is complete, and will also provide quality assurance review when data are released as final Tier C on the AWLW portal.
Status: Complete.
- **Contract to JOA to install a long term water level station in Dillingham, AK.**
Original completion date: Summer 2021.
A long term water level tide station was installed at the Port of Dillingham in October 2021. The primary goal is to have the two gauges installed such that valid water level readings are produced year round. Each tide gauge will consist of a sensor, data logger, modem, power, antenna for data telemetry and an antenna for precise timing. Ideally the gauges will be tied into AC power. Other tasks for this project included recovering existing tidal benchmarks; establishing 2 non-traditional tidal benchmarks on existing structures; providing third order differential levels between the orifice staff stops (i.e., level points), up to three existing tidal benchmarks in good condition and the two newly established non-traditional benchmarks. taping down measurement from the orifice staff stop to the zero point for both sensors. This is only required if a pressure

sensor is installed. Two hours of staff shots were made (i.e., manually measuring the water level as an independent check of the gauge readings). Conductivity, temperature, and depth readings were made at the location, and all of the electronics were secured in metal enclosures. A station report documenting the survey, condition of the station and suggested work requests for an Annual Inspection in 2021 was submitted in November 2021. Data are being prepared for posting on the AWLW data portal hosted by AOOS for supporting Tier B and C water level data collections in Alaska.

Status: Complete.

1.3.2.2. Increase wave observations for forecasting and planning.

- **Deploy & support CDIP buoy in Nome;** Original completion date: May 2021.

A buoy and mooring replacement were shipped to Nome, Alaska in June 2021, but delays in shipments en route (Seattle to Anchorage to Nome) and limited transport vessels traveling to Nome in 2021 caused unusual delays and the buoy did not arrive until late in July 2021. Due to these delays and inclement weather during August, the cost-effectiveness of a short 2021 deployment was deemed low, and the decision was made to postpone deployment until June 2022. The buoy stands ready for an early deployment in 2022.

Status: Delayed.

- **Support operations and maintenance for the National Renewable Energy Laboratory (NREL) owned Kodiak CDIP buoy.**

Original Completion Date: May 2021. Operate and maintain NREL-owned CDIP buoy off of Kodiak. The Kodiak Wave Buoy deployed in 2017 by NREL for a wave to energy project, was recovered on September 21, 2021 by Support Vessels of Alaska (SVA) R/V *Woldstad*. The buoy, which was located approximately 17 nautical miles southeast of Chiniak Island, was on loan from NREL and operated and maintained by AOOS since July 2019. CDIP continued to provide data management and logistical support for this asset. Though the buoy is on loan from NREL through 2022, with batteries set to expire mid-winter, AOOS identified potential opportunities with existing scheduled vessel operations to recover the buoy sooner to avoid the pitfalls of trying to coordinate a recovery during the Alaska winter. There are no plans to replace the wave buoy at this time. Mooring recovery is scheduled for spring of 2022. AOOS returned the buoy to NREL via CDIP in November, 2021, completing two additional years of wave observing for this area.

Status: Complete.

1.3.2.3. Initiate statewide geospatial mapping coordination

- Use funding acquired for a short-term AOOS position to develop a statewide coastal mapping strategy and implementation plan with support from NOAA and the state of Alaska. The strategist position ended in spring 2021.

Status: Complete.

- Wisdom represents AOOS on the AMEC Coastal Mapping Subcommittee, which meets monthly.

Status: On track.

- Janzen attended the virtual Coastal Mapping Summit for Alaska December 1-2, 2021.

Status: On track.

1.3.2.4. Improve the robustness of NOAA tsunami warnings for earthquakes in Alaska.

- **Subaward with the Alaska Earthquake Center at the Geophysical Institute of the UAF.**

- All milestones for this project have been completed.

Status: Complete.

1.3.2.5. Develop the Alaska Water Level Watch Data Portal

- **Subaward to Axiom to develop a prototype data management system and associated interface to house the various water level data at AOOS.**

- All milestones for this project have been completed.

Status: Complete.

1.3.3. Ecosystems, Fisheries & Climate Trends

1.3.3.1. Sustain ship-based sampling along the Seward Line.

- **Subaward to UAF to support sampling along the Seward Line.**

Original Completion Date: Sept 2021. Western PWS stations, including Icy Bay, and Montague Strait were also completed. Mean temperatures in the upper 100 m during September were 0.4°C below the 25-year Seward Line fall average. As is typical for late summer, chlorophyll was dominated by small cells, and the copepod community was dominated numerically by smaller-bodied species. Euphausiid biomass was unremarkable and macro-jelly biomass was low at nearly all stations. Supported the determination of carbonate chemistry (i.e., OA) as requested. Of note to this project, the ISIIS-DPI multiparameter imaging

system, partially supported by AOOS funds, underwent its sea trials during the summer LTER cruise. Most sampling systems, especially the zooplankton imaging system, performed as expected, although performance of the flight control system demonstrated that the platform will require re-engineering. We anticipate these will be resolved over the fall and anticipated a subsequent sea-trial in San Diego over the winter. The system is expected to be fully operational by next spring and operational for the May 2022 cruise.

Status: Complete.

1.3.3.2. Support ecosystem moorings in Alaska's Large Marine Ecosystems.

- **Subaward to UAF to continue the incremental build-out of a moored Gulf of Alaska Ecosystem Observatory (GEO) and the Bering Sea Ecosystem Observatory by providing funding for equipment purchases and continuing support for Chukchi Ecosystem Observatory (CEO).**
 - GEO Moorings recovery and re-deployment. Original completion date: July 2021.
All mooring deployments and recoveries went as planned at the GEO site in the GOA. Highlights included a recovered sediment trap and a water sampler each with a full set of samples, and an AURAL with a full year of data. The ITP did not return a full set of data and we are working with the manufacturer to assess reasons for this. The instrument did suffer excessive corrosion on the endcaps, which we have authorized for replacement (the main vehicle body remains in serviceable shape).
Status: Complete.
 - CEO Moorings recovery and re-deployment. Original completion date: October 2021.
CEO mooring deployed November 2021. The original CEO mooring cruise was delayed due to pandemic-related issues on the NOAA cruise, which was cancelled at Dutch Harbor. A last-minute replacement cruise on R/V *Sikuliaq* was able to deploy a single mooring with new sediment trap, sound trap, CTD, and SeapHOx, but we were unable to fly the tripod and eDNA sampler out of Dutch Harbor due to their physical sizes. Therefore, the tripod was not deployed. We did not attempt to recover the 2020 CEO ADCP and AZFP moorings because they should have enough battery power and memory to continue collecting data for another year. The CEO cruise cancellation resulted in cost-overruns related to additional personnel expenses and flights in/out of Dutch Harbor, and lodging in Dutch Harbor organizing the airlift of some CEO cargo to Nome, and the transport of the rest of the cargo back to Seward via barge. We are still assessing overall impact on the scope of work, as we have reason to believe that NOAA (who chartered the cancelled cruise) may be providing some financial support to help us mitigate these overruns.
Status: Complete.
 - Purchase equipment; Original Completion Date: October 2021.
Status: On track.
 - Continue updates of project website; Original Completion Date: March 2022.
Status: On track.
 - Monitor incoming data (ongoing); Original Completion Date: May 2022.
Status: On track.
 - Preparations for 2022 mooring turnarounds; Original Completion Date: May 2022.
Status: On track.
- **Subaward to UAF to add additional sensors to the CEO and GEO moorings with Fill the Gaps funds in support of Arctic Marine Biodiversity Observing Network (AMBON)**
 - Purchase Equipment. GreenEyes Aqua Monitoring System, Sexton Benthic Camera System, RBR Duet, ProOceanus Systems, and Tripod frame materials (pipe, frame mount plastic, etc.) purchased.
Status: Complete.
 - Assemble an O₂/N₂ biological gas rate system using RBR Duet T.ODO and Pro-Oceanus total dissolved gas pressure (TDGP) sensors. An identical system was deployed on the 2020 GEO mooring; this purchase will allow us to deploy this sensor suite on the 2021 GEO mooring.
Status: Complete.
 - A benthic time-lapse camera system will be developed in collaboration with The Sexton Corp. This will be installed on the CEO mooring array in the northeastern Chukchi Sea.
Status: Complete.

- Develop a modified mooring anchor - a bottom lander tripod platform - for deployment of the downward-looking benthic time-lapse camera and other sensors. The camera system was developed during 2020-2021 and was ready to deploy on the CEO during the turn-around in summer 2021.

Status: Complete.

- Deploy CEO and GEO moorings with new sensors. Original completion date: Summer 2021. The GEO moorings were deployed in July 2021. A single CEO mooring was deployed in November 2021, but the CEO Tripod and eDNA sampler were not deployed in 2021. The October 2021 scheduled cruise was delayed due to pandemic-related issues in which the NOAA charter was cancelled at Dutch Harbor. A last-minute replacement cruise on R/V *Sikuliaq* allowed for deployment of only a single refurbished mooring, as we were unable to fly the Tripod and eDNA sampler out of Dutch Harbor to meet the R/V *Sikuliaq* due to their physical sizes. Plans are now to deploy the tripod and the eDNA sampler at CEO in 2022.

Status: Delayed.

- **Funding set aside to NOAA/Alaska Fisheries Science Center to Expand Mooring Site M8 with New Sensors.**

- Deploy new equipment at mooring location, sampling at hourly intervals; Original completion date: September 2020.

Status: Complete.

- Turnaround equipment at mooring location; Original completion date: May 2021.

Status: Canceled due to COVID-19.

- Turnaround equipment at mooring location; Original completion date: September 2021.

Status: Canceled due to COVID-19.

- **Subaward to University of Texas at Austin (UTA) with Fill the Gaps (FTG) funds to purchase sensors to add to three moorings in the Beaufort Sea coastal area;** Original completion date May 2021.

- Status: Delayed. UT Purchase Order 2021C00926 issued to Sea-Bird for procurement of three SeaFET v2.0 instruments (with biofouling Guard). Total cost: \$31,805.09 (difference with AOOS allocation of \$28,986 paid with BLE LTER funds). This was a significant discount, and with that, three SeaFETs were possible, when normally, this would have only been enough to purchase two. Due to internal QA/QC issues between Sea-Bird and Honeywell (the supplier of a critical component required to assemble SeaFETs), the availability of new SeaFETs was delayed six months. The 2020 COVID-19 situation also caused delays on instrumentation procurement, as many businesses were working under reduced capacity and experiencing supply chain issues, delaying expected delivery dates of ordered equipment. Original completion date: September 2020.

Status: Complete.

- SeaFETs received from Sea-Bird. Original completion date: March 2021.

Status: Delayed.

- Field test all three SeaFET v2.0s prior to August deployment in the Beaufort Sea. Original completion date: May 2021.

Status: Delayed.

- Amended contract to include purchase of 4 Mini-DOT oxygen sensors submitted in November 2021. Purchase 4 Mini-DOT oxygen sensors for deployment on the BLE LTER. Original completion date: December 2021.

Status: On track.

- Expected scheduled delivery of 4 Mini-DOT oxygen sensors will be for deployment in summer 2022. Original completion date: February 2022.

Status: On track.

1.3.3.3. Pilot use of gliders to monitor ocean conditions and marine mammals

- **Subawards to Woods Hole Oceanographic Institute (WHOI), UAF, and University of Washington (UW) to conduct a simultaneous marine mammal and oceanographic survey of the Chukchi Sea using a Slocum autonomous underwater glider.**

- Deploy glider in southern Chukchi Sea using ship of opportunity; Original Completion Date: July 2021. The whale glider serial number 595, aka "Loki" was deployed from R/V *Norseman II* on July 11, 2021 approximately 100 km north of Wales, AK on Rebecca Woodgate's Bering Strait cruise.

Status: Complete.

- At sea data collection. Maintain a website with real time acoustic detections and oceanographic data;

Original Completion Date: October 2021.

Loki travelled in a zigzag pattern from the deployment site to a pickup location 5 km from the beach in front of Utqiagvik, AK. Loki was recovered on Sept 12. All science and passive acoustics functioned flawlessly during the deployment. Real time data and platform diagnostics were presented on the WHOI Website: Robots4Whales: http://dcs.who.edu/chukchi0721/chukchi0721_unit_595.shtml
Hydrographic data from the glider was also displayed in real time on the AOS data portal at: <https://portal.aos.org/#platform/d1373baa-68a2-50c5-8607-82e88225bb58/v2>

Status: Complete.

- Glider recovered, acoustic and oceanographic data downloaded; Original Completion Date: October 2021.

As of November 2021, all oceanographic and acoustic data has been downloaded from the glider and sent to our collaborators at partner institutions. The acoustic data will be examined and verified for marine mammal detections.

Status: On track.

1.3.3.4. Pilot the use of gliders to assist in an ecosystem approach to fisheries management

- **Subaward to UAF to purchase equipment and begin glider surveys in the Gulf of Alaska and the Bering Sea.**

- Send 3 gliders to Teledyne Webb for hardware upgrades; Original Completion Date: March 2020.

Status: Complete.

- Glider pilot training; Original Completion Date: September 2020; Revised to May 2021 during COVID-19 2020.

New expected completion date is May 2022 - Logistics during the COVID-19 period continues to preclude safe and cost-effective travel for in-person trainings run by Webb. In order to deepen our pool of glider pilots to support missions in 2021-22, we developed an in-house training seminar series. We are now in communication with Teledyne Webb Research to schedule an in-person training in Seward, AK.

Status: Delayed.

- Two Alaska region glider deployments; Original Completion Date: October 2020-May 2021.

Three separate glider deployments in PWS in the northern GOA were completed between January-May 2021. An additional deployment is scheduled for January 2022 along the Seward Line, also in the GOA. Batteries for the winter 2022 Seward line glider transect were acquired and preparation for the winter surveys is underway. Initial planning for a Bering Sea survey is also underway. Since the completed glider missions in PWS, ADF&G has expressed interest to assist with tagged snow-crab surveys in the Bering Sea. We are currently working through the planning for a 2022 Bering Sea deployment.

Status: Complete.

- Development of EAFM Indices; Original Completion Date: May 2021.

Expected December 2021 - January 2022. We are working toward providing a measure of environmental anomalies based on use of the World Ocean Atlas monthly gridded hydrographic datasets. Our sensor upgrades place us squarely in the realm of being able to capture fisheries-management-relevant data that extends beyond the near-real-time environmental conditions. Our partnership with the PWSSC in 2021 to find tagged herring using a glider equipped with a real-time PIT tag receiver resulted in over 3,000 total detections with about 30 unique tagged herring. The initial version of the dashboard being developed by Axiom Data Science is near ready for inspection and testing. Plans are to trial the dashboard during the January 2022 deployment if ready.

Status: Delayed.

1.3.3.5 Demonstrate operational readiness of AUV-based ecosystem monitoring through a field program supporting the International Year of the Salmon (IYS).

- **Subaward to UAF and UW to expand the sampling capability of a Slocum autonomous underwater glider to provide in-situ ecosystem monitoring.**

- Hardware upgrade; Original completion date: November 2020.

Status: Complete.

- Odroid and glider software upgrades; Original completion date: December 2020.

Software development of the python code to trigger the echosounder, process relevant data fields and send echo-metric data files to the glider science computer has been completed and verified. Additional modifications, validation, and testing of the system on the bench has increased robustness. Two programmers have been hired to complete tasks.

Status: Complete.

- Project website and *Ecometrics Dashboard* app version 1 developed; Original completion date: December 2020.

An initial version of dashboard under development with Axiom is nearly ready for inspection and testing. New target timeline for demonstration of the dashboard is December 2021 to January 2022 (tentative subject to Axiom progress).

Status: Delayed.

- Tank test and field test in Resurrection Bay; Original completion date: January 2021. The initial field trial completed in Sept 2021 revealed software and hardware installation errors by Teledyne Webb. Additional bench tests in Fairbanks were completed Oct – Nov 2021. An additional field trial is planned in Seward in Dec 2021 prior to the planned January 2022 deployment.

Status: Complete.

- Glider deployment; Original completion date: Deployment in February 2021 and recovery in May 2021. The IYS field program was delayed until the winter 2021/2022 due to COVID-19. The new target deployment timeline is for a glider launch in January 2022, ongoing glider mission during the IYS cruise in February 2022, and a glider recovery in March - April 2022.

Status: Delayed.

- Post-deployment assessments of software and glider ops; Original completion date: May 2021. Status: Delayed. No activity to date as glider deployment was delayed until 2022. Ongoing assessment and modification to acoustic brain software continues, from which the performance will be monitored during the deployment cruise in 2022. Post cruise assessment will be completed. New Target Completion Date: May 2022.

Status: Delayed.

- **Subaward to Axiom to expand the sampling capability of a Slocum autonomous underwater glider to provide in-situ ecosystem monitoring.**

- Make real-time and post-processed glider data accessible through the AOOS data portal; Original Completion Date: May 2021.

Four separate 2021 glider missions were ingested, visualized, and made available in real-time to the AOOS data portal. Three of the missions were part of the EAFM glider trials in Prince William Sound (see project H2400-89). The fourth was the annual Chukchi Sea Glider transect (see project H2400-626366) (link). This capability is now ready for the IYS glider deployment scheduled for January 2022.

Status: On track.

- Provide technical support for data formatting and metadata creation to ensure data products are submitted to IOOS Glider DAC; Original Completion Date: May 2021.

Axiom leveraged the Southeast Coastal Ocean Observing Regional Association (SECOORA)/gUtils package for reading, merging, and post processing four Slocum Glider deployments in PWS which included the metadata required for submitting and serving data via the IOOS Glider Data Assembly Center (DAC).

Status: On track.

- Develop Ecometrics dashboard to expose past and current environmental conditions along the glide path; Original Completion Date for Ecometrics Dashboard app version 1: December 2020. Completion of version 1 of the Ecometrics Dashboard was delayed a year, given the postponement of the 2021 IYS Glider deployments during COVID-19 related delays with glider readiness. Axiom has been developing a version 1 of the Ecometrics dashboard that compares real-time glider observations to the World Ocean Atlas climatologies and displays a current status indicator to users. Delivery of version 1 is expected in early December 2021 for feedback by project partners. The dashboard will be tested during the resumed 2022 IYS Glider missions. Necessary modifications will be implemented by May 2022.

Status: On track.

1.3.3.6 Improve the forecasting of ocean acidification that will benefit fishery biologists in NOAA's Integrated Ecosystem Assessment (IEA) Program and fisheries managers through the Ecosystem Status Reports (ESR).

- **Subaward to UAF to co-locate chemical monitoring and forecasts with current fishery and ecosystem monitoring.**

- Original completion date: May 2021. The plan to collect and analyze samples as part of the Bering Arctic Subarctic Integrated Survey (BASIS) survey cruise was canceled due to COVID-19. Because NMFS research cruises only take place in even-numbered years, this work will be picked up again in summer

2022. Under a normal timeline, we would analyze the samples during the year following the field work (Fall 2022 – Summer 2023) and finalize and archive the data before two years had passed (Summer 2024). Currently, a No Cost Extension (NCE) has been approved by AOOS/IOOS/NOAA for this project until March 2022. AOOS and UAF staff met with the IOOS Program Office in July 2021 to discuss the need for an NCE; the general consensus was the AOOS and UAF would ask for an NCE through May 2024 to allow for data collection and analysis.

Status: Delayed.

1.3.3.7. Regional Sentinel Observations

- **Subaward to PWSSC to support partnership to operate and maintain acoustic arrays across major PWS entrances and maintain conductivity sensor.**
 - Perform annual maintenance on the SnoTel stations; Original Completion Date: September 2021.
Status: Complete.
 - Swap conductivity sensor at Cordova tide station; Original Completion Date: June 2021
It was discovered that the system was not reporting beginning in May 2021. A swap of sensors did not correct the problem. The cabling needed to be replaced and that occurred in October 2021 once the spare parts and time became available. During that time the sensor was sent to the manufacturer for any necessary repairs and calibration.
Status: Complete.
 - Clean conductivity sensor at Cordova tide station; Original Completion Date: September 2021.
Status: Complete.
- **Funding set aside to NOAA/UAF's Kasitsna Bay Laboratory and other partners to collect oceanographic data along repeated transects in Kachemak Bay and lower Cook Inlet.**
 - Conduct monthly CTD surveys at mid-Kachemak Bay and along-bay transects; Original Completion Date: November 2021.
Status: Complete. All surveys were completed during this period. We leveraged support from National Centers for Coastal Ocean Science (NCCOS) and Exxon Valdez Oil Spill Trustees Council (EVOSTC) to enable monthly along-estuary sampling during this period, in addition to cross-bay sampling. Unfortunately, our EVOSTC Cook Inlet oceanographic monitoring project was not funded for FY22-31. This will affect field sampling and data analysis capabilities, starting in February 2022. We are currently evaluating the impacts on the scope of work for this project and will set up a meeting with AOOS staff in January to discuss it further.
Status: Complete.
 - Conduct three seasonal CTD surveys at outer Kachemak Bay transect (spring, summer, fall); with two scheduled in the June-November reporting period. Original Completion Date: November 2021.
Conducted two seasonal cross-bay surveys on outer Kachemak Bay transect in July and September 2021.
Status: Complete.
 - Deliver quality assured/quality controlled oceanographic data to AOOS data contractor Axiom within 6 months; Original Completion Date: November 2021.
QA/QC'd oceanographic data from the Kachemak Bay surveys through August 2021 have been provided to Axiom via the Research Workspace.
Status: Complete.
 - Deliver oceanographic data and metadata to other NOS offices, BOEM and other agencies and stakeholders (on request). Project oceanographic data are being used for a project with AOOS, Axiom Data Science, Cook Inlet Regional Citizens Advisory Council (CIRCAC), and Oil Spill Recovery Institute (OSRI) to validate the NOS Cook Inlet Operational Forecast System (CIOFS) model for ecosystem resource management and oil spill planning applications (beyond navigation services) and using it to develop new circulation-based tools for oil spill response and resource management. While the original proposal to the IOOS Coastal Ocean Modeling Testbed (COMT) funding opportunity was not funded, parts of the project are moving forward with funding support from NCCOS, OSRI, and the NOAA Alaska Regional Collaboration Team to start.
Status: On track.

1.3.3.8. Develop data products in the Alaska region to support NOAA's Regional Collaboration Team.

- Regional Ocean Data Sharing Coordinator (Prewitt) coordinated and worked with Axiom to continue reviewing data sources for the project and gather feedback on the prototype for the dashboard. Projected completion date May 2021.

Status: Delayed.

- **Subaward to Axiom to enhance the utility of the Alaska Fisheries Science Center's Ecosystem Status reports and IEA Indicators.**
 - Develop a detailed workplan collaboratively with the AOOS Regional Data Sharing Coordinator and the NOAA Alaska Regional Collaboration Team Lead and Coordinator; Original completion date May 2020.
Status: Complete.
Display NMFS ecosystem IEA indicators from current Alaska Ecosystem Status Reports (ESRs) as a report card/dashboard on AOOS portal as part of a State of Alaska's Coasts and Oceans synthesized report. Link all of the current ESRs together, as well as the Arctic Report Card.; Original completion date May 2021. Expected completion May 2022. Axiom worked with the AOOS project coordinator to isolate requirements for the ESR dashboard tool, in addition to the relevant ecosystem system indicators that will be included (Task 3). Data from the indicators was ingested, standardized, and exposed for interaction by end-users in an early version of the dashboard. The mock-up is accessible: http://dashboards.dev.axiomdatascience.com/?portal_id=25#dashboards/iea.
Status: On track.
 - Assess current indicators and the adequacy of the various data sources used to support them. Identify additional data sets to support the indicators that could be used by the Alaska Fisheries Science Center; Original completion date May 2021.
Status: Complete.
 - Assess the potential for adding new indicators, such as harbor usage rate, oil spill response capacity, ocean health index, living resources assessment, shipping, and vessel traffic change over time visualizations, etc.; Original completion date May 2021.
Expected completion May 2022. Initial indicators were developed using existing data within the AOOS data system, in addition to other sources of existing information, including: sea ice, water temperature, physical oceanography, biological productivity, shipping and infrastructure, marine mammals, fisheries, and human factors. Next steps involved working with end users to receive feedback and additional desired indicators to be included in a prototype version.
Status: On track.
 - Work with developers of the West Coast Ocean Health Index product and the AHAB Network and AK-OAN to determine the possibility for Alaska HABs, OA, ocean warming, and hypoxia indicators (or contextual information); Original completion date May 2021.
Status: Delayed.
 - Do a comparative analysis of other tools for possible incorporation into IEA data products, such as Google Earth engine tool, I-Naturalist (uses OBIS), etc.; Original completion date May 2021.
Status: Delayed.

1.3.3.9. Prepare historical records of seabird mortality data to conform with Darwin Core Standards for ingestion to AOOS data portals using Matt Howard funding.

- **Contract to Coastal Observation and Seabird Survey Team (COASST), UW to integrate COASST Beached Bird Monitoring Data into AOOS Using Darwin Core Standards.**
Status: Complete.
- **Contract to Axiom to align biological datasets to the Darwin Core Standard and make them available through ERDDAP servers and the AOOS and Marine Biodiversity Observing Network (MBON) data portals.**
Status: Complete.

1.3.4. Water Quality

1.3.4.1. Sustain OA monitoring including moorings, sampling along the Seward Line, Burke-o-lators (BoL), and an instrumented ferry.

- **Subaward to UAF to continue a ten-year time-series in the GOA along the Seward Line as well as support the deployment of OA moorings adjacent to the oceanographic sampling line.** Original Completion Date: September 2020.
 - This project has been completed.
Status: Complete.
- **Subaward to Alutiiq Pride Shellfish Hatchery to maintain continuous ocean acidification monitoring using a permanently installed BoL, including community sampling;** Original Completion Date: November 2020.
 - This project has been completed.

Status: Complete.

- **Subaward to UAF to conduct a regional OA Monitoring Cruise in the GOA.**

This cruise was originally planned to sample the entire Gulf of Alaska in summer 2019 but was postponed due to the 2019 Federal shutdown delaying funds to secure a research vessel. Due to the lack of vessels available for a Gulf-wide cruise in 2020, plans were pared down to only include observations in southeast Alaska. The revised cruise plans were canceled due to COVID-19. We are currently planning to execute this cruise in summer 2022. Under a normal timeline, we would analyze the samples during the year following the field work (Fall 2022 – Summer 2023) and finalize and archive the data before two years had passed (Summer 2024). Currently, an NCE has been approved by AOOS/IOOS/NOAA for this project until March 2022. AOOS and UAF staff met with the IOOS Program Office in July 2021 to discuss the need for an NCE; the general consensus was the AOOS and UAF would ask for an NCE through May 2024 to allow for data collection and analysis.

Status: Delayed

- **Subaward to Rutgers University to assess pH and plankton in the GOA.**

Original Completion Date: May 2021. AOOS and UAF staff met with the IOOS Program Office in July 2021 to discuss the need for an NCE; the general consensus was the AOOS and UAF would ask for an NCE through May 2024 to allow for data collection and analysis

- Prep glider for deployment. This includes calibration of sensors, glider ballasting, and packing for shipment; Original completion Date: March 2021. Batteries were received and the glider science bay with the calibrated pH/CTD sensor is ready for installation. Glider prep will be completed once the deployment schedule is determined in Fall 2022.

Status: Delayed.

- Ship glider to deployment location in Southeast Gulf of Alaska, final preparations for deployment (specifically re-condition the pH/CTD sensor after shipment); Original completion Date: Apr 2021.

Status: Delayed.

- Deploy vertically-profiling glider in Southeast Gulf of Alaska (either 1 long transect or two shorter transects, still TBD); Original Completion Date: September 2021.

Will occur Fall 2022. Discussions with the larger project team led to planning 1 (up to 90-day) deployment powered with a standard lithium battery pack. The deployment area will occur offshore near Ketchikan and will run north, with recovery offshore near Sitka.

Status: Delayed.

- Perform data quality control; Service sensors if needed; Original completion date: Dec 2021. Will occur after deployment

Status: Delayed.

- Glider data processing, analysis, and management; begin figure preparation, presentations, manuscript writing; Original completion date: May 2022. This will occur post-deployment, May 2023.

Status: Delayed.

- **Subaward to Hakai Institute to operate and maintain the ocean acidification instrumentation onboard the Alaska Marine Highway ferry *Columbia*.**

- This project has been completed.

Status: Complete.

- **Subaward to the Sitka Tribe of Alaska/ Southeast Alaska Tribal Ocean Research Network (SEATOR) to support the Indigenous led baseline ocean acidification data collection and monitoring efforts.**

- Purchase supplies for the discrete sample kits to be distributed to SEATOR Partners; Original completion date: September 2020.

Status: Complete.

- Build and distribute discrete sample kits for SEATOR Partners; Original completion date: October 2020.

Status: Complete.

- Run discrete sample analysis on SEATOR partner samples; Original completion date: May 2021. STAERL staff spent most of 2020 working from home due to COVID-19 and were unable to analyze samples. Additionally, STAERL has been short staffed since April-2021, resulting in additional delay. STA has hired a new BoL operator to assist with discrete sample backlog. After the lab was re-opened from COVID-19, STA staff cleaned out the BoL system and are prepped for discrete sample run.

Status: Delayed.

- As needed contractual service with Schmolck Mechanical; Original completion date: May 2021.

STA just opened their offices to contractors on June 1, 2021.

Status: Delayed.

- As needed consumable and replacement part replacement; Original completion date: May 2021.

Status: On track.

- **Subaward to the Alutiiq Pride Shellfish Hatchery to support ocean acidification infrastructure maintenance and improvement;** Original completion date: May 2021.

- This project is now complete.

Status: Complete.

1.3.4.2. Support Alaska OA Network

- AOOS received funding from the national OA Program to support the AK-OAN. Original Completion Date: May 2021. Now on track to be completed by May 2022.

Status: Delayed.

1.3.4.3. Support Alaska Harmful Algal Bloom Network

- **Subaward to Alaska Sea Grant to provide outreach support to Bering Strait Communities;** Original Completion Date: September 2019. One workshop was conducted in Nome in summer 2019 and other outreach activities are underway. On track for completion.

Status: Delayed.

- **Subaward to Axiom to provide data management support to the coordination of state-wide HAB data collection and sharing efforts across state, federal, local, tribal agencies, researchers, and communities.**

- Delivery of central data sharing platform to consolidate AHAB statewide data across regions; Original completion date: May 2021.

Axiom stood-up a dedicated Research Workspace campaign to assist the AHAB Network in efficiently meeting their objectives and ensuring data produced or consolidated through the effort are organized, documented and available to be used by community members and management agencies.

Status: Complete.

- Provide technical support for data formatting and metadata creation to ensure data products meet AOOS Certification standards; Original completion date: May 2021.

Throughout the performance period, Axiom maintained the Research Workspace for the storage of existing and new data collection. Additionally, Axiom worked to onboard the new AHAB Coordinator to the platform, who began this position in November 2020.

Status: On track.

- Maintain and enhance the AHAB data portal for visualization and public access to HAB data and data products; Original completion date: May 2021.

Axiom met with the AHAB Coordinator to discuss enhancements to the AHAB data portal and the data templates that will be used to feed HAB information to the system. This work will be ongoing through Q3-Q4 after new data become available.

Status: On track.

- Scope the requirements for developing a central, statewide data entry interface for regional phytoplankton and toxicity community monitoring data; Original completion date: May 2021.

Axiom gave input to the AHAB Coordinator relative to data entry template that will feed a statewide AHAB database and entry interface to input, store and share Alaska phytoplankton (assuming the potential sunset of the SoundToxin database) and toxicity data from across the regions. This feedback helps to ensure the AHAB data portal will be connected to the central database to allow users to access near real-time monitoring and shellfish toxicity information in an interactive map interface.

Status: On track.

- Submit final datasets, data products, and metadata to the NOAA NCEI repository for long-term preservation; Original completion date: May 2021.

This task is scheduled to begin in Q4.

Status: On track.

1.3.4.4. Support the University of Alaska's Ocean Acidification Research Center (OARC).

- **Subaward to the UAF to execute a comprehensive carbonate chemistry assessment of US Distributed Biological Observatory (DBO) activities.**

- Cruise planning, equipment mobilization; Original Completion Date: May 2021.

Status: Complete.

- Conduct research cruise for the DBO; Original completion date: September 2021.

This planned cruise was canceled at the start of the mission due to a COVID-19 outbreak on board in September 2021. The RV *Sikuliaq* was chartered for a combined mission Nov 7-17 and successfully occupied DBO survey sites 1-4.

Status: Delayed.

- Sample analysis at the OARC at UAF.; Original Completion Date: May 2022. Seawater samples from the 2020 DBO field campaign (SKQ202014S) were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA) in Fall 2021. The finalization and archival of the data rely on nutrient data collected by partners in the DBO program; therefore, the 2020 OA dataset remains preliminary. Seawater samples from the 2019 DBO field campaign collected aboard the USCGC *Healy* (HLY1901) were submitted for archival at the Ocean Carbon and Acidification Data Portal (OCADS) at the National Centers for Environmental Information (NCEI) in November 2021. All doi links for the DBO project are also located on the Data Resources page at the OARC.

Status: On track.

- **Subaward to the UAF to support the ocean acidification monitoring network in Alaska Coastal Seas.**

- Support equipment maintenance and turnaround for OA surface mooring at GAKOA Original Completion Date: Ongoing. The GAKOA surface mooring will be turned around in March 2022. Seawater samples collected at the moored sensor sites at GAKOA and GAK1 are collected during the monthly sampling missions aboard the R/V *Nanuq*.

Status: On track.

- Support equipment maintenance and turnaround for OA surface mooring at M2. Original Completion Date: Ongoing. The M8 surface mooring (southeastern Bering Sea) was successfully picked up by the *Sikuliaq* in Nov 2021. M2 is planning to be picked up in January or February 2022.

Status: On track.

- Delivery of updated database links to AOOS for inclusion in AOOS data portal; Original Completion Date: Ongoing. All final autonomous data have been archived and are publicly available at NCEI and on the OARC website.

Status: On track.

1.3.5. Streamline access to Observations

- FY19: AOOS received \$75k to help fill gaps and streamline access to ocean observations. Original Completion Date: June 2019. Some of the funds are used to develop the Tiered Water Level Data Portal (see section 1.3.2.5). The remaining FY19 FTG funds were to be used for an additional remote AIS/weather station on St. Lawrence Island; however, the determined costs for this installation exceeded available funding. The funds were reallocated by the AOOS Board for co-installations of weather sensors at existing AIS stations in the western Alaska communities of St. Paul, St. George and Shishmaref. Due to COVID-19 travel restrictions in rural Alaska during 2020, funds were used to update and add AIS/weather stations in southeast Alaska. COVID-19 travel restrictions to the three remote communities persisted throughout 2021, again preventing the weather station installations in St. Paul, St. George, and Shishmaref during 2021. When travel allows, funds provided to the MXAK as part of their annual award will be used to complete these western Alaska sites.

Status: Complete.

- FY20: AOOS received \$75k to help fill gaps and streamline access to ocean observations. Intended use to deploy NWLON-lite water level station in Dillingham. Original Completion Date: Fall 2020. COVID-19 travel restrictions during 2020 delayed this project, but with a no cost extension, the project was underway during the summer of 2021, and completed in November 2021.

Status: Complete.

1.4. Data Management & Communications Subsystem, subaward to Axiom

1.4.1. Provide Core Data Management & Cyberinfrastructure (DMAC) Support

1.4.1.1. Provide technical support for AOOS cyber infrastructure.

- During this performance period, Axiom maintained ongoing continuous performance of the AOOS data system following IOOS DMAC guidelines. Additionally, Axiom completed the new data center build out.

Status: Complete.

1.4.1.2. Data Portal Development.

- Axiom released version 2.13 of the data portal on December 8, 2020. Frontend and backend work occurred to develop features for the next version 2.14 release, scheduled for early 2022. This work includes: symbology changes to sensor layer for better contrast with lighter base layers, user settings for color bar management, user

settings for coordinate management, and print charts and data views as jpg files.

Status: Complete.

1.4.1.3. Maintain QARTOD testing for applicable data streams to remain RICE compliant and enhance the quality control system with advanced and user-requested applications.

- During this performance period, basic QARTOD tests were applied for 539 [historical and real-time](#) sensors that are accessible through the AOOS data portal.

Status: Complete.

1.4.2. *Provide DMAC support to the AOOS program*

1.4.2.1. Provide overall DMAC project management and oversight.

- Axiom participated in regular, weekly meetings with AOOS to discuss and communicate progress on project tasks. In addition, a Trello project management board was maintained to track data management task progress. One quarterly progress review meeting was held with AOOS staff during the reporting period. Axiom also contributed monthly data management highlights to the AOOS newsletter and spring e-newsletter.

Status: Complete.

1.4.2.2. Participate in regional, state, national and international DMAC activities.

- Axiom participated in the 2021 DMAC Virtual Annual Meeting held June 15-17, 2021. Axiom gave four oral presentations at the meeting. Axiom also participated in other regionally and nationally relevant DMAC meetings.

Status: Complete.

1.4.2.3. Implement recommended and standard data management procedures for AOOS data assets.

- Through this period, Axiom maintained IOOS compliant services and applications for integration with national products. Activities involved migrating AOOS metadata to the [IOOS v1.2 metadata profile](#), which included: improvements to attribution fields for more consistent attribution in IOOS national products, a new section to describe results of QARTOD testing, and an overhaul of platform section, including CF Discrete Sampling Geometry recommendations for different deployment scenarios. Effective January 2021, NDBC began harvesting observation data sets from the AOOS ERDDAP server for insertion to the GTS.

Status: Complete.

1.4.3. *Develop and maintain special data products*

1.4.3.1. Support existing data products.

Activities completed to support existing data products included:

- rebuilt the [NWS Alaska Sea Ice program](#) ingestor package into a packrat framework and migrated codebase to Python into a importer container to ensure continuous data integration in the v2 data portal system
- resolved technical issues and data download using the virtual sensor for the [Gulf of Alaska Hydrology Model](#) in order to deliver data to end user
- worked with data provider to adjust QC parameter flags for [Hakai Institute](#) BoL stations to display post-calibrated and quality-controlled data
- responded to bug fixes and making other ease-of-use improvements to datasets, including updating portal tags and exposing additional metadata for platform (i.e., mobile) instruments.

Status: Complete.

1.4.3.2. Ingest new datasets and metadata.

Activities completed to ingest new data and metadata included:

- added 3 new [Marine Exchange of Alaska](#) real-time stations to the AOOS data portal and catalog
- added 8 new [Fresh Eyes on Ice](#) river ice stations to the AOOS data portal and catalog
- ingested in real-time three [UAF Shackleton glider missions](#) in PWS for display in the AOOS data portal and submission to the ATN DAC
- ingested the GFS Wave model as a replacement to WaveWatch III (deprecated March 2020)

Status: Complete.

1.4.3.3. Develop new data products.

Activities completed under this task included supporting researchers in updating the 2021 [Yukon River Chinook run timing forecast model](#) and data delivery through AOOS Website. Axiom continued to provide support to the Arctic ION program for the development of the observing system's [Sankey diagrams](#) and website product. Three iterations of the Sankey diagrams have now been developed. Additionally, Axiom provided low-grade maintenance to the [Alaska Shellfish and HAB data](#) portal that displays near real-time phytoplankton and shellfish toxicity results. Last, Axiom has been developing an automated data processing pipeline for the post-processing of UNAVCO data from engineering to scientific units for water level data access and display in the AOOS data

portal.

Status: Complete.

1.4.4. Host and Support AOOS Website

1.4.4.1. Host and maintain the AOOS web portal.

During the performance period the AOOS website, hosted by Axiom, was stable and secure. Additionally, Axiom continued participating in regular meetings with the AOOS Web Team on the website redesign and new portal interface pages. During this performance period, data views were updated to fix broken links for stations that formerly were not available in the new v2 sensor system on the AOOS portal landing page. Additionally, Axiom assisted with project page content for new website pages.

Status: Complete

1.4.4.2. Provide access to data portal through website.

Axiom provided access through the AOOS website to the AOOS data portal user interface and visualization tools, data products, data query and access tools, decision-support tools, agency project tracking systems and databases, as well as IOOS Registry tools.

Status: Complete.

1.4.5. Support national IOOS Program data management activities

1.4.5.1. Maintain and Enhance Data Access Service Software: ERDDAP and Environmental Sensor Map (ESM) and Global Data Integration

- **Task 1: Maintain and Enhance Data Access Service Software – ERDDAP**

The key software stewardship activities include the following subtasks; approximate allocation of resources for each subtask is provided in parentheses.

- **Defining High-Level Feature Roadmaps (5%):** IOOS has spent the past two years investigating ERDDAP as the new recommended data access service for in-situ observations. ERDDAP's broad use in the community, robust APIs, and simple interface make it an attractive solution to improve accessibility and re-use of IOOS RA datasets. To implement this project, Axiom created a document entitled [IOOS Environmental Sensor Map: FY19 ERDDAP RoadMap](#) that outlines the release approach and timelines that were maintained throughout the project.
- **Release Planning and Management (10%):** A primary motivation for a new release of the ERDDAP service and v1.2 IOOS Metadata Profile is to ensure consistent dataset structure across RA ERDDAP servers, so that national partners can harvest data via a single process. Throughout the performance period, Axiom met at bi-monthly intervals to track development progress and coordinate project communications across IOOS RAs and NDBC. Axiom presented on the status of the ERDDAP transition project and guidelines at the October 2020 and the June 2021 virtual DMAC Meetings.
- **Development & Implementation (40%):**
The [IOOS Metadata profile](#) is a compound profile that builds off of the [NOAA NCEI NetCDF Templates](#), which in turn build off of the [Attribute Convention for Data Discovery \(ACDD\)](#) and [Climate and Forecast \(CF\) Conventions](#). Axiom worked with the IOOS Program Office to implement Version 1.2 of the IOOS Metadata profile that incorporates feedback from the IOOS community
As part of this effort, new CF standard names for describing QC/QARTOD tests were established for inclusion in the metadata profile. Effective January 2021, NDBC began ingesting data streams from AOOS, SECOORA, and CeNCOOS via ERDDAP for insertion into the GTS.
- **Improved User Documentation (15%):** As listed in task 1.c (above), user documentation was updated for:
 - [IOOS Metadata Profile version 1.2](#)
 - [QARTOD guidelines](#) using the CF ancillary variables approach
 - ['Gold standard' ERDDAP configuration documentation](#), with datasets compliant with IOOS Metadata Profile 1.2
- **Establishment of Test Environments and Test Datasets (10%):** To assist RAs or others in the community who are setting up ERDDAP for the first time, Axiom created a "Gold Standard" server with examples that follow the v1.2 Metadata Profile and QARTOD and GTS ingest standards. This ERDDAP server is live at standards.sensors.ioos.us and the setup is [available in a GitHub repository](#). This environment was created to support users working in this repository as a starting point for their own ERDDAP setup.

Status: Complete.

- **Task 2: ESM and Global Data Integration Environmental Sensor Map.**

- **Defining a high-level roadmap (5%):** The high-level roadmap for this project was defined in two documents: i) [FY20 Portal release schedule](#), which outlined the development lifecycle, features, and timeline for version releases of the Sensor Map, and ii) [Plan for Quality Control of Sensor Data](#), which outlined the approach for integration of QARTOD and other data quality end user functionality to the ESM and other IOOS Regional Association data portals.
- **Release Planning and Management (10%):** Throughout the performance period, Axiom met at bi-monthly intervals to track development progress and coordinate project communications with the IOOS Program Office. Project tasks were tracked and managed using a dedicated project [Trello Board](#) and shared with project partners.
- **Enhancements, Bug Tracking and Fixes (75%):** During this performance period, a version 2.14 of the ESM was released. Elements of this update included:
 - display of instrument narrative and annotations on the station page
 - introduction of data download queue that allows for saving, sharing, and building dataset downloads
 - introduction of user timezone selector
 - modularization and enhancements to the time slider, including time increment selection on the keyboard
 - integration of brush time selection for time series charts

During the performance period, approximately 85 new real-time sensors were added to the Environmental Sensor Map from observing systems across the IOOS enterprise. In FY20, 2,055 real-time stations or station updates were made to the ESM. Data from these stations can be viewed and downloaded through the map. Additionally, quality flags from QARTOD tests are available visually and via download, as applicable.

- **Improved documentation (10%):** A summary of the version releases is below and full release notes can be found: <https://axiomdatascience.com/portal-updates/>.

Status: Complete

1.4.5.2. MBON Data Portal

- **Task 1: Technical development to improve performance of POC portal.**

- Processing scripts for transforming biological data from its native state into Darwin Core and OBIS-ENV formats were persisted through the Research Workspace MBON campaign's Jupyter Notebooks to support reproducible, transparent formatting of data to biological standards. Additionally, development effort was invested to improve the visualization of large biological datasets, which involved prototyping three different solutions.

Status: On track.

- **Task 2: Scoping and build-out of MBON and ATN portal integration.**

- A prototype instance was developed for users to overlay animal movement tracks with physical environmental and biological data sets in the ATN or MBON data portal maps. With this capability users are able to: i) explore data spatially and temporally (i.e., using the time slider playback), ii) browse to adjacent environment or biodiversity data nearby animal locations, and iii) download data or access it through interoperability end points for analysis. The instance is undergoing review and feedback by the ATN Coordinator and ATN Program Managers ready for testing. Next steps include developing flexible data publication linkages needed to represent animal tagging projects in multiple catalogs/portals outside of its native environment (i.e., the MBON data portal).

Status: Complete.

- **Task 3: Load and visualize more data.**

- The MBON data portal was kept current with the latest versions of biodiversity observations data that was shared among program stakeholders. Axiom worked with CariCOOS and Abigail Benson to make revisions to the [Puerto Rico Long-Term Coral Reef Monitoring Program Database Compilation \(1999-2019\)](#) dataset (accessible from [OBIS/GBIF](#)) into the MBON data system..

Status: Complete.

- **Task 5: Improve documentation.**

- . During this performance period, minor updates were made to refresh the MBON data portal help documentation: <https://mbon.ioos.us/help/>. Additionally, documentation was maintained for how to contribute biological data to the MBON Data Portal at: <https://ioos.github.io/mbon-docs/>. A summary of the MBON portal version release notes were also kept current: <https://axiomdatascience.com/portal->

[updates/](#).

Status: Complete

- **Task 6. Engage with newly funded MBON projects.**

- Axiom is engaged with data management activities in support of the AMBON project, including hosting, documenting, transforming, and standardizing data. Additionally, Axiom responded to inquiries from the Gulf of Maine MBON about utilizing the Research Workspace for data store and documentation.

Status: Complete.

- **Task 7. Meeting Participation and Travel.**

- Axiom participated in semi-regular program phone meetings to represent data management for biological data and data products via the MBON Data Portal, the IOOS DMAC virtual meeting, and the xMBON virtual meeting in February 2021.

Status: Complete.

1.4.5.3. Finalize HFR Range Series File Archiving through the Research Workspace

- **Task 1: Provide space in the Research Workspace to store all range series files for all HFR operators within the IOOS HFRNet (100%)**

- As a continuation of funding from FY19, Axiom continued to provide storage capacity for transferring and storing up to 60 TB of HFRNet data through dedicated on-premises servers or via the Research Workspace (depending on the data volumes). Offsite back-up for stored HFR data files was maintained to guard against disaster and provide data recovery. This task also involved coordinating with data providers to receive data files, transfer them to the Axiom storage infrastructure, and ensure the data files were appropriately formatted and accompanied with compliant metadata.

Status: Complete.

- **Task 2: With input from the IOOS Program Office, scientists, and HFR operators, evaluate and develop new data tool(s) for improved decision-making.**

- During this performance period a [pilot IOOS HFR website](#) was developed to include: i) information about HFR data archive, ii) inventory of available data, and iii) data formatting guidelines. A data inventory tool was created that allows users to easily view and search the archive by location, IOOS region, and temporal availability. The intent of the inventory tool is to streamline HFR data access to end users. Next steps involve working with the IOOS Surface Currents Program Manager to review and finalize the content for publication on: <https://ioos.noaa.gov/project/hf-radar/>

Status: Complete.

- **Task 3: Improve documentation on IOOS HFR website.**

- To assist users in submitting data to the archive, guidelines and templates were developed and integrated into the website for organization, documentation, and submission of formatted data. Activities will be ongoing over the next fiscal year to work with the IOOS Program Office to integrate the components of the pilot website.

Status: Complete.

- **Task 4: Project communications.**

- In March 2021, Axiom met with the new IOOS Surface Currents Program Manager to review progress and recalibrate the project for FY21, given the limited success in receiving archive-ready datasets. The recommendation was made to push real-time data feeds to the Axiom infrastructure, for inventory and data access, in addition to storage data onsite and curating redundant data copies to the cloud for long-term storage.

Status: Complete.

1.4.5.4. Saildrone 2: Novel Streamlined Data from Platform to Application through Cloud hosted Data Acceptance and Quality Control

- **FY 2020 - Q4**

- **Task 1: Determine the optimal cloud provider solution for the serverless data need.**

Status: Complete. Axiom worked with NOAA PMEL to scope potential cloud-based, serverless capabilities for data hosting. Over several meetings the advantages and trade-offs of two core capabilities (AWS and Azure) were discussed and the optimal cloud provider solution was identified.

- **Task 2. Configure listeners and apply the modified PMEL RUDICS implementation to accept payloads from the Iridium satellite provider.**

Status: Complete. This task involves modifying ERDDAP to consume data from cloud native storage. The code modification was performed by PMEL, with technical support from Axiom.

- **Task 3. Modify PMEL RUDICS software for Cloud platform hosting, and integration into a serverless framework.**

Status: Complete. Technical scoping was completed to configure listeners and apply the modified PMEL RUDICS implementation to accept payloads from the Iridium satellite provider. Additionally, the technical steps required to modify the PMEL RUDICS software for Cloud platform hosting was conducted.

Status: Complete.

- **FY 2021 - Q1**

- **Task 1: Modify software to write parsed data payload into ERDDAP.** [PMEL/Axiom]

Backend development work was completed to integrate quality control software with the cloud platform notification service.

Status: Complete.

- **Task 2. Integrate quality control software with the cloud platform notification service.** [Axiom]

During this performance period, Axiom completed a climatology interface extension within the IOOS QARTOD library (See: https://github.com/ioos/ioos_qc/tree/add-config-creator). The `QcConfigCreator` instance generates a config for `QcConfig` informed by reference datasets, such as climatologies, defined via configuration. The CreatorConfig performs checks. Also included in the packages is a `get_assets.py` script, which has been provided to download and prepare climatology datasets from NARR and Ocean Atlas.

Status: Complete.

- **Task 3. Develop code to push quality controlled data, with QC flag information, into ERDDAP.**[Axiom]

Backend work has been completed to develop code to push quality controlled data, with QC flag information, into ERDDAP.

Status: Complete.

- The following tasks *are delayed* and were not completed during this performance period due to related tasks by project partners at NOAA PMEL not yet being delivered. These tasks will be ongoing through FY21:

- Task 4. Configure Docker containerization of all system components. [Axiom]
- Task 5. Operational dissemination with the Open-GTS framework. [PMEL/Axiom]
- Task 6. Acceptance testing (PMEL/Axiom)

1.5.1. Support Existing Models & Data Products Including Historical Sea Ice Atlas, Research Assets Map and Yukon-Kuskokwim Chinook Run Timing Forecast.

- **Subaward to University of Alaska International Arctic Research Center to update Historical Sea Ice Atlas twice a year.**

- Update database with data for January 1 – December 31, 2020; Original completion date: May 2021. Status: Update with data through June 30, 2020 is complete; still awaiting release of data for July-December, 2021 from National Snow and Ice Data Center (anticipated summer 2021). Will process immediately upon release by NSIDC.

Status: Delayed.

- Update visualization tool with new software, including full-color concentration scale and expansion to pan-Arctic domain; Original completion date: Early 2021.

Status: Complete.

- Monitor usage of database; Original completion date: May 2021.

Status: Complete.

- **Support and maintain Research Assets Map;** Original Completion Date: May 2020.

The future of this product is still being assessed.

Status: On hold.

- **Coordinate with the ADF&G to update Yukon-Kuskokwim Chinook Run Timing Forecast pages on AOOS.org website;** Original Completion Date: May 2021.

Status: Complete.

- **Subaward to Axiom to provide Statistically-generated Probabilistic Sea Ice Guidance for the week 3 to Seasonal Time Scale (S2S Sea Ice Guidance);** Original completion date: June 2021.

- Determine and gather viable forecast model outputs to be used to develop the statistical relationships over a training period for evaluation. This will likely include the operational NCEP Climate Forecast System

Version 2 (CFSv2) along with the experimental sea ice model and the Alaska Sea Ice Program (ASIP) analysis.

Status: Complete.

- In collaboration with NWS Alaska, determine the specific forecast points of interest to NWS stakeholders where guidance is needed. (This could be gridded if the approach supports this).

Status: Complete.

- Develop the statistical relationships over a specified training period to develop the probabilistic sea ice concentration guidance. Axiom staff have created a predictive model using one and three forecast point and forecast model outputs.

Status: Complete.

- Evaluate the guidance over a test period to determine guidance skill. (FY21Q2). In collaboration with the NWS, develop a prototype product to provide the probabilistic guidance information to NWS Alaska and Stakeholders. Axiom calculated model forecast skill for the given time scales for every station.

Status: Complete.

- In collaboration with the Arctic Testbed and Proving Ground (ATPG), evaluate usefulness of the prototype product and isolate functional improvements that would need to be made to operationalize the approach. Axiom met with the US National Ice Center to isolate improvements to the prototype product and plan for development of operational probabilistic forecasts capability.

Status: Complete.

- Coordinate with NWS Alaska on scope and approach for resolving the improvements identified in 4f. Minor modifications to the product will be made under this project, whereas changes more extensive in nature may exceed available resources. Establish the most efficient delivery process of the current version of the forecast guidance and transfer any software packages (processing scripts) and data required to support the system to NWS Alaska. The forecast guidance and software packages are to be hosted in the following locations (<http://stage-s2s.srv.axiomptk/>).

Status: On track.

- **Subaward to Axiom to provide a High Fidelity Prediction System for Coastal Storm Hazards in Support of Disaster Prevention and Safe Navigation;** Original completion date: May 2021.

- Project management (NOAA, USGS, and ONR): Gather requirements based on key stakeholders, and define and monitor the success metrics for meeting a requirement and the risk involved. Start: FY20Q3; End: FY22Q2.

Status: On track.

- Automated pre-processing (VIMS and NOAA): Implement required scripts and tools for automatically constructing forcing and boundary conditions required by the coastal ocean model. This includes implementing tools to automatically checkout the latest updated Digital Elevation Model (DEM) from OCS' National Bathymetry Source program. Start: FY20Q3; End: FY21Q1.

Status: On track.

- Data-driven mesh generation (NOAA and VIMS): Implement data-driven unstructured mesh generation framework based on DEM and forcing. Model implementation (VIMS and NOAA): Implement SCHISM 3D coastal ocean model, seamlessly coupled to wave and inland hydrology, as the coastal ocean model engine. This model provides flexibility and stability that allows us to locally increase unstructured mesh resolution to less than 20m mesh sizes. Start: FY20Q3; End: FY21Q2.

Status: On track.

- Model deployment (VIMS, NOAA and Axiom): Implement capability to seamlessly run modeling system on conventional HPC and cloud environments; Start: FY21Q1; End: FY21Q4. Axiom provided technical assistance for explorations of potential architectures for the system including hybrid HPC and AWS systems. AWS-only implementations have taken place between collaborators from Axiom, NOAA, and VIMS. ParallelWorks was explored for use for model simulations and potentially post-processing tasks that allows for orchestration on multiple cloud environments, high-level workflow definitions, and access to multiple storage providers.

Status: Complete.

- Post processing and dissemination (NOAA, VIMS and Axiom): Implement a cloud based environment for post-processing and dissemination of modeling system products; Start: FY21Q1; End: FY22Q1. Members of the team are developed scripts and applications specific to this use case utilizing libraries supported by the Pangeo community. Axiom developed a MVP of workflow on a TACC-provisioned

AWS system, in addition to systems to capture run metadata.

Status: Complete.

- Case studies and skill assessment (VIMS and NOAA): Perform inter-comparisons of atmospheric forcing from hindcasts of land-falling hurricanes from NOAA's numerical weather prediction models, Navy's COAMPS-TC (via our ONR partner) and other available national and international atmospheric hindcast products. NOAA's atmospheric forcing for recent storms will be available through our collaboration with EMC on the COASTAL Act program. This is an important step toward an eventual sediment transport and morphological prediction system, which will be a focus on a possible future ONR-NOPP proposal. Start: FY21Q3; End: FY22Q2.

Status: On track.

1.5.2. *Support for the NOAA State of the Arctic Report*

- **Subaward to UAF to support NOAA Climate Program Office development of annual report card.**

- Complete preparation of the Arctic chapter for the Bulletin of American Meteorological Society report State of the Climate in 2019, in anticipation of the report's publication; Original Completion Date: June 2020.

Status: Complete.

- Develop and implement a strategy to feature, on an annual basis, an essay highlighting the perspective of the Indigenous Peoples of the North, specifically describing the impact of changing conditions on their way of life; Original Completion Date: April 2020.

Status: Complete.

- Initiate, prepare and complete the 2020 NOAA Arctic Report Card, in anticipation of public release during the 2020 American Geophysical Union Fall Meeting; Original completion date December 2020.

Status: Complete.

- Initiate preparation of the Arctic chapter for the Bulletin of American Meteorological Society report State of the Climate in 2020; Original completion date: January 2021.

Status: Complete.

- Conduct workshop, convening production team (i.e., editors, authors, webmaster, video, POA, program manager, etc.) to reflect on the report content, production timeline, etc. and discuss changes that can be made to improve the utility of the reports; Original completion date: May 2021.

Status: Complete.

1.5.3. *Support enhancement of OceanMesh2D capabilities to develop more accurate and efficient meshes of the global and coastal ocean.*

- **Subaward to University of Notre Dame.**

- Develop improved strategies for meshing overland regions. Implement and test both Delaunay as well as Force Balance algorithms in order to keep shoreline nodes fixed in place or nearly in place on the actual shoreline; Original completion date March 2020.

Status: Complete.

- Develop strategies to optimize upriver river meshing so that the meshes can be readily couple to the National Water Model; Original completion date May 2020.

Status: Complete.

- Develop 1D mesh elements to be implemented in the OceanMesh2D code; Original completion date: September 2020.

Status: Complete.

- Develop element based internal barrier feature; Original completion date December 2020. Status: Complete.

- Targeted mesh refinements of the 120m mesh; Original completion date February 2021.

Status: Complete.

- Targeted mesh refinements of the 30m mesh; Original completion date March 2021.

We have completed a new version of the 30m mesh and are running tides and hurricanes in comparison to the 120m mesh with identical bathymetric, topographic, and Manning n based bottom friction definition applied for both meshes. The new mesh has 20.64 million nodes and is the largest ADCIRC mesh built to date. 95% completed and targeted completion date is now February 28, 2022.

Status: On track.

- Implement targeted bathymetric improvements into the 120m mesh; Original completion date April 2021.

Status: Complete.

- Implement targeted bathymetric improvements into the 30m mesh; Original completion date May 2021.
Status: Complete.
- Validating 120m mesh with hurricanes; Original completion date June 2021.
Status: Complete. We have been testing and validating the 30m mesh and model by simulating Hurricanes Katrina (2005), Gustav (2008), Ike (2008), Sandy (2012), Mathew (2016), and Irma (2017). We have plotted hydrographs and have quantified errors.
Status: Complete.
- Validating 30m mesh with hurricanes; Original completion date: July 2021.
Activities are to validate 30m mesh and model using select Atlantic and Gulf of Mexico hurricanes, and quantify errors. We have implemented select mesh fixes during this process. 70% completed and targeted completion date February 28, 2022.
Status: On track.
- Activating river flows for 120m mesh simulations; Original completion date: August 2021.
Activities are to validate 120m mesh and model for select rivers using flow-stage curves and/or USGS water level stations, and quantify errors. Targeted completion date March 31, 2022.
Status: On track.
- Activating river flows for 30m mesh simulations; Original completion date: September 2021.
Activities are to validate 30m mesh and model for select rivers using flow-stage curves and/or USGS water level stations, and quantify errors. Targeted completion date March 31, 2022.
Status: On track.

1.5.4. Support development of a Regional Ocean Data Partnership.

- Regional Ocean Data Sharing Coordinator continued working with stakeholders to determine data product priorities and assess availability of data. Original completion date May 2021.
 - Coordinated and worked with subawardees to complete their work, including the Bering Science reports, Bering Sea resource webpage, and Bering Sea data portal (see below).
 - Worked with the Bering Science “Community Advisory Panel” (CAP) and various research and monitoring groups to map out the content of the upcoming Bering Science report, focusing on the major topics of interest to communities, and the inclusion of community-led . Project completion date May 2022.
Status: On track.
 - Worked with World Wildlife Fund (WWF) U.S. Arctic Program and Russia to continue organizing the US-Russia Science Corner series (previously held in January and April 2021) with plans to focus on fisheries research collaboration in the Bering and Chukchi Seas at the Alaska Marine Science Symposium in January 2022, marine mammals in March 2022, and conserved/protected areas in April 2022. In this series, Russian and American colleagues will share research updates from research, monitoring, and observations in the waters of the Bering and Chukchi Seas. The goal will be to stimulate broader discussions about the need for more collaboration and identify opportunities to strengthen research and observing ties across the US-Russia border. Project completion date January 2022.
Status: On track.
- **Subaward to UAF International Arctic Research Center (IARC) to provide outreach materials and community engagement activities for this new data sharing initiative.**
 - Publish Bering Sea science status report; Original completion date May 2020.
Published Bering Science reports in May 2020, October 2020 and June 2021. The 2020 and 2021 spring reports were distributed to all box holders in 39 western Alaska coastal communities. Those reports, and the October 2020 report, were also distributed via listserv, social media and to Alaska media.
Status: Complete.
 - Hosted ACCAP webinars to recap and discuss Bering Sea research and observations following the release of the two largest Bering Science reports in June 2020 and July 2021.
 - Rick Thoman participated as an expert along with other scientists who contributed to the reports.
 - Heather McFarland and Jill Prewitt (AOOS) recruited participants for a CAP to guide priorities, provide review, and help ensure that Bering Science publications meet the needs of Indigenous communities.
 - Initiated planning for the Bering Science spring 2022 report.
 - McFarland, along with Prewitt, worked with the CAP to identify priorities for the coming publication: Salmon, crab, halibut, seabirds, walrus, and community-based research and monitoring highlights.

- McFarland coordinated, along with Prewitt, topical meetings with scientists to identify potential contributions of research and highlights that meet CAP priority topics.
- Conference presentations:
 - Thoman gave the plenary presentation at the Western Alaska Interdisciplinary Science Conference and Forum in spring 2021.
- Thoman outreach to various coastal communities; Original completion date: Summer 2020. In-person visits on hold due to COVID-19.
Status: Delayed.
- Additional Activities:
 - Participation (by) in weekly call-in shows on KNOM and KOTZ, ongoing
 - September 2020: Provided graphics and text for Bering Science Fall 2020 update
 - Bering Sea ice and ocean conditions are being highlighted in a MOOC (Massive Open Online Course) prepared by Thoman, J. Walsh and M. Delue of UAF/IARC; course was activated on November 9, 2021 and is now available for enrollees at <https://uaf-iarc.org/2021/11/09/iarc-launches-a-free-arctic-climate-change-course/>
- **Subaward to Axiom to develop data products in the Alaska region to support the national Regional Ocean Data Sharing Initiative.**
 - Develop and maintain the Bering Sea resource page on AOOS website with links to other resources at: <https://aoos.org/beringregion/> Original completion date May 2021.
At the project onset, Axiom acquired the website subdomain: www.beringregionoceanodata.org. Axiom worked with the AOOS Regional Data Sharing Coordinator to create a project website and populate it with initial information about the project.
Status: Complete.
 - Work with Regional Ocean Partnership Coordinator to assess current data management capacity, capabilities and needs of state and federal agencies in Alaska; Original completion date May 2021. During the performance period, Axiom met with the AOOS Regional Data Sharing Coordinator in bi-monthly meetings to discuss data management capacity and identify partnership opportunities or data sources relevant to Bering Sea information needs.
Status: Complete.
 - Identify existing “sustained” data streams for Bering Sea/Strait and adjacent areas & provide access through data portal on AOOS Ocean Data Explorer. A dedicated data discovery portal for the project is accessible at: <https://bering-sea.portal.aos.org/>. Work was completed to expand the data portal to include [913 relevant data layers](#) with regional or thematic significance, including adding several new data sets from the Arctic ERMA repository such as the Alaska Environmental Sensitivity Index (ESI) species and habitat maps and the Alaska Community Database.
Status: On track.
 - Develop data and information products. Through informational interviews with regional stakeholders, Axiom will continue to work with the AOOS Regional Data Sharing Coordinator to identify data or information products that will be developed during the next project performance period.
Status: On track.

1.6. Additional Activities and Successes Related to Mission

A significant amount of time was devoted to addressing delays in program activities due to COVID-19 travel restrictions. In addition, a major portion of this reporting period was devoted to developing, writing, and responding to questions on the FY21 descope for the new 5-year Cooperative Agreement, including setting up agreements and contracts with subawards.

2.0 SCOPE OF WORK

We do not expect any other changes to the project Scope of Work at this time.

3.0 PERSONNEL AND ORGANIZATIONAL STRUCTURE

Marta Kumle’s contract for employment ended in August 2021.

4.0 BUDGET ANALYSIS

All financial reports are up to date and have been submitted on time. There are no risks to the project that need identifying. The following equipment was purchased during this period:

Equipment	Serial Number	Use Description	Full Cost
Rechargeable Lithium Battery	sn303790	Power supply for EAFM Glider Surveys	\$17,200
Remote Power Module Lite for low-power CODAR SeaSonde Radar	snA4789	Power supply for off-grid surface current HF Radar installation at Bering Strait 3	\$80,000
SeaSonde combined Tx/Rx Antenna w/cable	sn 480	Refurbished SeaSonde for the Cook Inlet surface current radar installation	\$23,530
SeaSonde combined Tx/Rx Antenna w/cable	sn 481	Refurbished SeaSonde for the Cook Inlet surface current radar installation	\$23,530
Tripod (Bottom Lander)	sn001	Platform for CEO Benthic camera, AZFP & ADCP	\$13,882
Sea-Bird Scientific Dissolved Oxygen Sensor	SBE43-0452	Oxygen sensor for profiling CTD	\$5,329
ACS Spectrometer (AOOS share of purchase cost 25%)	ACS-0347	sensor for ISIIS-DPI multiparameter imaging system	\$40,026
Sea-Bird Scientific SBE49 FastCat CTD (AOOS share of purchase cost 25%)	Sea-Bird Scientific SBE49-0590	CTD for ISIIS-DPI multiparameter imaging system	\$13,060
Nitrate Sensor V2 (AOOS share of purchase cost 25%)	NTR-1551	sensor for ISIIS-DPI multiparameter imaging system	\$25,665
Sea-Bird Scientific Dissolved Oxygen Sensor (AOOS share of purchase cost 25%)	SBE43-4139	sensor for ISIIS-DPI multiparameter imaging system	\$5,329
Valeport Flow Meter (AOOS share of purchase cost 25%)	sn 76138	sensor for ISIIS-DPI multiparameter imaging system	\$7,072
Sea-Bird Scientific WetLABS Ecotriplet (AOOS share of purchase cost 25%)	FL#-5759	sensor for ISIIS-DPI multiparameter imaging system	\$10,400
2 count SIMRAD Acoustics (AOOS share of purchase cost 25%)	267853 267852	sensor for ISIIS-DPI multiparameter imaging system	\$36,000
ISIIS-DPI (AOOS share of purchase cost 25%)	ISIIS-DPI3-UAF2021	ISIIS-DPI multiparameter imaging system	443,483
MiniTDGP Sensor	41-830-33	GEO Mooring sensor/datalogger	\$6,210
RBR Duet	4041/206740	GEO Mooring sensor/datalogger	\$7,200
GreenEyes Aquamonitor		GEO Mooring sensor/datalogger	\$43,664
Sexton Intravalometer Camera System	9302047	CEO Mooring Benthic Camera	\$24,975

5.0 ADDENDA

- A. AOOS Region Glider Days Inventory 2021
- B. Data Management, Products and Services
- C. HFR Operations and Maintenance Expenditures
- D. 2021 HF Radar Expenditures

A. AOS REGION GLIDER DAYS INVENTORY 2021

GLIDER	Operator	Data Manager		
<i>Chukchi Sea Glider</i>	Seth Danielson (University of AK, Fairbanks), Mark Baumgartner (WHOI), Kate Stafford (Oregon State University (OSU))	Seth Danilelson (PhysicalData); Kate Stafford and Mark Baumgartner (passive acoustic data)		
<i>Bering Sea Ecosystem Assessment for Fisheries Management (BS EAFM) Glider</i>	Seth Danielson (University of AK, Fairbanks)	Seth Danielson		
<i>Gulf of Alaska Ecosystem Assessment for Fisheries Management (GOA EAFM) Glider</i>	Seth Danielson (University of AK, Fairbanks)	Seth Danielson		
<i>2019-2020 ONR Central Beaufort Sea Gliders</i>	Craig Lee (University of WA, APL, Seattle)	Craig Lee		
<i>Summer 2020 ONR Central Beaufort Sea Gliders</i>	Craig Lee (University of WA, APL, Seattle)	Craig Lee		
<i>Arctic SailDrones</i>	Jessica Cross			

GLIDER	1) How many glider-days of data were collected annually in this CY by glider operators in your RA?	2) Of the glider-days reported, how many were completed outside of the EEZ?	3) Of the glider-days reported, how many were supported by IOOS PO?	4) What missions were completed?
<i>Chukchi Sea Glider</i>	62	0	62	The UAF glider team coordinated a successful deployment and recovery for the 2021 Chukchi Sea annual glider transect. Deployed on July 12, 2021, the CS Glider ran its 9th mission since 2013. The glider was recovered on Sep. 11, 2021. The glider made it all the way to Utqiagvik and completed a 62 day at-sea mission. In 2021, the glider data reported in near real time to the AOOS Data Portal, a new functionality.
<i>Bering Sea EAFM Glider</i>	0	0	0	NA
<i>Gulf of Alaska EAFM Glider</i>	88	0	88	Three missions were completed in 2021 as part of a herring tagging project in Prince William Sound. Approximately 30 glider days per mission. Deployment 1: Jan 25 - Feb 23, 2021 (30 days) (https://portal.aos.org/?ls=7knRj1M7#platform/07197b36-867c-596b-bfc6-c059eefd3941/v2). Deployment 2: Mar 23 - April 21, 2021 (30 days) (https://portal.aos.org/?ls=7knRj1M7#platform/65d5e5df-0133-5201-938e-633c26b17d09/v2). Deployment 3: April 29 - May 26, 2021 (28 days) (https://portal.aos.org/?ls=7knRj1M7#platform/65d5e5df-0133-5201-938e-633c26b17d09/v2).
<i>2019-2020 ONR Central Beaufort Sea Gliders</i>	2021 number of glider days unknown at time of December 2021 SA report	Central Beaufort, assume within EEZ sometimes but not sure	0	
<i>Summer 2020 ONR Central Beaufort Sea Gliders</i>	2021 number of glider days unknown at time of December 2021 SA report	Central Beaufort	0	
<i>Arctic SailDrones</i>	NA	Please contact Jessica Cross (jessica.cross@noaa.gov) or Heather Tabisola (heather.tabisola@noaa.gov) for details.	NA	NA

GLIDER	Notes	Update completed for 2021
<i>Chukchi Sea Glider</i>	AOS supported: A Slocum G2 glider equipped with physical, ecosystem, and passive acoustic sensors to observe the occurrence of several species of marine mammals, including fin, bowhead, and beluga whales, as well as bearded seals and walrus along the survey route. This project is designed to examine relationships between marine mammal distribution and oceanographic conditions monitored by the glider. Internally recorded physical and eco- data are uploaded for post-processing and analysis, and will be uploaded to the AOS Data Portal within 1 year.	X
<i>Bering Sea EAFM Glider</i>	AOS supported: 2020 EAFM glider trials delayed in 2020 due to COVID. 2021 sea trials of EAFM gliders was restricted to Prince William Sound and the inner Gulf of AK into Resurrection Bay near Seward. Plans to trial glider in Bering Sea may be possible in 2022. Full deployment in Bering Sea now expected in 2023, following successful glider missions in Gulf of Alaska.	X
<i>Gulf of Alaska EAFM Glider</i>	AOS supported: Winter/spring 2021 EAFM Glider trial surveys were conducted in Prince William Sound in northern Gulf of AK, scheduled in collaboration with shipboard and aerial herring surveys ; three surveys completed. See story on first two missions here: https://aos.org/herring-glider-surveys-in-prince-william-sound/ . A full survey in the larger Gulf of AK is scheduled for winter/spring 2022, with dual deployment alongside the International Year of the Salmon OMAO glider (total of two gliders).	X
<i>2019-2020 ONR Central Beaufort Sea Gliders</i>	Office of Naval Research (ONR) supported: For more information, contact Craig Lee (craiglee@uw.edu)	Pending - Waiting to hear back from Craig Lee
<i>Summer 2020 ONR Central Beaufort Sea Gliders</i>	Office of Naval Research (ONR) supported: For more information, contact Craig Lee (craiglee@uw.edu)	Pending - Waiting to hear back from Craig Lee
<i>Arctic SailDrones</i>	NOAA supported: NOAA does not consider SailDrones gliders, so no information has been provided regarding the 2021 SailDrone deployments in the Arctic, summer 2021	X

B. AOOS Data Management, Products and Services Reporting for December 2020 IOOS Annual Report

Data Management, Products, and Services Section:

DMAC is the framework for RA ingestion, management, and publication of digital data sets. These data sets can be generated by observing system assets, numerical models, or through any other process that results in a value added product. The specific requirements for DMAC participation are described at <https://ioos.noaa.gov/data/contribute-data/>.

Each section contains specific requirements that, when implemented, provide the standards-based foundation for DMAC capabilities. Progress and challenges toward addressing each requirement should be described following the section headings on the web site above.

1. [Open Data Sharing](#)

IOOS, being a part of the Global Earth Observing System of Systems (GEOSS), ascribes to the [GEOSS data sharing principles](#):

GEOSS Data Sharing Principles:

- There will be **full and open exchange** of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation;
- All shared data, metadata and products will be made available with minimum time delay and at minimum cost;
- All shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

2. [Data management planning and coordination](#)

Data management is an increasingly important aspect of IOOS activities. Data management plans and the coordination of activities between Regions and the IOOS Program Office ensure that data are maintained in easily accessible formats that are archived for long-term storage.

3. [Provision of data to the Global Telecommunication System \(GTS\)](#)

U.S. IOOS is committed to ensuring that all relevant U.S. coastal ocean observations will be contributed in near real time to the global GTS network.

- All real-time stations must be assigned a WMO ID.
- All real-time observations must be submitted to the WMO GTS

4. [Data access services](#)

All IOOS Data Providers must serve all data and products through these DMAC recommended services.

- All data and products must be made available via data access services, and [registered in the IOOS Catalog](#)

- For gridded data you must use OPeNDAP and WMS
- For in-situ observations (including point, profile, trajectory, timeseries, or other sampling types) you must use SOS and optionally OPeNDAP
- For tabular data ERDDAP/TableDAP should be used

5. [Catalog registration](#)

The IOOS Catalog is the master inventory of IOOS DMAC datasets and data access services. All DMAC [data access services](#) shall be registered in the IOOS Catalog.

6. [Common data formats](#)

U.S. IOOS® data providers are expected to offer data in one or more approved U.S. IOOS® formats .

7. [Metadata standards](#)

All IOOS data providers are expected to ensure relevant metadata is produced, accessible and compliant with IOOS conventions, and to participate as appropriate in the development of such conventions. Descriptive information about datasets, sensors, platforms, models, analysis methods, quality-control procedures is essential for the long-term usability and reuse of information.

- [ISO 19115-2 XML Metadata](#): Metadata: Part 2: Extensions for Imagery and Gridded Data
- [CS-W](#): Catalog Service-Web
- [IOOS Metadata Profile for NetCDF](#)
- [NetCDF-CF](#): Climate and Forecast conventions for NetCDF
- [ACDD](#): Attribute Conventions for Data Discovery

8. [Storage and archiving](#)

Data providers are expected to provide for storage of data, metadata and other supporting documentation and algorithm descriptions, to establish data recovery mechanisms, and to perform off-site storage of backups until the data and metadata are submitted to NCEI for archiving.

9. [Ontologies, vocabularies, common identifiers](#)

IOOS is presently developing and adopting shared vocabularies for terminology such as names of observed properties, units of measure, coordinate reference systems, animal species, etc.

10. Consideration for Long-term Operations

The IOOS observing, data management, and modeling capacities being developed will, ideally, persist as the overall enterprise matures. In data management plans, IOOS partners should include a discussion of potential plans for maintaining such persistence as part of normal IOOS operations (e.g., by automating as many activities as possible, implementing operational procedures).

Requirements	AOOS Procedure	Progress	Challenges
<p>Open Data Sharing IOOS, being a part of the Global Earth Observing System of Systems (GEOSS), ascribes to the GEOSS data sharing principles.</p> <ul style="list-style-type: none"> • There will be full and open exchange of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation; • All shared data, metadata and products will be made available with minimum time delay and at minimum cost; • All shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education. 	<p>The AOOS Data System provides data resources in a one stop data portal, free to the public, with data assets originating from federal and state agencies, local municipalities, academic institutions, research organizations, private companies, non-profit organizations, and community observers.</p>	<p>Status: All data currently served by the AOOS data portal(s) carries with it the permission for public view and access, and carries no privacy or ethical restrictions. Data access is defined here as being permitted to download data through an AOOS data portal.</p> <p>Real-time and near real-time data are served as soon as the data become available.</p> <p>Data assets that come from AOOS funded programs without real-time capability are currently received within 2 years after data recovery, or by the end of the awarded project period (the lesser of both).</p> <p>Sustained AOOS funded assets are now submitted annually through the established AOOS Research Workspace. The AOOS Research Workspace streamlines data submittal, ingestion, and compliant metadata generation. It became operational to AOOS PIs in August 2017.</p> <p>The Research Workspace supports semi-automated pathways to archive</p>	<p>None at this time.</p>

		<p>final data set through the Research Workspace DataONE Member Node. Further, the Research Workspace is in a testing environment for archive submission to the NCEI national data repository. These efforts began in 2018 and are still ongoing as NCEI is working through internal processing procedures to establish sustained archive pathways.</p>	
<p>Data management planning and coordination Data management plans and the coordination of activities between Regions and the IOOS Program Office ensure that data are maintained in easily accessible formats that are archived for long-term storage.</p>	<p>The Alaska Ocean Observing System Data Assembly Center and Data Management Subsystem Plan (referred to as the Data Plan) provides the approach to the necessary implementation, describing how data are ingested, managed and distributed from the source to public dissemination.</p> <p>The primary processes involved with data management and flow include data ingestion, standards and format, metadata and discovery, quality control, stewardship and preservation, access and dissemination, archival and security.</p> <p>All non-federal AOOS data assets (referred to as Data Streams) are fully documented for data management in individual Data Stream Plans. These Data Stream Plans are maintained as an Appendix G to the larger AOOS Data Plan New non-federal additions to the regional observational data asset</p>	<p>AOOS became a NOAA certified data provider in 2016. The AOOS Data Plan was updated in 2020 and all related certification documentation are available at the link below.</p> <p>https://aoos.org/about/data-management/</p> <p>The AOOS data plan will be updated routinely (minimum 5 years) as needed to meet new requirements from the IOOS DMAC. The most recent update was December 2020 relative to updates to data quality testing (QARTOD implementation).</p> <p>A Data Policies and Procedures document to guide AOOS PIs on data and metadata submittal expectations is included in Statements of Work and contracts for all AOOS funded projects.</p>	<p>None at this time.</p>

	<p>inventory will have a Data Stream plan developed prior to serving of data.</p> <p>In 2017, AOOS and AXIOM developed a guidance document - Data Policies and Procedures – to inform the AOOS/Axiom Data Science (the AOOS data management team) roles and responsibilities. This document is included in all AOOS funded projects, and also provides a guide/pathway for AOOS funded PIs regarding data submission protocols and procedures.</p> <p>AOOS completed an external Data System Review November 27-30 2017, which included but was not limited to evaluation of AOOS data portals and functionality, system usability, documentation of operations, business models, process improvements, and strengths and weaknesses. (AOOS Data Management Review Report, compiled by Peter L. Pulsifer and Review Committee, Dec. 2017; internal document).</p> <p>Review recommendations were light on technology changes as Axiom provides a state-of-the-art technology foundation, which were key attributes the AOOS Data Management Advisory Committee provided guidance on. The committee was evaluated to determine if it has a role and if that role has changed, or if AOOS should take a different approach for a more mature data</p>	<p>The 2017 external Data Management Review recommendations for the AOOS Data System included process improvements (i.e., business model, providing user support tools for data portal; improve product release process in operations model). AOOS will focus efforts now on data priorities, portal interface, data products and discovery improvements.</p> <p>Update 2021: In response to the 2017 external review recommendations, AOOS has redesigned the AOOS website and data portal interface, launched in summer of 2021. Axiom has been developing data tools to support easy access to most frequently sought-after information and has added some data catalogue listings on the Ocean Data Explorer for externally funded projects, specifically, the Exxon Valdez Oil Spill Advisory Council funded projects <i>Gulf Watch Alaska</i> and <i>Herring Research Monitoring</i>. AOOS continues to update AOOS project pages to provide direct links to observational project data and related PI websites. AOOS and Axiom staff are also developing data portal products for externally funded projects to improve project-directed functionality needs.</p>	
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	<p>system. AOOS and the Board reviewed the status and future of the AOOS Data Management Advisory Committee at the December 16, 2019 Board Meeting, and tabled decisions on the committee until the spring 2020 Board meeting.</p>	<p>One major recommendation from the Data Management Review Report (2017) was for Axiom and AOOS to develop a clear business and operations plan for the AOOS Data System. The review motivated the development of an organizational operational and business plan that aims to strengthen the integrity and business operations of the AOOS data system. A response to the data management review report together with the operational and business plan was submitted to the AOOS Board of Directors in August 2020 for review and comment. The Draft Final plan is awaiting acceptance at the time of this report (December 2021).</p> <p>In May 2020, the AOOS Board disbanded the Data Management Advisory Committee. AOOS staff recommended removing the committee from standard operation procedures (AOOS SOP), noting that emphasis will continue to be placed on identifying AOOS data portal users and making data more easily accessible. The AOOS SOP is being updated for release in Spring of 2022, following the IOOS 2021-2026 funding award.</p>	
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<p>Provision of Data to GTS U.S. IOOS is committed to ensuring that all relevant U.S. coastal ocean observations will be contributed in near real time to the global GTS network.</p> <ul style="list-style-type: none"> • All real-time stations must be assigned a WMO ID. • All real-time observations must be submitted to the WMO GTS 	<p>A primary goal of the AOOS Data Plan is to deliver real-time, delayed-mode and historical data for in-situ and remotely-sensed physical, chemical and biological observations. The AOOS data inventories (Appendices B, C, and E of the Data Plan) list the multiple types of data, including real-time data and near real-time data (as well as historical and citizen science data) served by AOOS.</p> <p>AOOS defines real-time data consistent manner with IOOS RICE Guidelines:</p> <ol style="list-style-type: none"> 1. <i>Real-time data</i> are ingested, served, and displayed by the AOOS Data System at the same frequency the data are collected (and sometimes reported) by the originator with little to no delay. Examples of real-time assets include weather stations, oceanographic buoys, and webcams. 2. <i>Near real-time data</i> are ingested by the AOOS Data System at the same frequency that the data are made available; however, there is some delay (hours to days) between data collection and when the data provider makes it available. Examples of near real-time assets include satellite images and derived satellite products. 	<p>Most real-time data assets served by AOOS are federally operated and are already meeting required data management standards.</p> <p>AOOS owned assets include 3 real-time reporting wave buoys. The Lower Cook Inlet wave buoy data are received, processed and served through the CDIP program (WMO # 46108). The Port of Nome wave and current buoy data are also received, processed and served through the CDIP program (WMO # 46265). In July 2019, AOOS took over the Ops and maintenance of a Kodiak wave buoy owned by NREL and operated by CDIP (WMO # 46264).</p> <p>Update 2021: WMO 46264 station (NREL-CDIP buoy) was discontinued in September 2021, and currently there is no plan to reinstate this station. The Port of Nome buoy (WMO # 46265) was not deployed in 2021 but will be in 2022. The 3 Wave Buoy data streams (historical and current day) continue to be available through the CDIP and AOOS websites.</p> <p>Other assets served by AOOS that are not federally sourced fall outside this provision, (e.g., are land-based, funded</p>	<p>Some real-time assets are privately owned and are not currently reporting through the GTS. AOOS staff will continue to work towards making appropriate assets available to the GTS, which requires finding the resource contact person/company on the deployed assets, and also getting the metadata information required for reporting data.</p> <p>As of December 2019, the National IOOS Office has been working on a collaboration with NDBC to setup data ingestion from IOOS RAs through standardized ERDDAP instances. This work includes updating the IOOS metadata 1.2 profile, updating the IOOS Compliance Checker to handle 1.2 profile, and developing pathways to serve data from the IOOS Catalog to IOOS RA ERDDAP instances.</p>
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		<p>by other organizations who are just sharing data with AOOS, or considered citizen science). There is also a limit to the age of data that can be pushed to the GTS (about 6 hours or so), precluding some delayed data streams at this time. WMO IDs are not assigned to “delayed-mode only” moorings because of the GTS limit.</p>	<p>Effective December 2020, NDBC transitioned their data access endpoint to the AOOS ERDDAP service, which includes harvesting QARTOD versions of the data and the 1.2 metadata profile.</p> <p>Update 2021: There is an increasing number of SOFAR wave buoys being deployed in the AK region by non-AOOS affiliates. We would like to determine if these stations that are deployed with long term missions (> 3 Years) should be included in the GTS.</p> <p>AOOS is also supporting real time data streams from alternative (non-NWLON) water level installations in AK. These are not sanctioned by NOAA NWLON, hence AOOS has developed a data portal designed to share these Tier B and C water level data streams. As these technologies and data reporting methods mature,</p>
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			<p>and these technologies become more mainstream, we might want to investigate if they qualify to be added to GTS.</p>
<p>Data Access Services</p> <ul style="list-style-type: none"> • All data and products must be made available via data access services, and registered in the IOOS Catalog • For gridded data you must use OPeNDAP and WMS • For in-situ observations (including point, profile, trajectory, timeseries, or other sampling types) you must use SOS and optionally OPeNDAP • For tabular data ERDDAP/TableDAP should be used 	<p>All data and products are registered in the IOOS Catalog.</p> <p>AOOS offers six access points:</p> <ol style="list-style-type: none"> 1. <i>Thematic Realtime Environmental Distributed Data Services (THREDDDS)</i> AOOS provides THREDDDS access points for raster (gridded) data stored in NetCDF format. THREDDDS 4.6.10 2. <i>Open-source Project for a Network Data Access Protocol (OPeNDAP)</i> - AOOS provides OPeNDAP access points for raster (gridded) and time-series data. 3. <i>Web Map Service (WMS)</i> - AOOS provides WMS access points for point, vector, and polygon information, as well raster (gridded) data. 4. <i>Web Feature Service (WFS)</i> - AOOS provides WFS access points for point, vector, and polygon information, as well as time-series and raster (gridded) data. 5. <i>Environmental Research Division's Data Access Program (ERDDAP)</i> - AOOS primarily uses this service to facilitate device-level downloads (e.g., tabular data). ERDDAP 1.84 - http://erddap.aos.org/ 6. <i>File Downloads</i> - AOOS often provides data as downloadable files. These files 	<p>Any data served by the AOOS portal carries with it the permission to view and access, and carries no privacy or ethical restrictions. Data access is defined here as being permitted to download data through an AOOS data portal.</p> <p>The IOOS Data Catalog is being updated at the time of this report. AOOS Data Managers are involved and aware of updated catalog.</p>	<p>Challenges- Large datasets and heavy usage can strain data access servers and negatively impact user experiences. Axiom and AOOS are continually tuning and enhancing data service software and developing deployment techniques to maximize performance and stability of these services. Effective 2020, Axiom updated its backend cached services to improve load time performance of on-demand timeseries.</p>

	are mostly served in the standard shared data file formats above, or in the case of project-specific data, in their native file formats.		
IOOS Catalogue Registrations	All data and products are registered in the IOOS Catalog. AOOS maintains a WAF (https://thredds.aos.org/iso), which is harvested by the IOOS Catalog.	Compliant and up to date.	None at this time
Common Data Formats	AOOS provides nearly all data in four open, standardized forms: <ol style="list-style-type: none"> 1. <i>Network Common Data Form (NetCDF)</i> - a self-describing, machine-independent data format that AOOS uses primarily for raster (gridded) data. Some data stored as unstructured grids use this format as well. 2. <i>Comma Separated Values (CSV)</i> - a human-readable ASCII format that is nearly universally accepted by spreadsheet and programming languages. AOOS uses CSV formats to allow users to download (1) time-series extractions from raster data, and (2) GIS vector and polygon information (e.g., boundaries). 3. <i>Shapefile</i> - an open geographic information system format for point, vector, and polygon data. AOOS allows users to download shapefiles of static GIS layers such as 	AOOS offers data in IOOS compliant formats through the use of THREDDS and ERDDAP.	None at this time

	<p>boundaries, biologic distributions, etc.</p> <p>4. <i>Portable Network Graphics (PNG)</i> - PNG is a lossless, image format provided as an alternative to shapefiles in the AOOS catalog. PNGs are limited in use as they are pre-projected, pre-scaled, and pre-sized images of data layers. However, AOOS provides PNG files as example WMS requests, which are useful to users who cannot access GIS services and who do not understand how to manipulate WMS requests.</p>		
<p>Metadata standards</p> <ul style="list-style-type: none"> • ISO 19115-2 XML Metadata: Metadata: Part 2: Extensions for Imagery and Gridded Data • CS-W: Catalog Service-Web • IOOS Metadata Profile for NetCDF • NetCDF-CF: Climate and Forecast conventions for NetCDF 	<p>AOOS requires standards-compliant metadata for project-level data (AOOS or IOOS-funded projects). Though AOOS does not require specific metadata standards for ingesting other types of data, most modern data submittals are accompanied by standard ISO/FGDC metadata records.</p> <p>Details and availability of metadata are discussed in individual AOOS Regional Data Stream Plans.</p>	<p>AOOS is compliant with the v1.2 IOOS metadata profile for in-situ observation data sets.</p> <p>For non-real time data, the AOOS web-based data management application, named the Research Workspace ('Workspace'), is used to assemble, store, and share data by researchers or AOOS partners. The Workspace provides users with an intuitive, web-based interface that allows scientists to create <i>projects</i> to represent particular scientific studies or focuses of research within a larger effort. Standard, discovery-level ISO 19115-2 and 19115-10 compliant metadata can be</p>	<p>AOOS continues to work on data discovery in order to provide quality sourced metadata in the data catalog in addition to the links already leading to source metadata. As part of this effort, development is underway to improve data asset discoverability through tagging and keywords within the data portal. This is a work in progress and will be ongoing.</p>

<ul style="list-style-type: none"> • ACDD: Attribute Conventions for Data Discovery 		<p>generated in the Workspace using a metadata editor for both projects and individual datasets.</p> <p>Many historical datasets come with informal metadata documentation that is variable in terms of completion and detail required by modern standards. Some data sets are only accompanied with narrative information. In these cases, AOOS works to make the source information easily accessible to the end-user by providing links to source data or data providers, and by making all available metadata information that came with the data available in the data catalogue.</p>	<p>Current and future data ingestion efforts make use of a metadata editor in the Research Workspace to streamline this process and ensure standards-compliant metadata are uploaded with the data.</p> <p>Historical data sets continue to provide occasional difficulties in terms of metadata generation. AOOS will continue to do the best possible to make these valuable data resources available with as much documentation as possible. In some cases, we are able to find data reports that go with these datasets, and can have them scanned and uploaded to the workspace where we can access more metadata information.</p> <p>Update 2021: Several externally funded project data sets are now discoverable through the Ocean Data Explorer Catalogue, though data are not visualized, access to the</p>
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			<p>data for download is improving data discovery of these project data.</p>
<p>Storage and Archiving Data providers are expected to provide for storage of data, metadata and other supporting documentation and algorithm descriptions, to establish data recovery mechanisms, and to perform off-site storage of backups until the data and metadata are submitted to NCEI for archiving.</p>	<p>AOOS <u>stores</u> ingested data in a secure, professionally managed external facility and currently has total storage space for over 1.8 petabytes of data. Those resources are geo-replicated between Portland, Oregon and Providence, Rhode Island. Local data storage in Anchorage is limited to temporary files only that are checked in to the main servers on a sub-daily basis.</p> <p>AOOS <u>stores</u> all aggregated data indefinitely beyond the life of each individual project. Real-time sensor feeds will become historical sensor feeds one-month after collection. The only assets that are not kept indefinitely in storage are webcam images.</p> <p>As a federally funded program, AOOS is required to submit data it generates to a national archive center. AOOS is working with the National Centers for Environmental Information (NCEI) to assist with the <u>archival</u> of appropriate data types accepted</p>	<p>AOOS serves many datasets that already have archival mechanisms in place, including CDIP wave buoy data, real-time sensor streams from federal sources (e.g., NSF Circum-Arctic Lakes Observing Network, NOAA CO-OPS, NOAA NDBC, NOAA PMEL, USGS NWIS, etc.), and marine mammal telemetry data from the BOEM-funded MARES program.</p> <p>The AOOS Data System became a DataONE Tier 3 Generic Member Node (GMN) and is attached to an updated version of the Research Workspace launched in 2017. This Tier 3 Member Node will serve as the primary archive for AOOS-managed data assets that NCEI does not accept.</p> <p>Beginning October 2020, Axiom has been meeting monthly with IOOS’s Matt Biddle and NCEI on</p>	<p>NCEI still does not accept all AOOS data assets served. AOOS continues to make future interest in these data accessible to NCEI and with the required formats to meet NCEI archival requirements.</p> <p>AOOS will continue to work with NCEI to identify the relevant data streams of interest for long-term archival within NCEI and will make those data available.</p>

	<p>by NCEI. AOOS maintains an NCEI archive WAF at https://ncei.axiomdatascience.com/aoos/</p> <p>The bulk of the data assets managed by AOOS are non-real-time, nonfederal assets, sometimes from small data originators (e.g., weather reported by a ski resort), and often from distinct research projects or large, integrated ecological research programs. These data may not fall under the purview of the NCEI. Accordingly, AOOS plans to <u>archive</u> these data in the DataONE network.</p>	<p>programmatic approach for submitting ATN data to NCEI for long-term archive.</p>	
<p>Ontologies, vocabulary, and identifiers IOOS is presently developing and adopting shared vocabularies for terminology such as names of observed properties, units of measure, coordinate reference systems, animal species, etc.</p>	<p>The AOOS data system is divided into four logical tiers. <i>Tier 3 (Asset Catalogue)</i> includes an Asset Catalogue, which provides (1) ontological metadata and (2) connections to externally-hosted data via web services. The ontological metadata in the catalogue describes the characteristics including geographic locations, spatial and temporal resolution, units, source location and CF parameter, taxonomy, date of last update, etc. of each data resource. Storing the metadata outside of the files themselves is critical to providing a responsive, up-to-date public-facing catalog. It also allows AOOS to optimize data discovery tools such as advanced searching by parameter or geographic location and build tools such as on-the-fly unit conversions for gridded datasets. External web services in <i>Tier 3</i> provide the catalogue access to external</p>	<p>Data processed through the AOOS data portals have been transformed to adhere to the following CF (Climate and Forecast) conventions. These conventions are designed to promote the processing and sharing of files created with the NetCDF API. The CF conventions are increasingly gaining acceptance and have been adopted by a number of projects and groups as a primary standard. The conventions define metadata that provide a definitive description of what the data in each variable represent, and the spatial and temporal properties of the data.</p> <p>CF Standards used by AOOS most often are provided in Appendix I of the</p>	<p>Some parameters have no related name on the CF Standards table, or had the incorrect (non-CF standard) name related to the variable on our RA Asset Inventory list. AOOS and Axiom staff will update this list, and work to make sure all variables are consistent with CF standards where possible, and will seek guidance from IOOS office where we have questions.</p> <p>IOOS should ensure that the RAS are reporting data for salinity as Practical Salinity (PSS-78), and not Absolute Salinity. We stress that the</p>

	<p>(web-based) sources of information. This is commonly used to display data and basemaps from reliable data providers so data do not have to be stored and maintained by AOOS. CF Standards are provided in Appendix I of the AOOS Data Plan. http://www.aos.org/data-management-advisory-committee/</p>	<p>recently revised AOOS Data Plan, available at: http://www.aos.org/data-management-advisory-committee/</p> <p>The IOOS QARTOD project promotes standards for real-time quality control procedures. One missing piece in this process was how to specify the "QC" data variables in a dataset. To fill this gap, IOOS and Axiom worked with the Climate and Forecast (CF) Conventions group to add QC standard names to the CF Standard Name table. Those updates were accepted in June 2020, after which Axiom worked collaboratively with AOOS to ensure all data streams were updated with the new 1.2 profile and CF standard names.</p>	<p>correct variable for archival representing salinity should be stored as Practical Salinity using PSS-78. The temperature standard for data archival is ITS-90. However, IPTS-68 is used with electrical conductivity to compute using PSS-78 to compute salinity. So It is best if all the raw variables used to compute salinity are also archived, in case someone makes an error in this calculation (it is not uncommon, even in our oceanographic institutions). So, it should be clear what temperature standard people are using in the CF standard. AOOS will review the CF definitions to be sure this is clear. Absolute Salinity is a correction to the Practical Salinity error caused by non-conducting ions in the water. This correction is incomplete and will change with time as more total fractional solids data are available to improve the correction regionally. Therefore, we</p>
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			<p>are to archive PSS-78 salinity, and that allows future generations to compute Absolute salinity with the latest corrections.</p>
<p>Consideration for long-term operations Potential plans for maintaining persistence of IOOS observing assets (e.g., automating as many activities as possible; implementing operational procedures).</p>	<p>The AOOS Data System hosts several integrated data management tools to ease data access, storage, and sharing by its users including the Research Workspace and its metadata editor, and the AOOS Ocean Data Explorer, the statewide data portals.</p> <p>The AOOS web-based data management application, named the Research Workspace (‘Workspace’), is used to assemble, store, and share data by researchers or AOOS partners.</p> <p>The Workspace includes an integrated metadata editor to support the documentation of data and facilitate its accuracy and reuse. Content collected in the Research Workspace metadata editor uses fields from the ISO 19115 suite of standards for geospatial metadata, which is the FGDC endorsed successor to the CSDGM, extended to describe taxonomic classification for biological datasets. Standard, discovery-level ISO 19115-2 compliant metadata can be generated for both projects and individual datasets.</p>	<p>The AOOS Data Plan was completed in September 2016 and will be updated routinely as needed to meet new requirements from the IOOS DMAC.</p> <p>Standard Operations Protocols or Roles and Responsibilities documentation for AOOS owned assets are helping with OnM activities and budget planning. (example: Port of Nome CDIP Wave buoy involves cooperative efforts with Port of Nome, AOOS, CDIP, and Marine Exchange of Alaska).</p> <p>Update 2020: AOOS underwent an internal data management audit by IOOS in the fall of 2020. To address questions in this audit, the AOOS Data Plan was updated to include details of how AOOS is implementing QARTOD requirements.</p> <p><u>These updates are summarized here:</u> For sources that do not provide quality flags, the AOOS Data System runs QARTOD tests after ingesting observation data. Tests are run using the open-source <code>ioos_qc</code> library</p>	<p>AOOS’s data management contractor, Axiom Data Science, has made significant progress redesigning the back end AOOS data system to implement open-source libraries for basic QARTOD tests of real-time data streams. QARTOD flags and libraries are available in the Ocean Data Explorer for visual exploration and download through ERDDAP. The AOOS Glider data provider is also working on QARTOD implementation, and is finding that some tests are flagging good data. They are working on fine tuning the tests and limits. This takes time. The glider data is particularly difficult to use QARTOD standard TS corrections on, especially on unpumped CTD data due to salinity spiking caused by a</p>

		<p>https://github.com/ioos/ioos_qc which implements a suite of QARTOD tests as well as other quality control algorithms. The quality test code and test thresholds are documented and publicly available through the AOOS data portal.</p> <p>Within one hour after observations are ingested to the AOOS Data System, a process is run to calculate flags for the following QARTOD tests, depending on the parameter:</p> <ul style="list-style-type: none"> • Gap Test- checks that the times supplied are in monotonically increasing chronological order, and optionally that time intervals between measurements do not exceed a value. • Syntax Test- checks for parity errors by testing if data can be extracted from the downloaded or scraped data. • Location Test- checks that a location is within reasonable bounds. • Gross Range Test- Checks that values are within reasonable range bounds. • Climatology Test- Checks that values are within reasonable 	<p>mis-match in T C sensor response and sample volume.</p> <p>Implementing QARTOD takes resources. The current trend is to continue to increase QARTOD manual generation without a clear understanding of how the current QARTOD implementations are coming along and how well they are performing. In 2016, 2017 and again in 2018, we suggested that IOOS assess the current implementation of QARTOD for the existing manuals to ensure that these manuals are providing the correct level of guidance for implementing appropriate QC at the regional level <u>prior</u> to continued development of more complicated parameter manuals.</p> <p>Not all AOOS regional RT assets are capable of sending data to the GTS. As</p>
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		<p>range bounds for a given location and depth</p> <ul style="list-style-type: none"> • Spike Test- checks if the difference in values between a data point and its neighbors exceeds a threshold. • Rate of Change Test- checks if the first order difference of values exceeds a threshold. • Flat Line Test- checks for consecutively repeated values within a tolerance. <p>Update 2021: As a part of the IOOS transition from SOS to ERDDAP, the Beta IOOS Environmental Sensor Map harvests data from regional association ERDDAPs registered in the IOOS Catalog using the IOOS Metadata Profile (version 1.2). AOOS data assets are being displayed in the Beta IOOS Environmental Sensor Map given that it is compliant with both the IOOS Catalog and IOOS Metadata Profile. Further, AOOS data assets are being accessed by NDBC from the AOOS ERDDAP instance and inserted into the GTS.</p>	<p>long as the data are QC flagged accordingly, AOOS will continue to provide access to these gap filling observations.</p>
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C. HFR Operations and Maintenance Expenditures - AOS 2021 - AOS Subaward H2400-91, H2400-91, NA16NOS120027

Operator/Principal Investigator	Field Engineer/Technician Salary including fringe benefits & overhead*	O&M Oversight (PI or O&M manager) salary including fringe benefits & overhead*	Travel	Supply and equipment expenses, fees: computer equipment, air conditioners, generators, enclosures, antenna whips, test/calibration/repair tools, cables, services, electrical power, rentals, data communications/networking	# of radars	# of FTE	# of students (FTE)
University of Alaska/Seth							
AOOS HFR Sites	\$193,136	\$3,647	\$5,152	\$37,653	5	1.3	0
				\$80,000			
	*indirect cost rate(s) = 50.5%	*indirect cost rate(s) = 50.5%	Does not include overhead	Does not include overhead		Personnel dedicated to project	
				This includes contract costs for UIC Science Native Coporation			
				and Wales Native Corporation			
				* \$80k is for the RPM Lite (Remote Power Module) build - equipment			

*indirect cost rate(s)

FTE Calculations

PI Danielson 0.2 mos

Potter 3.9 mos

Statscewich 3.2 mos

Maisch 8.3 mos

Total of 5 HFR sites in

2021, 3 Chukchi

Radars, 2 Bering

Strait Radars

D. 2021 HF Radar expenditures – AOOS

NA16NOS0120027

AOOS Subawards H2400-96 (was H2407) (Bering Strait Radars) and H2400-91 (was H2404) (Chukchi Radars)

Staff Member	(% FTE or #person-months)
Principal Investigator: Seth Danielson	1 person/0.2 month/year
Technicians/Engineers: Rachel Potter, Hank Statscewich, Jordan Maisch	RP 3.9 months/year + HS 3.2 months/year+ JM 8.3 months/year = 15.4 months/year total technician time
Students: Not Applicable	

Total # of Radars Supported: 5
2021 Funding Sources: AOOS/IOOS (100%)
Names, locations (lat,lon), locations (city, state), Transmit Frequency, Operating Institution for each radar: SIMP (Simpson) - 71.0586°N, 154.75056°W - Cape Simpson, AK - 4.55 MHz - University of Alaska Fairbanks (UAF) PBRW (Point Barrow) - 71.3784°N, 156.4801°W - Point Barrow, AK - 4.75 MHz - University of Alaska Fairbanks (UAF) WAIN (Wainwright)- 70.6434°N, 160.0271°W - Wainwright, AK - 4.80 MHz - University of Alaska Fairbanks (UAF) SHSH (Shishmaref)- 66.2543°N, 166.0785°W - Shishmaref, AK - 4.80 MHz - University of Alaska Fairbanks (UAF) WALE (Wales) - 65.6110°N, 168.0943°W - Wales, AK - 4.55 MHz - University of Alaska Fairbanks (UAF) <i>NOTE: WALE (Wales) site was to be relocated in 2021, but was not possible due to COVID-19 travel restrictions. New planned site location will be - 65.7663°N, 167.7695W</i>