

**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, 2020 – November 30, 2020  
Prepared by Sheyna Wisdom, Project PI on January 13, 2021**

**1.0. PROGRESS AND ACCOMPLISHMENTS**

**1.1. Regional Governance & Management Subsystem**

*1.1.1. Support ongoing board and committee activities.*

- The AOOS Executive Committee met August 10, 2020 to approve the final Year 5 AOOS/IOOS budget. The full Board met September 2 to review the proposed AOOS FY21-25 conceptual proposal and to develop a new Inclusion Working Group, charged with reviewing board membership, engagement policies and procedures, and subaward and contracting provisions and developing recommended changes.
- The Executive Committee met again October 26 to review and approve the recommendation of the AOOS Executive Director Search Committee to hire Sheyna Wisdom as the replacement for current director Molly McCammon, effective January 1, 2021. That decision was ratified by email of the full board on October 29.
- At its September 2 meeting the Board approved extension of the Axiom data management contract through September 2021.
- The new Inclusion Working Group met during this period to review AOOS board membership. The group will continue its work into January 2021 and will develop a set of recommendations for board consideration in the spring.
- A Board working group met to review potential changes in AOOS governance and grant management.
- AOOS benefitted from a 3-month detail of Nicole Kinsman from the Office of Geodetic Survey, as part of NOAA's Leadership Competency Development Program. Nic contributed enormously to AOOS during our strategic planning and preparation for proposal development.

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

- Due to the COVID-19 pandemic, the Anchorage office continued to be shut down, with staff working from home. There were significant delays in a number of our observing projects, given that most travel and field work was cancelled for the year.
- A Request for Project Ideas to be included in the next AOOS 5-year proposal to the IOOS office resulted in the submission of more than 80 project ideas and proposals. These were reviewed by a technical committee in late June and many were included in the final proposal (submitted in December 2020). Developing that proposal consumed a majority of staff time in this reporting period and is the basis for a new 5-year Strategic Planning Document.
- Executive Director Molly McCammon conducted annual evaluations for Darcy Dugan and Carol Janzen.
- A final descope of the Year 5 funding award was submitted to and approved by the IOOS Program Office in September. Subawards and contracts for Year 5 of our NOAA Cooperative Agreement were developed.
- AOOS continues to seek additional external funding, and in this reporting period, three proposals are pending and one proposal was funded for a glider demonstration project in conjunction with the International Year of the Salmon.

*1.1.3. Support national and international partnerships and collaborations.*

- Multiple staff represented AOOS at NOAA's OA-HABS Workshop and IOOS-OAR Pacific

Workshop, both in August, as well as an external review of NOAA's Ocean Acidification Program in September.

- McCammon co-chaired the planning committee and participated in the September 16-18 workshop on Sustaining Ocean Observations, supported by the National Academy of Sciences Ocean Studies Board. A final report for that workshop was expected in December.
- McCammon sits on the IOOS Federal Advisory Committee, which met virtually in August, as well as held several administrative calls. She sits on the Vision and Strategy Working Group which is looking at potential IOOS Grand Challenges that could be incorporated into UN Decade of Ocean Science planning efforts.
- McCammon met virtually for the annual fall IOOS meeting in October. She also participated in the IOOS Association's strategic planning sessions, as well as IOOS Association Public Policy calls.
- McCammon represents AOOS in the Consortium for Ocean Leadership and participates in their member calls, as well as their Public Policy Committee calls.
- McCammon facilitated a breakout group at the annual meeting of the Arctic Research Consortium of the US in October.
- McCammon is co-lead of the IARPC Environmental Intelligence Collaboration Team and participated in 3 days of planning sessions for IARPC July 14-16. 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 which met virtually July 15-16 and November 17-18 and produced a report on "Managing under deep uncertainty."
- McCammon continued to represent SAON on the planning committee for an Arctic Action Plan as part of the upcoming UN Decade of Ocean Science (2021-2030). She is co-chairing Working Group 6 on data management.

#### *1.1.4. Support Alaska and regional partnerships and collaborations.*

- The three IOOS regions that use Axiom to support their data management efforts have begun to meet on a regular basis to discuss new opportunities for collaboration.
- McCammon sits on the Alaska Center for Climate Assessment and Policy's Advisory Committee and participated in numerous strategic planning sessions.
- McCammon participated in monthly meetings of NOAA's Alaska Regional Collaboration Team.
- See section 1.2.3 for activities relating to the Alaska Ocean Acidification Network, the Alaska Harmful Algal Bloom Network, and the Alaska Water Level Watch. See section 1.2.6 for Alaska Marine Science Symposium 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 AOOS website and Facebook page, including news, featured stories, and descriptions of new data tools.
- Staff produced monthly updates and monthly (as needed) proposal updates for board members.
- Staff circulated e-newsletters in June and November to a list of over 2,000.
- Kent continued her work on a refresh of the AOOS website, with a targeted February 1, 2021 launch date.

#### *1.2.2. Support ongoing stakeholder interactions.*

- AOOS continues to use the Alaska OA Network, the AK HAB Network, the AK Water Level Watch and other forums to engage with stakeholders. See section 1.2.3 for specific actions.
- Staff continued their engagement activities in preparation for the next AOOS 5-year proposal to NOAA.

#### *1.2.3. Support stakeholder working groups including ocean acidification network, integrated water level*

*observation network, harmful algal bloom network.*

Alaska Ocean Acidification Network

- Dugan facilitated the first meeting on addressing OA on the local government level with participants from six communities across Alaska.
- Dugan facilitated two meetings of the Alaska OA Network steering committee to keep track of progress and identify new activities and objectives for the network.
- Dugan continued working through the OA Network work plan, including advancing a carbon policy podcast series, a framework for a new State of the Science website, highlighting “good news” stories on carbon reduction in Alaska, and strengthening engagement with the fishing and shellfish communities.
- Dugan continued writing and producing 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 and McCammon participated in an external review of NOAA’s Ocean Acidification Program, focusing on science and outreach components.
- Dugan organized and facilitated two “CAN calls”, virtual meetings to communicate and coordinate between the six coastal acidification networks in the US.
- The network continued to give presentations and circulate outreach material, including a panel presentation to the United Fishermen of Alaska, a webinar during the ACCAP webinar series, a lightning talk and discussion during the SACNAS conference, and presentations to other audiences.

Alaska Harmful Algal Bloom Network

- The network has continued to host monthly calls to share updates on HABS monitoring efforts and conditions around the state and maintain the AHAB website.
- The network coordinated the submission of the first-ever HABS section in the North Pacific Fishery Management Council’s Ecosystem Status Report with content contributed by partners across the state.
- With IOOS pilot HAB Observing Network funding, AOOS was able to advertise for and hire a full-time coordinator the Alaska HAB Network. Dr. Thomas Farrugia started in November and has been conducting listening sessions with HAB partners in preparation for updating the draft Alaska HAB Action Plan.

Alaska Water Level Watch

- McCammon and Janzen continue to work with partners to implement pilot projects for alternative water level observation technologies, including purchase of a “Hydroball” for a summer 2020 pilot project, as well as continued support for iGages and GNSS stations.
- McCammon organized a demonstration of the new tiered water level data portal to other IOOS regions in November 2020.
- See section 1.3.2.5 for additional information about the new water level data portal.

*1.2.4. Support partnerships with marine education and outreach programs.*

- Staff continue to support the Shorezone project as a partner.
- Kent maintained a web page with resources for educators on AOOS.org.
- Staff provided support to Alaska Sea Grant’s marine education programs.

*1.2.5. Support Alaska Marine Policy Forum.*

- AOOS partnered with Alaska Sea Grant to host sessions of the Alaska Marine Policy Forum (AMPF) in July, September, and November 2020.

*1.2.6. Continue to co-sponsor the Alaska Marine Science Symposium.*

- AOOS staff serve on the organizing committee and help coordinate workshops and keynote addresses for symposium week. The 2021 symposium will be held virtually.

*1.2.7. Participate in IOOS Outreach Committee.*

- Kent attended monthly meetings of the committee and responded to various requests for materials

from the IOOS office for inclusion into IOOS publications and website.

1.2.8. *Engagement Metrics*

<b>Audience Name</b>	<b>Type of Presentation</b>	<b># of people</b>
<b>JUNE</b>		
SAON Board	Presentation on Arctic UN Decade planning	12
<b>JULY</b>		
ACCAP webinar	Presentation on Bering Sea data sharing project & Bering Sea change	100+
Kotzebue (KOTZ) and Nome (KNOM)	Radio call-in shows on Bering Sea data sharing project & Bering Sea change	
<b>AUGUST – MID SEPTEMBER</b>		
Alaska Marine Policy Forum	public conference call	51
IARPC Arctic Data Collaboration Sub-Team	Bering Region Ocean Data Sharing Initiative	20
<b>MID SEPTEMBER - OCTOBER</b>		
PICES Monitor Technical meeting	Oral presentations - Virtual	30+
OA Municipal engagement	OA presentation + dialogue	12
SACNAS conference	OA presentation lightning talk	6
Aleutian Islands Waterways Safety Committee	Short public comment/ presentation	25
IOOS DMAC annual meeting	Presentations + hosting breakouts	140
<b>NOVEMBER</b>		
IOOS RA Directors and PO	AWLW data portal demo	30
United Fishermen of Alaska	Ocean acidification presentations and panel Q&A	35
University of Illinois environmental economics course	Ocean Acidification	150
GulfWatch Alaska and Herring Program researchers	Data management	38

**1.3. Observing Subsystem**

1.3.1. *Marine Operations*

1.3.1.1. Sustain weather observations in the GOA.

- **Subaward to Prince William Sound Science Center to service 8 SnoTel stations in Prince William Sound 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: September 2020.  
Status: Complete.

1.3.1.2. Increase access to weather observations using AIS.

- **Subaward to the Marine Exchange of Alaska to increase access to Weather Observations using AIS.**
  - Install new weather sensors and peripheral equipment at Nelson Lagoon; Original completion date: August 2020.  
Status: Completed September 2020.
  - Install new weather sensors at Midway Island; Original completion date: September 2020.  
Status: Delayed – Due to COVID-19 installation has been delayed until spring 2021.

- Install new weather sensors at Cape Spencer; Original completion date: May 2021.  
Status: On Track
  - Recapitalize six existing weather sensors; Original completion date: May 2021.  
Status: Completed.
- 1.3.1.3. Sustain critical wave buoys for navigation safety.
- **Operate and maintain Cook Inlet buoy; Original completion date: May 2021.**  
Status: Complete.
- 1.3.1.4. Map surface currents with high frequency radars (HFRs).
- **Subaward to University of Alaska Fairbanks to support operation and maintenance of three HFR sites on the Chukchi and Beaufort Seas.**
    - Reinstate Wainwright and Point Barrow HFR field sites to collect hourly surface current data in real-time; Original completion date: June 2020.  
Status: Complete.
    - Reinstate Cape Simpson HFR field site to collect hourly surface current data in real-time; Original Completion Date: July 2020.  
Status: On Track.
    - Monitor HFR and power systems and perform maintenance, as necessary, until freeze up; Original Completion Date: July – November 2020.  
Status: Complete.
- 1.3.1.5. Install three new high frequency radar field sites in the Bering Strait.
- **Subaward to University of Alaska Fairbanks to install three new HFR field sites in the Bering Strait Region.**
    - Identify/hire field help in Wales, Alaska, to help get the field site located there up and running for the season; Original completion date: July 2020.  
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 – We have been working with the Bering Strait School District School Maintenance Department to get a new power source for the radar equipment. Efforts continue.
    - Operate and maintain HFR sites in Wales and Shishmaref, Alaska; Original completion date: September 2020 – May 2021.  
Status: Delayed – We have issues with internet availability in Wales and electrical power in Shishmaref. Solutions for both of these are on hold due to COVID-19 travel restrictions.
    - Fabricate Remote Power Module Lite; Original Completion Date: May 2020.  
Status: Delayed – The fabrication of the new RPM Lite was delayed due to COVID-19, but a final design has now been drawn up by APRS World, LLC, with fabrication beginning very soon. We are hopeful to be able to test the system in summer/fall 2021.
- 1.3.1.6. Upgrade two out-of-date High-Frequency (HF) Radar systems that are no longer operable, so that they can be utilized for future projects, thereby increasing coverage along the Alaskan coastline.
- **Subaward to University of Alaska Fairbanks to upgrade two out-of-date High-Frequency (HF) Radar systems.**
    - Send HF Radar systems to CODAR Ocean Sensors to begin bench tests and fabrication of the necessary components for the equipment upgrades; Original completion date: September 2020.  
Status: Complete.
    - Receive modernized equipment, antennas, and cables from CODAR Ocean Sensors; Original completion date: March 2021.  
Status: On track.

### 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 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 on an opportunistic basis. Status: Delayed due to COVID-19 travel restrictions.
  - Create color-indexed maps for flood communication at communities where tide datums, community infrastructure, and elevation information are available. Status: On Track.
  - Develop state database for coastal storm flood documentation. Status: Parts Delayed; but other components are On track.
  - Inform the National Weather Service (NWS) of potential flood impacts in advance of storm events. Status: On track.
  - Maintain Alaska Water Level Watch Webpage. Status: On track.
  - Train NWS and SEOC to use coastal flood mapping products. Status: On track.
  - Attend conferences and meetings for discussions on water level sensors and deployments. Status: Complete
  - Monitoring coastal hazard conditions with near real-time camera systems. Status: Delayed to 2021 due to COVID-19.

- **Contracts to JOA Surveys and ASTRA to install water level instrumentation at Utqiagvik, Alaska.**

Status: Delayed. Contracts in place, travel restrictions from covid-19 have delayed installation.

- **Contract to ASTRA to operationalize codes that process GNSS observations to extract water level measurements.**

Status: Delayed. Contract in place, expected completion summer of 2021.

#### 1.3.2.2. Increase wave observations for forecasting and planning

- **Deploy & support CDIP buoy in Nome;** Original completion date: May 2021.  
Status: On track.
- **Support operations and maintenance for the NREL owned Kodiak CDIP buoy;** Original Completion Date: May 2021.  
Status: On track.

#### 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.  
Status: On Track. The 10-year strategy was released in June 2020, and development of the Implementation Plan is nearly complete. The strategist position is expected to end in spring 2021.
- The AMEC Coastal Mapping Subcommittee met monthly to produce an implementation plan for the strategy for review at the Alaska Coastal Mapping Summit in December 2020. 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 University of Alaska Fairbanks.**
  - Field maintenance was performed at Bremner, Coldfoot, Divide, Dot Lake, Paxson, and Pinnacle from June through September 2020. Original Completion Date: May 2021.  
Status: On track.

#### 1.3.2.5. Develop the Alaska Water Level Watch Data Portal

- **Subaward to Axiom Data Science to Develop a prototype data management system and associated interface to house the various water level data at AOOS.**
  - Support the continued development of a publicly accessible “Alaska Water Level Watch” project website; Original completion date: November 2020.

Status: Complete.

- Ingest planned Tier B and C water level station data; Original completion date: May 2021.

Status: On track.

### *1.3.3. Ecosystems, Fisheries & Climate Trends*

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

- **Subaward to University of Alaska Fairbanks to support sampling along the Seward Line.**  
Original Completion Date: September 2020.  
Status: Complete.

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

- **Subaward to University of Alaska Fairbanks 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 continue support for Chukchi Ecosystem Observatory (CEO).**
  - Moorings recovery and re-deployment; Original Completion Date: September 2020.  
Status: Complete.
  - Purchase equipment; Original Completion Date: October 2020.  
Status: On track.
  - Continue updates of project website; Original Completion Date: March 2021.  
Status: On track.
  - Monitor incoming data (ongoing); Original Completion Date: May 2021.  
Status: On track.
  - Preparations for 2021 mooring turnarounds; Original Completion Date: May 2021.  
Status: On track.
- **Subaward to University of Alaska Fairbanks to add additional sensors to the CEO and GEO moorings with Fill the Gaps funds in support of Arctic Marine Biodiversity Observing Network and other programs.**
  - Place orders for new equipment; Original completion date: September 2020.  
Status: On track.
  - Add sensors to CEO and GEO moorings; Original completion date: March 2021.  
Status: On track.
  - Deploy CEO and GEO moorings with new sensors; Original completion date: Summer 2021.  
Status: On track.
- **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: On track.
  - Turnaround equipment at mooring location; Original completion date: September 2021.  
Status: On track.
- **Subaward to University of Texas at Austin with Fill the Gaps funds to purchase sensors to add to three moorings in the Beaufort Sea coastal area;** Original completion date May 2021.  
Status: On track.

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

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

- Update marine mammal call library, prepare DMON; Original Completion Date: April 2020.  
Status: Complete.
  - Deploy glider in southern Chukchi Sea using ship of opportunity; Original Completion Date: July 2020.  
Status: Complete.
  - At sea data collection. Maintain website with real time acoustic detections and oceanographic data; Original Completion Date: October 2020.  
Status: Complete.
  - Glider recovered, acoustic and oceanographic data downloaded; Original Completion Date: October 2020.  
Status: Complete.
  - Purchase two ST500 hydrophone packages and deploy on Chukchi Ecosystem Observatory array; Original Completion Date: August 2020.  
Status: Complete.
- 1.3.3.4. Pilot the use of gliders to assist in an ecosystem approach to fisheries management
- **Subaward to University of Alaska Fairbanks to purchase equipment and begin glider surveys in the Bering Sea.**
    - Send 3 gliders to Teledyne Webb for hardware upgrades; Original Completion Date: March 2020.  
Status: Delayed but on-track for completion spring 2021.
    - Glider pilot training; Original Completion Date: May 2021.  
Status: Delayed due to COVID-19.
    - Two Alaska region glider deployments; Original Completion Date: December 2020.  
Status: Delayed due to COVID-19.
    - Development of EAFM Indices; Original Completion Date: May 2021.  
Status: On Track.
- 1.3.3.5 Demonstrate operational readiness of AUV-based ecosystem monitoring through a field program supporting the International Year of the Salmon.
- **Subawards to University of Alaska Fairbanks, Axiom Data Science, and University of Washington 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: On track.
    - Odroid and glider software upgrades; Original completion date: December 2020.  
Status: Delayed.
    - Project website and *Ecometrics Dashboard* app version 1 developed; Original completion date: December 2020.  
Status: On track.
    - Tank test and field test in Resurrection Bay; Original completion date: January 2021.  
Status: On track.
    - Glider deployment; Original completion date: May 2021.  
Status: Delayed. The IYS field program has been delayed to winter 2021/2022 due to COVID-19.
    - Post-deployment assessments of software and glider ops; Original completion date: May 2021.  
Status: Delayed due to field season delay.
- 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 University of Alaska Fairbanks to co-locate chemical monitoring and forecasts**

**with current fishery and ecosystem monitoring;** Original completion date: May 2021.  
Status: Sample collection was to begin in the Fall of 2020 and due to COVID-19 the original cruise was cancelled. Project PI is currently investigating opportunities aboard cruises in 2021.

#### 1.3.3.7. Regional Sentinel Observations

- **Subaward to Prince William Sound Science Center to support partnership to operate and maintain acoustic arrays across major PWS entrances and maintain conductivity sensor.**
  - Swap conductivity sensor at Cordova tide station; Original Completion Date: June 2020  
Status: Delayed. Shipping delays.
  - Order new conductivity sensor; Original Completion Date: September 2020  
Status: Complete.
  - Clean conductivity sensor at Cordova tide station; Original Completion Date: September 2020.  
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 transect; Original Completion Date: November 2020.  
Status: Complete.
  - Conduct three seasonal CTD surveys at outer Kachemak Bay transect (spring, summer, fall); with one scheduled in the December-May reporting period. Original Completion Date: November 2020.  
Status: Complete.
  - Deliver quality assured/quality controlled oceanographic data to AOOS data contractor Axiom within 6 months; Original Completion Date: November 2020.  
Status: Complete.
  - Present oceanographic and nutrient monitoring results at one or more science conferences annually (Alaska Marine Science Symposium or other); Original Completion Date: November 2020.  
Status: Complete.
  - Deliver oceanographic data and metadata to other NOS offices, BOEM and other agencies and stakeholders; Original completion date: November 2020.  
Status: Complete.

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

- Regional Ocean Data Sharing Coordinator hired in April 2020 to manage project.
  - Coordinated and worked with Axiom Data Science to complete the work under that subaward, including reviewing data sources for the project, developing a prototype for the dashboard, and gathering information on user needs and stakeholder feedback.  
Projected completion date May 2021.  
Status: On track.
- **Subaward to Axiom Data Science to enhance the utility of the Alaska Fisheries Science Center's Ecosystem Status reports and Integrated Ecosystem Assessment Indicators IEAs.**
  - 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.  
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: On track.
  - 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.  
Status: On track.
  - Work with developers of the West Coast Ocean Health Index product and the AHAB and Alaska OA Networks to determine the possibility for Alaska harmful algal bloom, ocean acidification, ocean warming, and hypoxia indicators (or contextual information); Original completion date May 2021.  
Status: On track.
  - 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: On Track.
- 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, University of Washington to integrate COASST Beached Bird Monitoring Data into AOOS Using Darwin Core Standards.**
    - COASST contacts all relevant authorities and partners to solicit their consent to have raw data viewable and downloadable, or only at a higher resolution and not downloadable; Original completion date: June 2020.  
Status: Complete.
    - Provide AOOS/AXIOM with status of these agreements, with signed documentation if required; Original completion date: July 2020.  
Status: Complete.
    - COASST will generate and upload flatfile(s) for all data collected up to October 2019 to the AOOS Research Workspace according to Axiom specifications; Original completion date: August 2020.  
Status: Complete.
    - COASST will work with Axiom to transform COASST data and metadata into DwC format; Original completion date: December 2020.  
Status: Delayed.
    - COASST provides input to the data catalog page as needed including landing page content; Original completion date: February 2021.  
Status: On track.
    - COASST reviews staging visualizations with Axiom. COASST staff will work with Axiom on any needed troubleshooting, additional metadata creation and/or visualization of these data; Original completion date: March 2021.  
Status: On track.
    - Approval from COASST to publish finalized data prior to making the data available to the public via the AOOS data catalog; Original completion date: March 2021.  
Status: On track.
    - Data made public on the AOOS Data Portal; Original completion date: April 2021.  
Status: On track.
  - **Contract to Axiom Data Science 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.**

- Identify and prioritize a list of seabird datasets and information resources; Original completion date: May 2020  
Status: Complete.
- Ingest, standardize, and process data layers for display in the seabird data portal; Original completion date: May 2020.  
Status: Delayed. This task will be completed in December 2020.
- Enhance the web map tool to ease discovery, access, and visualization of seabird colony data; Original completion date: May 2020.  
Status: Delayed. Waiting for delivery of draft data.
- Provide training to USFWS staff regarding use of the fully operational version of the web map; Original completion date: May 2020.  
Status: Delayed. Will be completed Spring 2021.

*1.3.4. Water Quality*

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

- **Subaward to University of Alaska Fairbanks to continue a ten-year time-series in the Gulf of Alaska along the Seward Line as well as support the deployment of OA moorings adjacent to the oceanographic sampling line.** Original Completion Date: September 2020.  
Status: Complete.
- **Subaward to Alutiiq Pride Shellfish Hatchery to maintain continuous ocean acidification monitoring using a permanently installed Burke-o-Lator, including community sampling;** Original Completion Date: November 2020.  
Status: Complete.
- **Subaward to University of Alaska Fairbanks to conduct a regional Ocean Acidification Monitoring Cruise in the Gulf of Alaska.**
  - Support OA Calibration Sampling along NGA-LTER; Original Completion Date: December 2021.  
Status: On track.
  - Support equipment maintenance and turnaround for OA surface mooring at GAKOA; Original completion date: May 2021.  
Status: On track.
  - Support recovery and service of surface mooring platform at M2 and M8: Original completion date: Spring 2020.  
Status: Delayed due to COVID-19 planned for Spring 2021.
  - Participate in a national meeting or workshop to present any new findings; Original completion date: January 2021.  
Status: On track.
  - Delivery of updated database to AOOS for inclusion in AOOS data portal; Original completion date: May 2021.  
Status: On track.
- **Subaward to Rutgers University to assess pH and Plankton in the Gulf of Alaska;** Original Completion Date: May 2021.  
Status: On Track.
- **Subaward to Hakai Institute to operate and maintain the ocean acidification instrumentation onboard the Alaska Marine Highway ferry Columbia;** Original Completion Date: May 2019.  
Status: Delayed. Ferry operations have been stalled due to budgetary constraints and now covid-19; project will continue in summer 2021.

- **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: Delayed due to COVID-19 related disruption in supply chains.
  - Build and distribute discrete sample kits for SEATOR Partners; Original completion date: October 2020.  
Status: Delayed due to COVID-19 related disruption in supply chains.
  - Run discrete sample analysis on SEATOR partner samples; Original completion date: May 2021.  
Status: On track.
  - As needed contractual service with Schmolck Mechanical; Original completion date: May 2021.  
Status: On track.
  - 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.  
Status: On track.

1.3.4.2. Support Alaska OA Network

- AOOS received funding from the national OA Program to support the Alaska OA Network.  
Original Completion Date: May 2021.  
Status: On track.

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.  
Status: Delayed due to covid-19; one workshop was conducted in Nome in summer 2019 and additional outreach activities continue to be planned for this area.
- **Subaward to Axiom Data Science 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.  
Status: Complete.
  - Provide technical support for data formatting and metadata creation to ensure data products meet AOOS Certification standards; Original completion date: May 2021.  
Status: On track.
  - Maintain and enhance the AHAB data portal for visualization and public access to HAB data and data products; Original completion date: May2021.  
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.  
Status: On track.
  - Submit final datasets, data products, and metadata to the NOAA NCEI repository for long-term preservation; Original completion date: May 2021.  
Status: On track.

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

- **Subaward to the University of Alaska Fairbanks to execute a comprehensive carbonate chemistry assessment of US Distributed Biological Observatory (DBO) activities.**
  - Cruise planning, equipment mobilization; Original Completion Date: May 2021.  
Status: On track.
  - Conduct research cruise for the DBO; Original completion date: September 2021.  
Status: On track.
  - Cruise demobilization; Original completion date: December 2021.  
Status: On track.
  - Sample analysis at the Ocean Acidification Research Center (OARC) at the University of Alaska Fairbanks (UAF).; Original Completion Date: May 2022.  
Status: On track.
- **Subaward to the University of Alaska Fairbanks to support the ocean acidification monitoring network in Alaska Coastal Seas.**
  - Recover and service surface mooring platform at M2 in southeastern Bering Sea. Turnaround (recover/ service and deploy) subsurface moored sensors at M2 and M8; Original Completion Date: October 2020.  
Status: Delayed due to COVID-19; now scheduled for March 2021.
  - Equipment demobilization from fall Bering Sea mooring cruise. Data processing, QA/QC, archival.; Original Completion Date: December 2020.  
Status: Delayed due to COVID-19.
  - Equipment mobilization for the spring mooring turnarounds; Original Completion Date: January 2021.  
Status: On track.
  - GAKOA mooring turnaround in Resurrection Bay, Seward, AK; Original completion date: March 2021.  
Status: On track.
  - Deploy surface platform at M2 in Bering Sea. Turnaround subsurface sensors at M2; Original completion date: May 2021.  
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).

Status: Delayed. The remaining funds are to be used for an additional AIS/weather station on St. Lawrence Island to support the needs of the National Weather Service and subsistence hunters. New stations were installed in the communities of Gambell and Savoonga, but another location on the island was determined to be unfeasible at this time. The Board determined that 4 other locations on the Bering/Chukchi coast were priorities for additional AIS/weather stations. However, due to COVID-19, all travel to rural Alaska is on hold for this entire field season.

FY20: AOOS received \$75k to help fill gaps and streamline access to ocean observations. Original Completion Date: Fall 2020.

Status: Delayed due to COVID-19 travel restrictions.

### **1.4. Data Management & Communications Subsystem, subaward to Axiom Data Sciences**

#### *1.4.1. Provide Core Data Management 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 a data center expansion, which included four new racks, 10 Gb internet connection, 10 Gb ethernet network, a Ansible 2.9 upgrade, and additional new generation hardware (compute blades and storage cluster). Technical scoping and experimentation were done with new storage technologies (Ceph, using S3 compt APIs more) for system optimization. Further, server

building/bootstrapping processes were improved and Docker image store was compressed using multi-stage builds.

Status: Complete.

#### 1.4.1.2. Data Portal Development.

- Frontend and backend work occurred to develop features for the v2.13 data portal release, scheduled for mid-December. Changes include: custom map drawing and print tools, display of instrument narratives on station pages, improved dataset download, and brush time selection for timeseries charts. Additionally, work was completed to add timezone support to the portal backend, including formatting, timezone switching, and state saving implementations. Effort is underway to develop frontend capability for migrating timezone selector into the unit management system.

Status: Complete.

#### 1.4.1.3. Implement QARTOD QA/QC checks for AOOS real time and delayed-mode data feeds.

- During this performance period, basic QARTOD tests were applied for 537 [historical and real-time](#) sensors that are accessible through the AOOS data portal. Quality flags are summarized on both the [station](#) and [sensor](#) pages within the data portal for visual exploration. In addition, the documentation of the test code and thresholds are displayed on sensor pages ([example](#)) with links available to the v 1.0 version [QARTOD GitHub library](#) accessible through the portal. During this performance period, qc codebase for the [Argo Quality Control Manual for CTD and Trajectory Data](#) tests, including location test, range test, spike test, and speed tests were created and merged into the [ioos\\_qc library](#) for integration into the AOOS data system. The metadata attributes were updated to also include quality flags for those test types.

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, bi-monthly 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. Two quarterly progress review meetings were held with AOOS staff during the reporting period. Axiom also contributed monthly data management highlights to the AOOS newsletters.

Status: Complete.

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

- The 2020 DMAC Virtual Annual Meeting was held Oct 13 - 15. Axiom Data Science participated in the meeting to present on recent projects and lead a handful of breakout sessions. Kyle Wilcox reported on QARTOD Implementation and `ioos\_qc` Improvements, in addition to co-hosting a presentation with the IOOS Program Office on the history and evolution of DMAC services to meet user needs. Jessica Austin presented about ERDDAP Dataset monitoring and alerts using Prometheus and Grafana, which spotlighted both AOOS and CeNCOOS data services. Additionally, Jessica gave a live demonstration of the new NSF Ocean Observatories Initiative (OOI)'s Data Explorer, developed by Axiom, and discussed applying IOOS DMAC techniques to those data services. Axiom also co-hosted two breakout sessions: SanctSound and Soundscapes Data Management (Rob Bochenek) and Data management techniques and metadata standards for audio and video datasets (Kyle Wilcox).

Axiom Data Science also participated in the following regionally and national relevant DMAC meetings:

- Exxon Valdez Oil Spill Trustee Council (EVOSTC) GulfWatch Alaska and Herring Program PI meetings: November 17-18, 2020 and July 22, 2020
- Northern Connections – Bridging Indigenous Knowledge & Observations workshop: November 17-19, 2020
- IOOS DMAC webinar hosted by AOOS and partners, Alaska Water Level Watch-

November 9, 2020

- Mariculture Task Force- July 22, 2020
- Polar to Global Online Interoperability and Data Sharing Workshop/Hackathon- June 30, 2020

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.

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:

- reworked ingestion of ocean acidification sensor data to display post-calibrated and quality-controlled data served by NCEI (see [UAF Ocean Acidification Research Center \(OARC\)](#))
- backfilled 2017 data gaps and applying QARTOD to all historical data for the [Marine Exchange of Alaska sensors](#)
- added station information and contextual narratives for the ASTRA stations([Seward Sealife Center ASTRA GPS Water Level](#) and [Seward Marine Center ASTRA GPS Water Level](#))
- updated the Alaska Storm Surge Forecasting System's [Sea Ice Fraction data layer](#) to load and serve data using a polar projection
- migrated [74 Snotel sensors](#) to the v2 sensor system and backfilled historical data to 1994. Applied QARTOD tests to historical and real-time data streams.
- created a new layer for historical [Alaska Department of Fish and Game: Fish Count Data \(1955-2015\)](#)
- updated NWS Sea Ice shapefile to backfill missing June 2020 data
- updated webcam data access endpoint for [182 FAA stations](#)
- upgraded [Lower Cook Inlet](#) buoy ingest with new sensors deployed in August 2020
- reworked the [Chukchi Sea Ice Detection buoy](#) to correct the display of real-time vs historical (2015 and 2017) moored and trajectory data in the portal.
- 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 9 [Deep-ocean Assessment and Reporting of Tsunamis \(DART\)](#) real-time stations to the AOOS data portal and catalog
- refreshed the data ingestor for the [CORDC HFR Wainwright and Point Barrow](#) 2020 installations
- ingested and visualized the [biophysical data from an AUV glider in the Beaufort Sea](#) from the 2016-13 Sir Wilfrid Laurier Beaufort Marine Hazards cruise by the MARES program
- supported UAF researchers for set-up and standardization of real-time glider data and metadata ingestion to the IOOS DAC and AOOS data portal

- curating, documenting, and submitting ten years of Ocean Acidification data from the biannual oceanographic cruises on the Seward Line: 2008-2017 to the NCEI Ocean Carbon Data System (OCADS) for long-term archive.

Status: Complete.

#### 1.4.3.3. Develop new data products.

- Activities completed under this task included supporting the National Weather Service (NWS) Arctic Modeling Testbed project to ingest nowcasts and forecasts from five ice models (Canadian Met Centre's Regional Ice Ocean Prediction System (RIOPS), Canadian Met Centre's Global Ice Ocean Prediction System (GIOPS), NOAA-ESRL Coupled Arctic Forecast System (CAFS), HYCOM 3.1, and HIOMAS (2K) - run "in house" at Axiom) and make them available to researchers through the Research Workspace. This effort also involves using Jupyter Notebooks to generate identical plots for each set of model results (i.e. results currently exist in different resolutions, projections, and have differing parameters) for comparison to satellite observations produced by the NSIDC Sea Ice Concentration product. The first set of comparisons between nowcasts and forecasts were completed and efforts are ongoing to incorporate feedback and process revisions. Axiom continued to provide support to the Arctic ION program for the development of the observing system's [Sankey diagrams](#) and website product. Additionally, Axiom provided low-grade maintenance to the [Alaska Shellfish and HAB data](#) portal that displays near real-time phytoplankton and shellfish toxicity results.

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 and assisted with project page content for the new website.

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. Support the Implementation of the Animal Telemetry Network's Data Assembly Center; Original Completion Date: May 2021.

Status: On Track

- Develop national data aggregation capability through continuous data integration with tag manufacturers and other data sources, and make data publicly-available in the ATN Data Portal. Scheduled and unscheduled enhancements were made to the ATN data portal, including: data cache services were updated to improve load time performance and aggregations of animal movement hexbin visualizations (i.e. 'ALL' layer); an update to the project tag naming convention was made in the data catalog to account for various animal tag types; a prototype of physical environmental data layer integration with animal tracks was completed; and, back and frontend developed to offer a custom timezone selection tool.
- Develop the capability to deliver real-time ocean profile data from animal-borne sensor tags to weather and ocean forecasting centers via the Global Telecommunications System (GTS). During this performance period a [BUFR encoding package](#) was developed in Python using a subset of ATN profiling animal datasets. The template was submitted to NODC for initial review and approval, and is scheduled for final review and approval by the committee in March 2021.

Ultimately, the BUFR template will be used to insert animal telemetry data into the GTS. Additionally, the qc codebase for the [Argo Quality Control Manual for CTD and Trajectory Data](#) tests, including location test, range test, spike test, and speed tests were created and merged into the [ioos qc library](#) for running QARTOD tests on animal telemetry trajectory and profiling datasets. The metadata attributes were updated to also include quality flags for those test types.

- Develop data synthesis products inform scientific and ecosystem-based management needs, including integration of reproducible state space model functionality into the ATN DAC: The Animal Telemetry Network was a goal of using the [Foie Gras state space model](#) to produce “most-probable” tracks for visual display within the ATN portal. During this performance period the model was run on a sample variety of ATN-provided datasets to test the feasibility for implementation within the ATN data portal. A variety of raw tracks were tested against the model, and the output plots were compared with the original tracks. The outcomes and operational risks were summarized and shared with the ATN program managers for review and discussion, which resulted in a revised version of the Foie Gras model that responds to many of the limitations encountered during testing.
- Develop optimized processing pipelines for data from new, sophisticated multi-sensor tag types for centralized access among the ATN community to facilitate data interpretation and accessibility: Axiom implemented an Octave kernel in the ATN Research Workspace to facilitate end-users running a customized dTAG processing package. During this performance period a template dTAG project was created with domain experts in the Research Workspace using a Jupyter notebook with the Octave kernel selected. A test implemented was run, which highlighted technical improvements that need to be made for the package to be more user-friendly. A latest version of the package is under development by domain experts that should be ready for additional testing in early 2021.
- Host regional data workshops to improve accessibility of tagging datasets to the ATN community, and to provide focused technical assistance to researchers for data submission, access, and re-use of ATN data: Axiom maintained regular communications and weekly meetings with the ATN Data Coordinator to provide technical assistance for onboarding new data contributions to the ATN DAC. Additionally, routine and non-routine activities occurred to ensure continuous showcasing of animal telemetry data. During the performance period 32 new projects encompassing 1,748 deployments were added to the ATN DAC. The ATN DAC now provides access to 131 projects, 4,785 tag deployments from over 72 different species. Additionally, new tag types were ingested into the data portal for interactive discovery and visualization, including GPS tags, pop-up archival tags, and SPLASH tags. A training workshop was held virtually with over 20 participants from the NOAA Northeast Fisheries Science Center to learn about the ATN DAC and how to contribute their data.
- Develop the capability to serve as a national aggregation hub for publicly available U.S. acoustic telemetry datasets: During the performance period, a test pathway for data and metadata exchange from OTN to the ATN DAC was developed. Revisions were made by OTN to the metadata structure to improve the transfer of content. Additionally a database for acoustic data stored was enabled within the ATN DAC and the backend Registration Application was enhanced as an early step in allowing users to register acoustic telemetry tags.
- Provide technical support and maintenance to the ATN DAC cyberinfrastructure: Throughout the performance the system remained healthy and secure; maintained continuous uptime; was protected for the privacy and security of the system, users, and their data; was supported for existing hardware systems, software and OS patches and general upkeep; and operations and debugging were traced to optimize performance.
- Publish and archive ATN data to national archives and data centers, making it available for research, management, and long-term preservation: During this period 6 animal telemetry datasets have been archived with DataONE using the automated pathway from the Research

Workspace DataOne Member Node. An additional 4 datasets were prepared to a near-final curation state and are awaiting final revisions from the PI prior to dataset archive.

- Provide project management support for the ATN DAC: Axiom maintained participation in regular weekly calls with the ATN Data Coordinator and bi-weekly calls with ATN Coordinator and ONR program manager to provide progress summaries and coordinate on Year 3 activities. Project tasks were assigned and tracked using two Trello boards (ATN DAC and ATN Data Coordination).

#### 1.4.5.2. Maintain and Enhance Data Access Service Software - ERDDAP and Environmental Sensor Map and Global Data Integration.

Status: Complete

- 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 virtual DMAC Meeting.
  - 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, and included updates such as:
    - Complete overhaul of documentation and examples for clarity and simplicity;
    - Improvements to attribution fields, for more consistent attribution in IOOS national products;
    - New section on how to describe results of QARTOD testing;
    - Overhaul of *platform* section, including CF Discrete Sampling Geometry recommendations for different deployment scenarios, with examples;
    - Guidance on dataset requirements to enable GTS to ingest by IOOS/NOAA.

As part of this effort, new CF standard names for describing QC/QARTOD tests were established for including in the metadata profile. 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, Axiom and [IOOS worked with the Climate and Forecast \(CF\) Conventions group](#) to add QC standard names to the CF Standard Name table. These names are generic enough to apply to any QC process, not just QARTOD. By using the *ancillary variables* attribute on the data variable, and the QC standard name on the QC variable, users of the dataset can clearly understand which tests were run for each parameter. For more information, see the [Metadata profile documentation QARTOD section](#) and [the CF Standard Name Table v72](#). Last, this task also included working with IOOS and NDBC to allow RAs to publish data

from their regions to the GTS via ERDDAP. So far, two new stations from PacIOOS are being pulled by NDBC, and datasets from many other RAs are in review. For more information, see the [Requirements for GTS Section in the IOOS Metadata Profile](#).

- Improved User Documentation (15%): As listed 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](https://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.
- Environmental Sensor Map and Global Data Integration
  - 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 Environmental Sensor Map 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 2.13 of the Sensor Map 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 timeseries charts

During this performance period a v1.0 of open-source QARTOD/QC Python library was released. Documentation was updated for the [IOOS QC Releases and Migration Guide](#) and the [v1.0 release notes](#). The IOOS QARTOD and other Quality Control tests implemented in Python are publicly accessible at [https://ioos.github.io/ioos\\_qc/](https://ioos.github.io/ioos_qc/). Updates to the v1.0 completed include:

- Complete review of all tests
  - QARTOD test suite: Gross Range Test, Spike Test, Flat-line Test, Rate of Change Test, Attenuated Signal Test, Climatology Test, Location Test
- Improvements to netCDF processing and export, including generation of proper QC metadata
- Completely revamped documentation and notebook examples
- Performance review and improved testing speeds

During the performance period, approximately 936 new real-time sensors were added to the Environmental Sensor Map from observing systems across the IOOS enterprise. 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.

- Metrics for observation data made available during this performance period are: IOOS Environmental Sensor Map Metrics (December 9, 2020):
  - All stations (includes both historic and real-time stations, across the entire globe):
    - 40,384 stations
    - 120 data sources across 263 affiliates
    - 311 unique parameters
  - Real-time stations ("real-time" stations have data from the past week):
    - 27,887 stations with observations in the past week, across 79 data sources
    - Approximately 62,700 sensors with observations in the past week
    - Approximately 41,901,000 sensor observations per week

Historic Metrics for comparison:

January 1, 2020

- 39,448 stations
- 159,758 total sensors (devices)
- 114 data sources across 250 affiliates
- 239 parameters

January 1, 2019

- 36,430 stations
- 155,504 total sensors (devices)
- 91 data sources across 173 affiliates
- 145 parameters

January 1, 2018

- 35,390 stations
- 123,240 total sensors (devices)
- 81 data sources across 167 affiliates
- 143 parameters

January 1, 2017

- 34,360 stations
- 117,590 total sensors (devices)
- 76 data sources across 162 affiliates
- 139 parameters

January 1, 2016

- 32,565 stations
- 110,357 total sensors (devices)
- 68 data sources across 135 affiliates
- 139 parameters

January 1, 2015

- 1,624 stations
- 16,193 total sensors (devices)
- 31 data sources across 51 affiliates
- 104 parameters

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

1.4.5.3. MBON Portal

Status: On track

- 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. Research and development of these solutions consisted of:

- a simple (but potentially slow and excessively large) addition of finer scale grids to the existing hexagonal grid pyramid
  - the use of new and experimental functionality within PostGIS which could generate finer scale hexagonal grids on the fly, and
  - use of spatial aggregation algorithms to directly reduce visual point density at scales beyond the finest hexagonal grid.
- Scoping and build-out of MBON and ATN portal integration; During this performance period, Axiom developed a prototype instance of animal telemetry data integrated with physical environmental data in the ATN data portal. See <https://portal.atn.ioos.us/?ls=mg7KehFZ#map>. In this case, a regional GFS model showing wind speed was mapped together with the IOOS real-time data layer (selected also for wind speed) and animal movement tracks in the central California region. In this prototype, a user is able to:
    - Explore animal movement and environmental data spatially and temporally (using the time slider playback)
    - Browse to adjacent real-time and historical environment data nearby to animal locations
    - Download environmental data or access it through interoperability end points for analysis

The instance is undergoing review and feedback by the ATN Coordinator and ATN Program Manager and is 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 (ie, MBON data portal).

- Load and visualize more data; The MBON data portal was kept current with the latest versions of biodiversity observational data that was shared among program stakeholders. Axiom worked with CariCOOS and Abigail Benson to ingest the [Puerto Rico Long-Term Coral Reef Monitoring Program Database Compilation \(1999-2019\)](#) dataset (accessible from [OBIS/GBIF](#)) into the MBON data system. The ingestion process including multiple meetings with the data provider to address revisions to the OBIS dataset and improve data representation in the MBON data portal, including: data post-processing for various species measurements (i.e. mean counts per area, rugosity, etc.), customization of data summary statistics, changes to parameter naming, and other bug fixes. Axiom worked with data providers in the CeNCOOS regions to refresh the [Zooplankton Species Distribution and Abundance Data, Applied California Current Ecosystem Studies \(ACCESS\)](#) data layer to include an additional year of data (2018) and expanded the taxonomic compilation to include all zooplankton species. Dataset transformation to the Darwin Core standard is underway for additional biological datasets in the CeNCOOS region to be visualized in the MBON data portal, including adding an additional 12 years of data (ie through 2018) to the [Marine Mammal Distribution and Abundance Data, 2004-2005](#), [Seabird Distribution and Abundance Data, 2004-2005](#), and over 10 years of CTD and nutrient timeseries data. Axiom worked with partners in the AOOS region on visualization of a test batch of COASST beached bird data. The data was transformed to Darwin Core and a [prototype data layer](#) was developed, with customization underway relative to partner feedback. Last, a visualization of over 35 years of kelp biomass data along the California coastline was ingested and visualized in the MBON data portal ([SBC LTER: Time series of quarterly kelp biomass in the canopy from Landsat 5, 7 and 8, since 1984](#)). Last, previous versions of four AMBON datasets formatted in the OBIS-ENV format were revised based on feedback from USGS Abigail Benson prior to submitting to OBIS.
- 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/>.

- 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.
- 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 to discuss streamlined biodiversity data standards for OBIS-ENV, and participate in a webinar to demonstrate the [Puerto Rico Long-Term Coral Reef Monitoring Program Database Compilation \(1999-2019\)](#) to regional stakeholders.

#### 1.4.5.4. Finalize HFR Range Series File Archiving through the Research Workspace;

Status: On track.

- 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 will continue to provide storage capacity for transferring and storing up to 60 TB of HFRNet data through a 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.
- 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/>
- 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.
- Project communications; This task is expected to be carried out in Q3-Q4 with input from the IOOS Surface Currents Program Manager.

#### 1.4.5.5. Saildrone: Novel Streamlined Data from Platform to Application through Cloud hosted Data Acceptance and Quality Control;

Status: On track.

- Cloud hosted data acceptance system; 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. 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.
- Payload processing; This task involves modifying ERDDAP to consume data from cloud native storage. The code modification will be performed by PMEL, with technical support from Axiom, in Q1 2021
- Adaptive Quality Control; This task involves integrating quality control software with the cloud platform notification service. 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](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. Backend work has been completed to develop code to push quality controlled data, with QC flag information, into ERDDAP.

- **Data Dissemination;** This task involves configuration testing, operational dissemination with the Open-GTS framework, and acceptance testing, which will be completed in the final project phase (Q2 2021).

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 July 2019 through June, 2020; Original completion date: October 2020.  
Status: Update for July-December 2019 was completed in August 2020. Data release for January-June 2020 from National Snow and Ice Data Center has been delayed until February 2021. Will process immediately upon release of data by NSIDC
  - Update the visualization tool to include 2019 data; Original completion date: May 2019.  
Status: Complete.
  - Monitor usage of database; Original completion date: May 2021.  
Status: On track.
- **Support and maintain Research Assets Map;** Original Completion Date: May 2020.  
Status: On Hold. The future of this product is still being assessed.
- **Coordinate with the Alaska Department of Fish and Game to update Yukon-Kuskokwim Chinook Run Timing Forecast pages on AOOS.org website;** Original Completion Date: May 2021.  
Status: On track.
- **Subaward to Axiom Data Science 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.  
Status: On track.
  - Determine and gather viable forecast model outputs to be used to develop the statistical relationships over a training period for evaluation; Discussion & planning meetings between Axiom data analysis staff and NWS stakeholders to determine viable models, access to said models, and determine their applicability for this project.
  - In collaboration with NWS Alaska, determine the specific forecast points of interest to NWS stakeholders where guidance is needed; Discussion & planning meetings between Axiom data analysis staff and NWS stakeholders to determine forecast points of interest.
  - Develop the statistical relationships over a specified training period to develop the probabilistic sea ice concentration guidance; This task has not been started.
  - 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; This task has not been started.
  - 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; This task has not been started.
  - 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; This task has not been started.

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

Status: On track.

- 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.
- 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.
- 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.
- Model deployment (VIMS, NOAA and Axiom): Implement capability to seamlessly run modeling system on conventional HPC and cloud environment; Explorations of potential architectures for the system including hybrid HPC and AWS systems and AWS-only implementations have taken place between collaborators from Axiom, NOAA, and VIMS. A task list with preliminary work required has been described and is being actively worked on by the modeling team.
- Post processing and dissemination (NOAA, VIMS and Axiom): Implement a cloud based environment for post-processing and dissemination of modeling system products; Early discussions took place indicating that post-processing would likely include a combination of post-processing tools from the SCHISM community and utilization of AWS deployed PANGEO-based visualization and analysis tools accessible through Jupyter Lab.
- 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. The NOAA's atmospheric forcing for recent storms will be available through our collaboration with EMC in COASTAL Act program. This is an important step toward eventual sediment transport and morphological prediction system, which will be a focus on a possible future ONR-NOPP proposal; This task has not been started.

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

- **Subaward to University of Alaska Fairbanks 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: Completed.
  - 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: Delayed due to COVID-19.

- 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: Completed.
  - 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: On track.
  - 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: On track.
- 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: On track.
    - Targeted mesh refinements of the 30m mesh; Original completion date March 2020.  
Status: On track.
    - Implement targeted bathymetric improvements into the 120m mesh; Original completion date April 2021.  
Status: On track.
    - Implement targeted bathymetric improvements into the 30m mesh; Original completion date May 2021.  
Status: On track.
    - Validating 120m mesh with hurricanes; Original completion date June 2021.  
Status: On Track.
    - Validating 30m mesh with hurricanes; Original completion date: July 2021.  
Status: On track.
    - Activating river flows for 120m mesh simulations; Original completion date: August 2021.  
Status: On track.
    - Activating river flows for 30m mesh simulations; Original completion date: September 2021.  
Status: On track.
- 1.5.4. *Support development of a Regional Ocean Data Partnership.*
- Regional Ocean Data Sharing Coordinator hired in April 2020 to manage project.
    - Began conducting stakeholder interviews to determine data product priorities and assess availability of data. Original completion date May 2021.

- Status: On track.
  - Coordinated and worked with subawardees to complete their work, including the Bering Science reports, Bering Sea resource page, and Bering Sea data portal (see below).
  - Assembled a “Community Advisory Panel” (CAP) for the Bering Science reports. The CAP is comprised of Tribal and community members across the Bering Sea region who will advise on content of the reports, provide information on community observations and projects for inclusion in the report, and review the document before publication. Project completion date May 2021.
  - Status: On track.
  - Partner with WWF Arctic and Russia to organize a panel on US-Russia research collaboration in the Bering and Chukchi Seas at the Alaska Marine Science Symposium in January 2021. Russian and American colleagues will share research updates from work in the waters of the Bering and Chukchi Seas, including the Kamchatka region. 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 2021.
  - Status: On track.
- **Subaward to University of Alaska Fairbanks 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.  
Status: Completed two Bering Science reports that were released in June and October 2020.
  - Rick Thoman to conduct outreach at Dillingham Science Conference and various coastal communities; Original completion date May 2020.  
Status: Delayed. The Western Alaska Interdisciplinary Science Conference was postponed due to COVID-19 pandemic and tentatively rescheduled for Spring 2021.
- **Subaward to Axiom Data Science 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.  
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.  
Status: On track.
  - Identify existing “sustained” data streams for Bering Sea/Strait and adjacent areas & provide access through data portal on AOOS Ocean Data Explorer; Original completion date May 2021.  
Status: On track.
  - Develop data and information products; Original completion date May 2021.  
Status: On track.
    - Develop a “Bering Strait Transboundary Incident Response Tool” in partnership with WWF Arctic and Russia. The Tool will provide a catalog of data layers and information from both US and Russian waters of the Bering Strait. This information is valuable not only for a potential response to an emergency event such as an oil spill and would also be useful to a broader group of interested parties on both sides of the EEZ, including coastal communities, resource managers and academic researchers. Projected completion date May 2021.  
Status: On track.

- Develop an “Ocean Dashboard” to provide information on the status of the coasts and oceans of the Bering Sea in a easily accessible and public friendly “dashboard”. Projected completion date May 2021.  
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 and writing the next 5-year proposal to IOOS.

**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**

- McCammon will transfer to a senior advisor position on January 1, 2021, at which time Sheyna Wisdom will become the new Executive Director.
- AOOS hired Dr. Thomas Farrugia as coordinator of the Alaska Harmful Algal Bloom Network with funding from the pilot IOOS HABON project.

**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:

Quantity	Description	Cost
2	ST500 Sound Traps	\$11,000
1	SBE-43 Seabird Dissolved Oxygen Sensor	\$5,693